Biology and Conservation of

Sea Turtles

Revised Edition

Edited by Karen A. Bjorndal

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Front cover: Adult female green turtle, *Chelonia mydas,* at French Frigate Shoals, the major migratory breeding site for this species in the Hawaiian Islands. Photo by G. H. Balazs.

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Subsistence Hunting of Sea Turtles in Australia

ABSTRACT

Information sources included the results of a questionnaire survey, the biological and anthropological literature, and personal observations made in Torres Strait. The main findings were:

1. Hunting of turtles in Australia occurred north of 21°S on the east and west coasts by Aboriginal and Torres Strait Islander people for subsistence purposes.

2. The green turtle (*Chelonia mydas*) was the most preferred and most commonly taken species.

3. There were some regional differences in the sex and size composition of the catches, and in the seasonality of turtle hunting.

4. There was also regional variation in the apparent importance of turtles to the hunters, both from nutritional and cultural aspects.

5. The number of turtles caught seemed to depend on the extent of the desire of people to be involved in this activity.

6. An estimate of the total annual catch by Aboriginal and Torres Strait Islander people in Australian waters came to between 7,500 and 10,500 turtles.

7. Relative to turtle hunting, turtle egg collecting has insignificant impact on wild turtle stocks.

8. The hunting pressure on turtles before the time of white settlement was probably as great, if not greater, than at present.

9. Future levels of hunting pressure will depend more on changing socio-economic goals of Aboriginal people than on present trends of population increases.

Introduction

Australia's coastline north of the Tropic of Capricorn stretches for over 7,500 km through 3 major political

subdivisions: Queensland, Northern Territory, and Western Australia (Figure 1). Australian territorial waters include a zone of 3 international nautical miles from low water mark; in addition there is an Australian Fishing Zone of 200 international nautical miles from low water mark, defined by the Fisheries Amendment Act 1978. Several changes are pending with respect to delineation of sea borders (Appendix A).

The extant indigenous population of Australia can broadly be divided into 2 groups, the Aborigines and the Torres Strait Islanders, the latter people being defined in anthropological literature as having lived within the area bounded by latitudes 9°20' and 10°45'S and longitudes 142° and 144°E (Beckett 1972). In 1971 there were approximately equal numbers of Aboriginals in Queensland, the Northern Territory, and Western Australia; however, about 95 percent of the total number of Torres Strait Islanders in these 3 political subdivisions lived in Queensland (1971 census of Population and Housing).

Legislation pertaining to the taking of sea turtles in Australian waters varies between political subdivisions (Appendix B). In summary, in both Queensland and Western Australia, noncommercial taking of turtles is permitted for Aborigines and Torres Strait Islanders, with the additional qualification of living on a reserve applying to those people in Queensland. In the Northern Territory, the taking of green turtles is permitted only within specified areas adjacent to some settlements. At the federal level, the taking of turtles in proclaimed waters (that is, outside the 3-mile territorial limit) is prohibited; there is apparently no provision made at present for noncommercial taking of turtles by Aboriginals or Torres Strait Islanders, but in practice this is permitted.

General accounts of aspects of subsistence hunting of turtles in Australian waters can be found in the biological and anthropological literature (for example, Beckett 1972; Cogger and Lindner 1969; Duncan 1974; Kowarsky 1978; McCarthy 1955; Moore 1972; Nietschmann, in press; Turner 1974); most of this information deals with the Torres Strait region. I have been privileged to have access to an unpublished manuscript on subsistence hunting of turtles in the north of Western Australia (Capelle 1979).

This investigation had 3 main aims: 1) collect and summarize information on subsistence hunting of turtles throughout Australia: 2) to assess the importance of turtles to those people who have traditionally hunted them; and 3) to provide information which, with data on the status of sea turtle populations in Australian and adjacent waters (documented elsewhere in these proceedings), might enable an assessment of the present, and future, impact of turtle hunting on sea turtles in the region.

Methods

A questionnaire (Appendix C) was distributed to persons and communities in coastal northern Australia. At the time of writing, 31 completed questionnaires had been returned. The areas of coastline of which respondents indicated knowledge are shown in Figure 1 (note: some respondents indicated familiarity with more than 1 region). Replies were from the following sources:

Source	*Number of respondents*
Aboriginal and/or islander community resident or administrator	9
Department of Aboriginal Affairs (federal)	3
Department of Aboriginal and Islanders Advancement (Queensland)	4
National Parks and Wildlife Service (Queensland)	4
Western Australian Department of Fisheries and Wildlife	4
Other	7
Total	31

Results

Turtle Hunters

All sources of information indicate that among Australians, turtle hunting is virtually the exclusive domain of Aboriginal and Islander people (with the proximity of the border to Papua New Guinea, residents of that country certainly would hunt turtles in Australian waters, but I have not documented these activities here). I have attempted to estimate the number of people living in reasonable proximity to the tropical coast who could legally, or who would traditionally, use turtles for subsistence (Appendix D).

Figures obtained from the above are certainly overestimates of numbers actually using turtles at present. In the Northern Territory, for example, most turtle hunting would be carried out by the 13 major coastal settlements of Aboriginal people; their numbers would be far lower than the figure estimated for that division. In Western Australia, the total number of persons who might hunt turtles between Pt. Hedland and Wyndham would not exceed 600 (Capelle 1979), yet over 10 times that figure is obtained by summing numbers of Aboriginals and Torres Strait Islanders living in coastal Local Government Areas along the same coastline.

Two factors could be advanced to explain these discrepancies. Firstly, the basic census unit, the Local Government Area, was too large and would have included many people living away from the coast. This would apply particularly to Western Australia and the

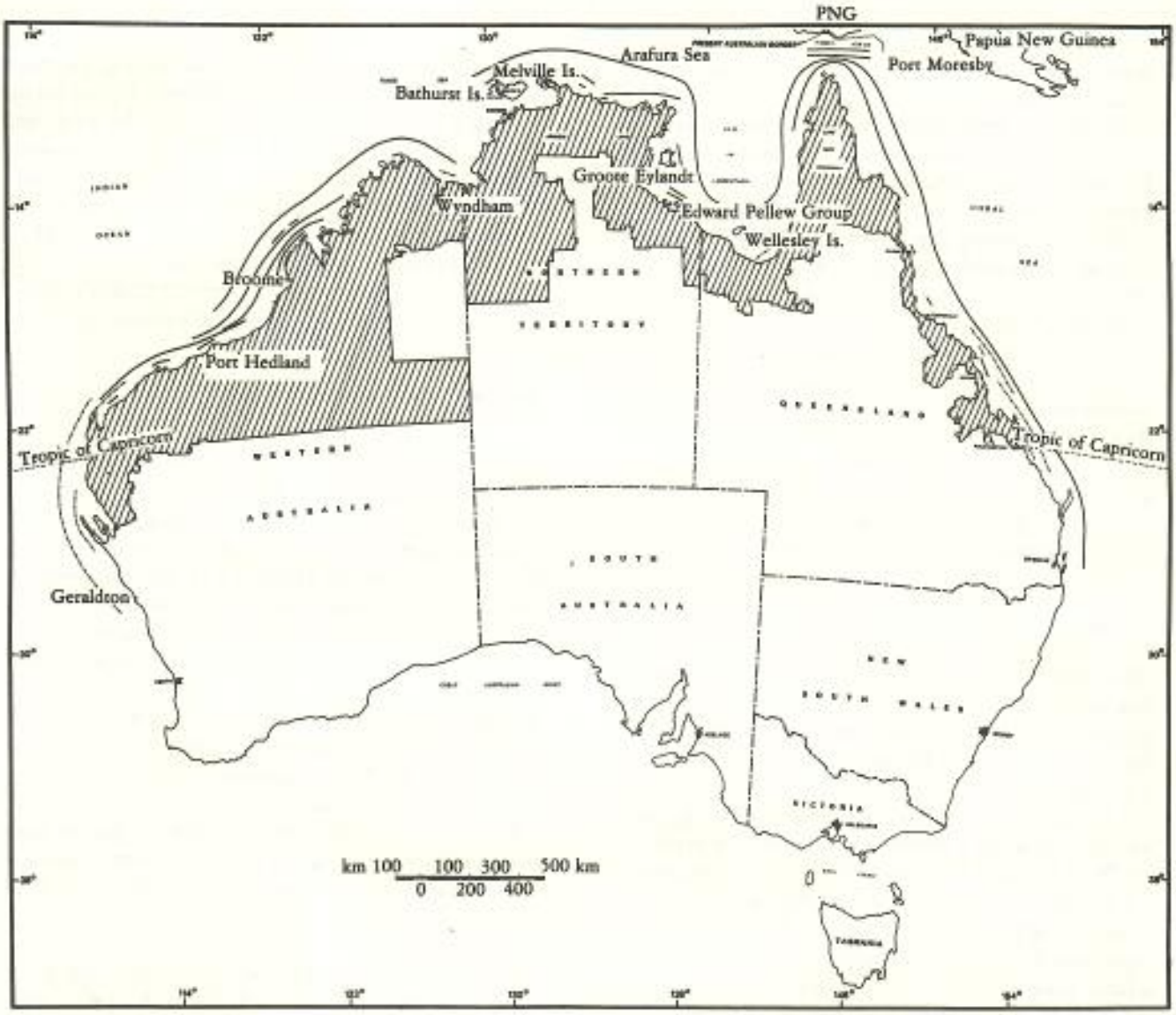

Figure 1. Map of Australia showing: 1) major political subdivisions; 2) regions of coastline about which respondents to the questionnaire indicated knowledge: continuous lines = turtle hunting reported, broken lines = no turtle hunting known; 3) local government areas north of the Tropic of Capricorn with a coastal border = shaded areas.

Northern Territory. Secondly, as will be discussed later, many Aboriginals and Torres Strait Islanders would now no longer hunt turtles.

Geographical Extent of Turtle Hunting

The survey indicated that turtle hunting was limited to north of about latitude 21° S on the east and west coasts of Australia (Figure 1). This distribution is very similar to that described by McCarthy (1955).

Hunting Methods

According to the survey, the most common method of capturing turtles is by use of a spear or harpoon from a boat. Less commonly, turtles are taken by hand, either in pools on the reef, while basking in very shallow water, or after chasing by boat. Turtles are also sometimes taken while nesting. Descriptions of hunting techniques can be found in McCarthy (1955), Turner (1974) and Capelle (1979). Today there is widespread use of aluminium dinghys, powered by outboard motors, as fishing platforms (Duncan 1974, Capelle 1979) as opposed to the traditional dugout canoes powered by sail or paddles (McCarthy 1955, Beckett 1972, Moore 1972).

Composition of the Catch

SPECIES

The survey indicated that green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), flatback (*Chelonia depressa*),loggerhead (*Caretta caretta*), and ridley (*Lepidochelys olivacea*) turtles were hunted, in order of decreasing frequency. There are apparently regional differences in the composition of catch, which may, at

least in part, reflect differences in the relative abundances of species.

In Torres Strait predominantly green turtles are hunted; I found a widespread belief there that hawksbill turtles were sometimes poisonous and would be eaten only if they had been butchered by someone skilled in removing the poison parts. The reputed toxicity of the hawksbill is documented for Torres Strait (Beckett 1972, Bustard 1972) and for northwestern Australia (Capelle 1979).

In the Northern Territory *Chelonia mydas* was a staple item in the diet of coastal Aboriginals, being much preferred to *Chelonia depressa*, while the flesh of neither the loggerhead nor the ridley was locally esteemed, and these turtles were rarely hunted (Cogger and Lindner 1969). McCarthy (1955) reported the hunting of green, hawksbill, and leatherback (*Dermochelys coriacea*) turtles by Aboriginals.

SEX AND SIZE

Most respondents to the questionnaire reported that any turtle encountered would be taken; a reasonable proportion indicated that large turtles were preferred, but there was little to indicate a marked preference for a particular sex.

From other sources such a preference was apparent. In Western Torres Strait (Nietschmann, in press) and on Yorke Island in central Torres Strait (Kowarsky 1978) predominantly female turtles were taken. By contrast Capelle (1979) witnessed the release of captured female and juvenile turtles and the retention of a large male during a turtle hunting expedition by Aboriginals in the northwest of Western Australia.

A marked regional variation in size composition of the catch occurs in Torres Strait. On Yorke Island turtles taken were below reproductive size (Kowarsky 1978), while in western Torres Strait mature turtles, as adjudged by the presence of eggs in females, and by their carapace measurements, were commonly taken (Nietschmann, in press).

In western Torres Strait, Islanders distinguish between 2 general types of turtles, the more esteemed fat turtles and the poorer condition turtles; they claim that the former feed on seagrasses while the latter eat more algae (Nietschmann, in press). A similar distinction is reported by Pritchard (1976).

SEASONAL VARIATION IN CATCHES

In Torres Strait there appear to be regional differences in the seasonality of catches. In the eastern islands, turtles were taken only during their mating and egg-laying season (Duncan 1974). My records indicate that peak catches of turtles on Yorke Island between October 1975 and July 1976 occurred during the mid-summer months. However, in western Torres Strait, hunting activity took place throughout the year, and the recorded catches did not exhibit any clear seasonal trends (Nietschmann, in press). In northwestern Australia the main period of turtle hunting ran from mid-November through to March (Capelle 1979). Most respondents to the questionnaire reported either that turtles were taken all year or that the main period of capture was during the mating and nesting season.

REASONS FOR HUNTING AND USE OF TURTLE PRODUCTS

A large majority of respondents to the survey marked "subsistence" as the reason for hunting, while a few also marked "cash income" (this category was never exclusively given). In 1973 the price of turtles in Torres Strait varied between $10 and $15, but the extent to which sales took place was not documented (Duncan 1974). One respondent to the questionnaire reported a price of $160 for a full-grown adult turtle. Overall it would appear that the number of turtles hunted for cash income would be insignificant compared to the number hunted for subsistence. Systems of distributing meat among kin and neighbors have been described for Torres Strait (Duncan 1974; Nietschmann, in press).

Replies to the questionnaire indicated that the main turtle product used was the meat, with some respondents indicating that turtles were used for their shells and as curios. I had noticed this tourist trade occurring to some extent on Thursday Island in Torres Strait. Capelle (1979) reported some trade in turtle shells around the Broome area in Western Australia, stimulated by the increasing number of tourists visiting the region.

Most respondents did not regard turtle meat as a main source of protein in their diet, and most did not regard it as a very important food for traditional occasions. There were however, exceptions to these generalizations, with emphasis mainly on the cultural importance of turtles. In Torres Strait Nietschmann (in press) considered hunting (turtles and dugongs) to be important both culturally and nutritionally.

A different situation may apply to some turtle hunters living on mainland Australia or on some of the larger offshore islands. For example, along the Western Australian coast from Pt. Hedland to Wyndham there are permanent reserves of freshwater, easily obtainable vegetable foods, abundant game, available shellfish, clams, mussels, oysters and fish, and food from community stores which make turtles only one of a number of food resources (Capelle 1979). An account of subsistence hunting on Bickerton and surrounding islands in the Northern Territory (Turner 1974) presents a similar picture to that apparent in Western Australia,

with turtles being but one component in a diet of fish, birds, lizards, small marsupials, dugong and various vegetable foods like yams and berries.

FACTORS LIMITING THE CATCH

Almost all respondents to the questionnaire marked "lack of inclination by local people" as the major factor limiting the number of turtles caught; some added the comment that turtles were taken only in accordance with community needs. In Torres Strait, lack of access to boats and working outboard motors was not considered a limiting factor in the development of subsistence fishing (Duncan 1974). Nietschmann (in press) lists several factors influencing the frequency of hunting including money available to buy fuel, desire for fresh meat, occurrence of feast days, and environmental variation.

ESTIMATING THE ANNUAL CATCH

Most respondents indicated that fewer than 20 turtles a week are taken; some gave figures as low as 1 per fortnight or per month. The highest estimate was one for the Cape York Peninsula and Torres Strait of 50 to 100 turtles a week, 2,500 to 5,000 a year.

Some regional estimates of annual turtle catches are available. Nietschmann (in press) made a "very rough estimate" of the average annual catch of green turtles in Torres Strait as being just over 2,000 turtles. By extrapolating from catch records from one community in Torres Strait, an estimate of over 2,500 turtles annually for Torres Strait was obtained (Kowarsky 1978). Recently, Dr. John Parmenter, of Applied Ecology Pty. Ltd., made a similar extrapolation and arrived at a figure of about 4,000 turtles slaughtered annually by Torres Strait Islanders. He and I are aware of the number of untested assumptions implicit in such calculations, but nevertheless I consider such estimates useful in indicating the order of magnitude of the depletion of turtle populations by people of the region.

I have made estimates of the turtle catch per capita per year for 4 communities in Torres Strait using population figures from Duncan (1974) and turtle catch records from Kowarsky (1978) and Nietschmann (in press):

Community	*Number turtles per capita per year*
Yorke	0.55
Mabuiag	1.28
Kubin	1.99
Badu	0.80

In Queensland, excluding Torres Strait, the number of people living on reserves and former reserves near the coast within the area of turtle hunting as indicated by data in Figure 1 was taken to be about 6,500. Using the lowest estimate above of turtles taken per capita per year, a projected figure of about 3,500 turtles per year is obtained. Thus for the whole of Queensland, including Torres Strait, a broad estimate of the total annual catch could range between about 5,000 and 8,000 turtles.

To obtain an estimate of the extent of turtle hunting in the Northern Territory it has been necessary again to extrapolate from data of one community. At South Goulburn Island, the Aboriginal population of about 200 take about 3 turtles a week (D.L. Grey, personal communication 1979). In the Northern Territory there are about 13 major coastal settlements of such people. A projected total catch for the region of about 2,000 turtles a year can thus be obtained.

Capelle (1979) has made the following estimate of annual turtle catch on the coast of Western Australia between Pt. Hedland and Wyndham:

Locality	*Annual catch*
One Arm Point	48
Kalumburu	40
Other isolated communities (3)	10
Towns (4)	6
Total	104

Outside the area defined above, little turtle hunting would be expected on the basis of replies from the questionnaire survey (Figure 1).

The above estimates taken together would suggest that between about 7,500 and 10,500 turtles are taken annually by Aboriginal and Torres Strait Islander people in Australian waters. Assuming an average weight per turtle of 100 kg, between 750 and 1,050 tonnes of turtle would be taken.

EGG COLLECTING

Most respondents to the questionnaire reported that few, if any, eggs were taken during the nesting season. Weekly egg collections were commonly estimated at 20 or less, but 2 respondents gave estimates of about 1,000 per week. It would appear that green, hawksbill, loggerhead, and flatback eggs were eaten. Compared to exploitation of turtles by hunting, the collection of eggs in Australia would appear to have insignificant impact on the wild turtle populations.

Discussion

For many Aboriginals and Torres Strait Islanders to-

day, sea turtles have little or no significance. Among those people still engaged in turtle hunting activities there appears to be a broad spectrum of attitudes. For some a captured turtle is a bonus food item; for others turtles are an integral part of their socioeconomic and cultural organization.

It would be useful to compare past hunting pressures with those of the present as one means of assessing the potential impact of such activities on the wild turtle populations. The absence of quantitative records of past hunting make such a direct comparison impossible; as an alternative, one can consider technological, population and socioeconomic changes which may have influenced the extent of hunting which takes place.

Modern technology, plus a cash income from employment opportunities and widespread social security payments, have provided the present day turtle hunter with a fast and efficient means of traveling over long distances at sea. This apparent increase in hunting power may be offset to some extent by dependence on factors such as fuel supplies and motor maintenance. Other developments such as increasing use of domestic refrigerators and increasing availability of fresh, frozen, and canned foods at community stores could act to remove some pressure on turtles as a food resource.

Australia's Aboriginal population at the time of arrival of white settlers is thought to have been about 300,000; since that time it drastically declined until in 1954 the total number of "full-blood" Aboriginals was about 40,000 (Anonymous 1965). The Torres Strait Islander population in Torres Strait apparently did not follow the same decline, with numbers in that region in the nineteenth century being estimated between 3,000 and 4,000 (Beckett 1972).

White settlement in Australia, as well as resulting in a decline in population, also brought profound socioeconomic changes to Aboriginal society, with a breakdown in tribal organization and religion, and often a forced movement from traditional homelands (Anonymous 1965, Brokensha and McGuigan 1977). In fairly recent times there has been a voluntary movement of Torres Strait Islanders from their home islands to the Australian mainland, and a decline in numbers in Torres Strait of about 5 percent in 5 years (Caldwell 1975).

On the basis of the above, and particularly since one of the main regions of Aboriginal settlement before the arrival of whites was the northern tropical coast (Brokensha and McGuigan 1977), it would be reasonable to presume that hunting pressures on turtles in the past were at least as great, if not greater, than those existing today.

Since the 1950s the Aboriginal population of Australia has been increasing. The total number of Torres Strait Islanders is also increasing, but this is due to increasing numbers on mainland Australia. In Torres Strait the Islander population will probably decline to under 3,000 by the end of the century (Caldwell 1975). A study of mainland Torres Strait Islanders found that their lifestyle changed markedly from that on reserves in Torres Strait and that they seemed to have a general lack of attachment for that region (Fisk, Duncan, and Kehl 1974).

If the projections of numbers of Torres Strait Islanders in Torres Strait are accurate, no significant increase would be predicted in hunting pressure on turtles in that region in the future. The extent to which increasing numbers of Aboriginals place additional hunting pressure on turtles would depend upon the proportion of those people maintaining a traditional lifestyle in future years.

This leads to a factor which is perhaps more likely to result in a rapid change in the pressure of hunting on turtles, and that is a change in the socioeconomic aims of Aboriginals. It is clear that in the general regions where turtles are hunted, there are far more Aboriginals than those now involved in hunting activities. Fairly recently, there has been a trend of movement away from settlements (established by government or missions) toward traditional clan territories which has been termed the "outstation" or "homelands" movement (Coombs 1974, Brokensha and McGuigan 1977, Anonymous 1979a). An example of this was the formations of 10 homeland centers by people formerly living at a mission (established in 1938) in northeastern Arnhem Land in the Northern Territory (Brokensha and McGuigan 1977). Such a movement, if widespread, could be expected to result in an increase of hunter-gatherer acitivities, including the subsistence hunting of sea turtles.

Appendix A. Changes in Present Australian Sea Borders

Recently the Commonwealth (federal), State, and Northern Territory governments agreed to changes in the division of responsibility in offshore areas, but the relevant legislation has not yet been passed. The present situation with regard to fisheries is that within the 3-mile territorial area, fisheries are subject to State or Northern Territory legislation, while outside this area they are subject to Commonwealth legislation.

Borders with Indonesia and Papua New Guinea present special problems and are yet to be settled (Prescott 1978). That with the latter country is of particular relevance to turtle biologists as the region in between, Torres Strait, includes significant nesting beaches and extensive reef systems and shallow waters which are apparently important feeding areas for turtles (Bustard 1972; Kowarsky 1978; Nietschmann, in press).The Torres Strait Treaty (summarized by Stanford, 1978) between Australia and Papua New Guinea was signed in December 1978 but is yet to be ratified. Among

other provisions, it delineates a Seabed Jurisdiction Line, a Fisheries Jurisdiction Line and a Protected Zone within the Torres Strait region; the combined area enclosed by these 3 lines does not differ markedly from the position of the present border (shown in Figure 1).

Appendix B. Legislation Related to the Taking of Sea Turtles in Australian Waters

Queensland

All species of the families of Chelonidae and Dermocholydae [sic] are "protected species" under the Fisheries Act 1976. This act does not, however, apply to ". . . the taking, otherwise than by the use of any noxious substance or explosive and for purposes other than commercial purposes, . . . by any Aborigine or Torres Strait Islander who at the material time is resident on a reserve . . ."

The terms Aborigine and Torres Strait Islander are defined in the Aborigine Act 1971 and the Torres Strait Islander Act 1971.

Northern Territory

The Fisheries Ordinance 1965–66 declares all waters of the Territory closed against the taking of green turtle except specified areas which correspond to the local people's more important traditional turtle hunting areas. Although commercial exploitation of turtles is not prohibited, this practice is discouraged by the fisheries authorities in the Northern Territory.

Western Australia

Under the Fauna Conservation Act 1950–70 turtles are wholly protected throughout the entire State at all times; however a person who is a native according to the definition in the Native Welfare Act 1963 may take turtles " . . . sufficient only for food for himself and his family, but not for sale" on land other than that of a sanctuary.

Commonwealth (Federal) Legislation

The Fisheries Act 1952–74, through Fisheries Notice No. 48, prohibits the taking of turtles from proclaimed waters. This Act makes an exception for "traditional fishing," defined as "fishing by indigenous inhabitants of an external Territory" if the fish are taken in a traditional manner and landed in that Territory. It would thus appear that traditional fishing by Australian residents (Aboriginals or Torres Strait Islanders) is not excepted from the provisions of this Act. However, discussions I have had with Federal authorities indicate that a wider definition of traditional fishing than that in the Act has been applied in practice, so that, effectively, the noncommercial taking of turtles by Aboriginals and Torres Strait Islanders would be permitted in proclaimed waters.

Appendix C. Turtle Hunting Questionnaire

1. Name
2. Organisation
3. Coastal region (including islands) of which you have knowledge (indicate, as far as possible, the extent of the region on the attached map).
4. Does turtle hunting take place in the above region? If yes, go straight on. If no, go to question 14.
5. Which people go turtle hunting? Aboriginal, Islander, Other (give details).
6. Reason for hunting: Subsistence, Cash Income
7. What species of sea turtles are caught? Green, flatback, hawksbill, loggerhead, ridley
8. What species are used for: meat, shells and curios, leather products, soup?
9. How are turtles caught? On beach while nesting, from boat with spear or harpoon, by rope after chasing by boat, other (give details)
10. What number of turtles are captured per week in the region? (If possible, make a guesstimate). Less than 20, 20–50, 50–100, more than 100
11. How important are turtles as: a main protein source in diet, a main source of cash income, a traditional food for important occasions?
12. Is there a preference for particular types of turtle? small, large, male, female, any turtle
13. What are reasons given for the preference above?
14. What is the major factor limiting the number of turtles caught? scarcity of turtles, lack of boats and equipment, lack of inclination by local people
15. Where in your region are the most significant aggregations of turtles, and what species are they?
16. What species' eggs are eaten by people within your region? (If possible make a guesstimate of number of eggs eaten per week). Green, hawksbill, loggerhead, other (give details)
17. Are there seasonal trends in the quantities of turtles/eggs collected by people in your region?

Note: Spaces for answers have been deleted to conserve space.

Appendix D. Population Statistics for Aboriginals and Torres Strait Islanders

The most recent comprehensive data in this regard is the 1976 Census of Population and Housing by the Australian Bureau of Statistics. Explanation of the question in that census relating to racial origin is given in Anonymous (1979b). The basic unit of area used in the census was the Local Government Area (LGA).

To gain an idea of the number of Aboriginals and Torres Strait Islanders who could be potential users of turtles, I extracted their numbers in each LGA north of the Tropic of Capricorn with a maritime border (shaded area, Figure 1) from the 1976 Census Data: Queensland, 19,300; Northern Territory, 12,931; Western Australia, 8,736; total, 40,427.

In Queensland, because of present legislation, more apposite in the present context would be the number of people resident on reserves near the coast. Excluding the Torres Strait region, for which recent data were not separately available, the number of persons resident on such reserves (either government or church) under the auspices of the Queensland Government Department of Aboriginal and Islanders Advancement was 7,552 in March 1978 (Anonymous 1978).

A special situation is found in Torres Strait itself. Here are 14 reserve islands with a total resident population of about 2,500 and some 2,000 Islanders living on Thursday Island, the region's Administrative center (Nietschmann, in press). From a stay of 4 months on Thursday Island, I gained a strong impression that turtle meat was available locally irrespective of the reserve-residency status of the Islander. It would probably be more realistic, therefore, to use the total number of Aborigines and Islanders in the region as the number of potential users of turtle products than to restrict the number to those actually resident on reserves in Torres Strait.

In Queensland, the total number of people who potentially could use turtle products would thus be 7,552 + 4,500 = 12,052, approximately 62 percent of Aboriginal and Islander people living in the LGA's already defined.

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East and Southeast Asia

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Sea Turtles in the Waters Adjacent to Japan

Five species of sea turtles are found around the southern districts of the Japan Islands: the green turtle (*Chelonia mydas*), the hawksbill (*Eretmochelys imbricata*), the loggerhead (*Caretta caretta*), the ridley (*Lepidochelys olivacea*), and the leatherback (*Dermochelys coriacea*). There are few sighting records of, and no report of laying eggs by leatherback and ridley turtles. However, the loggerhead, green turtle, and hawksbill have nested in Japan.

The Loggerhead Turtle (*Caretta caretta*)

Aka-umigame is the Japanese standard name for the loggerhead turtle, one of the very commonly distributed sea turtles along the coast of Japan (Figure 1). It breeds along the coasts farther north than any other species in the western Pacific. Along the Pacific coast of Japan's mainland, it nests occasionally as far north as Fukushima Prefecture, 37°N. While on the coast of the Sea of Japan, it nests as far north as Ishikawa Prefecture also about 37°N. These nesting areas can be considered margins of the loggerhead population in the western Pacific. In the Japan Islands, the number of nesting places is not large. The places where loggerheads nest in abundance are in Shizuoka Prefecture, Kii Peninsula, Shikoku, and the east coast of Kyushu. Nesting places in the Ryukyus and the Ogasawara (Bonin) Islands are rarer than those in the above places. Generally, it is considered that loggerheads or sea turtles are more abundant in the south. This report does not support that general consideration, although the loggerheads coming to these nesting places are considered to be recruits from subtropical waters. Between late May and August, their breeding season, loggerheads congregate in the offshore waters of the breeding places. This gregarious phenomenon is seen at the beginning of the season every year. In these areas, courting behavior is seen among rocks offshore

Figure 1. The distribution and nesting areas of the loggerhead turtle (*Caretta caretta*) in Japan. ● Sighted positions; ○ Laying eggs and hatched.

in 20 to 30 m of water. The nesting season starts when 20°C isothermal waters approach the coast of Japan in the spring. Adults, subadults and juvenile loggerheads, over 1,000 in number, were tagged with "Roto-tag" (plastic cattle ear tag) in our study at Gamouda Beach, Tokushima Prefecture, during 1969–1979. Most of the females that came to the beach and were examined were between 72.0 cm and 107.5 cm in straight carapace length, (89.0 cm in average; n = 118) and between 53.0 kg and 125.0 kg (96.8 kg in average; n = 15).

The Green Turtle (*Chelonia mydas*)

Ao-umigame is the Japanese standard name for *Chelonia mydas*. As shown in Figure 2, the green turtle migrates to the southern coasts of the Japan Islands. Its nesting area is exclusively in the southern islands of Japan at about 30°N. Yakushima, Kagoshima Prefecture, is the northernmost nesting site recorded. Thus, the green turtle shares most of the beaches with the loggerhead; both of them prefer warmer sandy beaches. The Ogasawara (Bonin) Island at about 27°N is also an important nesting place.

The Hawksbill Turtle (*Eretmochelys imbricata*)

Figure 3 shows the distribution of the hawksbill turtle, whose Japanese standard name is *tamai*. There are only 2 records of nesting females of this species in Ishigakijima and Kuroshima in the Yaeyama Archipelago in the Ryukyus of Japan, at about 25°N. The area must be the margin of the hawksbill in Japan. Records of stranded turtles in other places are of subadults and juveniles. The hawksbill is the third least common species of sea turtle in Japan, and there is little knowledge about its nesting sites.

Figure 2. The distribution and nesting areas of the green turtle (*Chelonia mydas*) in Japan. ● Sighted positions; ○ Laying eggs and hatched.

Human Incursion on Sea Turtles

Recently, there has been worldwide concern about the nesting places of sea turtles. There are problems from human activities along the coast of Japan. Some measures should be taken to conserve the animals; otherwise we may soon see a decrease in the population. Only a few Japanese people, shore villagers, eat turtle meat and eggs, which do not appear at markets. At Yakushima, Kagoshima Prefecture, a popular nesting site, villagers take loggerhead and green turtle eggs to eat, and fishermen in Kagoshima, Wakayama and Kouchi Prefectures sometimes catch loggerheads or green turtles by hand harpoon for their own food during the nesting season. According to our investigation, about 50 to 100 adults are killed annually. These turtle catches seem to have begun after the second world war.

In Japan, the only turtle shell used for handicraft work is from the hawksbill, and all hawksbill shells are imported from Southeast Asia and tropical Atlantic and African countries. The major use of turtle shell in Japan is for making ornaments and accessories with long traditional workmanship. At present, about 1,200 people are engaged in this work. Their work is quite delicate and detailed, based on long training and tradition. If this work were to be interrupted once, a traditional and long-maintained skill should be lost forever. The hawksbill-shell workers organized an association to preserve their precious workmanship.

Figure 3. The distribution and nesting areas of the hawksbill turtle (*Eretmochelys imbricata*) in Japan. ● Sighted positions; ○ Laying eggs and hatched.

Japan and Sea Turtle Conservation

Japan's ratification of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has been postponed for a variety of reasons, but it is to be ratified by the Congress, maybe in 1980. As a result of this ratification, trade in turtle shell will be seriously limited. Because of this, some ill-advised people have tried to hoard the shell with the help of dealers. However, following criticism by the public these activities have become difficult to continue. Recently, taxidermy dealers have entered the turtle shell-purchasing business, which had hitherto been done by shell dealers connected to handicraft workers. Stuffed hawksbills and green turtles are now sold in resort areas. Stuffed turtles are loved by people as a symbol of good luck and longevity in Japan as well as in some Asian countries. Large, stuffed turtles are so profitable to dealers that the weight of traded turtles has increased rapidly and prices have shot up. Now people tend to prefer smaller turtles because big ones cost so much. Catching smaller turtles may have a very bad effect on the population. As mentioned before, there is no hawksbill or green turtle catch for profit along the coast of Japan, so almost all of these stuffed turtles are imported. Importation of stuffed turtles has been done exclusively by dealers, and no handicraft workers on turtle shell are concerned with this business. The government of Japan announced an import ban on stuffed turtles on November 24, 1979.

At the same time, the Japanese government is trying to encourage the cultivation of hawksbills and other turtles to stabilize the supply of shells to protect the handicraft workers and their long-traditional skill, and to find a way to give aid to cultivation projects in the Southeast Asian countries for mutual understanding and interest. Cooperative conservation and cultivation projects have made progress, drawing attention to the Japanese and other shell-producing countries. To undertake this sort of cooperation, a fundamental biological knowledge, instead of purely a profit-slanted consideration, is indispensable to both sides. For conservation to succeed scientific reason must prevail over emotional or frantic action.

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Distribution of Sea Turtles in China Seas

Introduction

To learn about the habits and geographical distribution of our sea turtles, we have made investigations from Haiyang Island of the Bohai Sea in the north through the Yellow Sea to the Zhoushang Islands of the East China Sea, then south along the coastal sea of Fujian (Fukien), Guangxi (Kwangsi), and Hainan Island of Guangdong (Kwangtung) to the Xisha Islands. The sea turtles increased in species and number as we sailed southward. Only a few scattered green turtles (*Chelonia mydas*), loggerhead turtles (*Caretta caretta*), and leatherback turtles (*Dermochelys coriacea*) were found in the Bohai Sea and Yellow Sea. Hawksbill turtles (*Eretmochelys imbricata*) appeared in the East China Sea. Sea turtles increased in number around Hainan Island, while only the islands in the South China Sea were the center of reproduction and habitat of the sea turtles in China.

Over the years, the fishermen of Hainan Island have often fished the Xisha and Nansha Islands. While sea turtles have been one of their quarries, their catches, made by hand from small sailing boats, have been small.

Individual Ecology and Distribution of the Sea Turtles

Sea turtles can be seen around Xisha Islands and Nansha Islands all year. One migrant population returns annually to reproduce beginning about April with the southwest warm currents. In addition, a local population resides there.

Four species of sea turtle are distributed in our country: the leatherback turtle, the loggerhead turtle, the green turtle, and the hawksbill turtle.

The Leatherback Turtle (Dermochelys coriacea)

The leatherback turtle's main egg-laying season is from May to June; 90 to 150 eggs are laid in each clutch. The young turtles hatch after 65 to 70 days and swim quickly out into the sea, but often a dozen eggs in each

clutch fail to develop. Leatherback nests are about 65 cm deeper than those of other sea turtles. This species continues to lay eggs even when disturbed while laying. Because leatherbacks cover their eggs with sand, their nests are hard to find. Leatherback turtles feed on algae, shrimps, crabs, molluscs, and fish.

In China, leatherbacks occur along the coastal seas of Guangdong (Kwangtung), Guangxi (Kwangsi), Fujian (Fukien), Zhejiang (Chekiang), Jiangxi (Kiangsi), Shandong (Shantung) and Liaoning.

The Loggerhead Turtle (Caretta caretta)

The loggerhead turtle nests from April to August, digging nests 33 to 65-cm deep and laying from 60 to 150 eggs in a clutch. The eggs generally hatch in about 2 months, depending on the season and the nest site. Loggerheads eat fish, shrimps, crabs and molluscs.

In China loggerheads are found along the coastal seas of Taiwan, Gungdong (Kwangtung), Guangxi (Kwangsi), Fujian (Fukien), Zhejiang (Chekiang), Jiangsu (Kiangsu), Shandong (Shantung), and Hebei (Hopei).

The Green Turtle (Chelonia mydas)

In the Xisha Islands, the green turtle's main breeding season is from May to July. Eggs can be found from April to December.

Large green turtles weigh about 450 kg (Figure 1). They often hold their head above water for 15 to 20 minutes when swimming. Mating is often observed from January to April. Males and females chase each other in a round-about way before mating, and they mate at the base of the reef. During the breeding season the female crawls up the beach beyond the high tide line, digs a big hollow pit with its fore limbs and then a nest pit 33 to 65-cm deep with its hind limbs. It will go back into the sea if disturbed immediately after landing but generally will not stop laying once it begins to lay. The female lays 3 times a year at intervals of about 2 weeks, 300 to 500 eggs annually. The spherical soft-shelled white eggs, 40 to 44 mm in diameter, are covered up with sand in the nest. Young turtles, 4-cm long, hatch in 40 to 50 days and quickly crawl into the sea. They eat algae, shrimps, crabs, molluscs, and fish.

Figure 1. Green turtles captured for market.

Table 1. Catch of sea turtles in Xisha region, 1959–70

Year	*Catches* ($kg \times 10^3$)
1959	130.63
1960	40.60
1961	54.02
1962	38.74
1963	103.01
1964	61.10
1965	181.35
1966	86.86
1967	149.91
1968	42.96
1969	104.78
1970	122.56

In China green turtles are found along the coastal seas of Taiwan, Fujian (Fukien), Guangdong (Kwangtung), Guangxi (Kwangsi), Zhejiang (Chekiang), Jiangsu (Kiangsu) and Shandong (Shantung).

The Hawksbill Turtle (Eretmochelys imbricata)

The hawksbill, fierce and scarce, inhabits coral reefs, laying 3 clutches of eggs a year in the daytime in March and April. Each clutch consists of 130 to 200 eggs which hatch after 2 months or so. The hawksbill feeds mainly on fish, shrimps, crabs, molluscs, and algae.

In China, hawksbills are found along the coastal seas of Taiwan, Guangdong (Kwangtung), Guangxi (Kwangsi), Fujian (Fukien), Zhejiang (Cheking), Jiangsu (Kiangsu) and Shandong (Shantung).

Turtle Catch Records

The statistics of our Yong Xing purchasing station are shown in Table 1. Around the Xisha Islands, only the green turtle and the loggerhead turtle were objects of fishing, while the green turtle was the main object. Because the purchasing station has no classified statistics, the values shown in Table 1 represent both species. The amounts purchased in 1959–70 represent basically the catch of the area around the Xisha Islands.

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The Status of Research, Exploitation, and Conservation of Marine Turtles in The Philippines

ABSTRACT

Four marine turtles are found in Philippine territorial waters, namely: *Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea* and *Dermochelys coriacea*.

Turtle research has been sporadic. Domantay did some work in the 1950s, and Alcala and de Celis in the 1970s. Preliminary studies show that turtle populations are fast diminishing due to poaching. The turtle population is low in the northern part of the country and dense in the southern part, especially around the Turtle Islands.

Government regulations are administered by the Ministry of Natural Resources through the Bureau of Forest Development. On 26 June 1979, President Ferdinand E. Marcos created the Task Force Pawikan through Executive Order 542 to conserve the marine turtles and develop turtle industries.

Introduction

Several decades ago in the Philippines, marine turtles abounded in most regions of the archipelago. Today, for various reasons, marine turtles are limited in distribution. In only a few remaining areas within the territorial waters of the country can the species breed. Turtles are harvested on a commercial scale, despite the existing rules and regulations because enforcement is weak. In the Philippines, there are no special marine areas where the species are truly protected.

In recognition of the precarious status of this marine resource and of the worldwide concern for its conservation, the Philippines created an interagency task force in order to focus activities calculated to mitigate the degenerating situation.

We share common problems and common goals of saving the marine turtles; we differ only in the extent of work. Many countries are already far advanced in their research and conservation measures. Sea turtle management in our country is just now receiving the attention it deserves. Since very few research studies are being conducted, we hope to profit from the ex-

perience of countries that have long been engaged in turtle conservation.

For an appreciation of the strategic position of the Philippines relevant to marine turtle conservation, its geographic setting is described here.

The Philippine archipelago is composed of approximately 7,107 islands and islets. It extends from north to south for 1,850 km, and from east to west for 1,060 km. Located in a most strategic position in the Pacific Ocean, it straddles major sea lanes of commerce. Surrounded by a vast water domain, only about 470 islands are each more than 1 km^2, while the vast majority are merely rocks, atolls, and reefs. The coast line is no less than 17,462-km long, 1,000 km of it sandy beaches offering turtles a potentially ideal nesting habitat. The remaining coastline is either mangrove or too steep or already appropriated for coastal towns, villages, fishponds, and coconut plantations.

Background

Four species of marine turtles are found in the Philippine territorial waters. Listed according to relative abundance and local importance, they are: *Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea* and *Dermochelys coriacea*. All are commonly known as *pawikan* throughout the archipelago. Information on distribution is still limited to collection locations and to occurrence on nesting beaches.

The northern part of the country harbors few turtles; the populations increase towards the southernmost islands. The Pacific side of the country has the fewest records of capture and nesting sites; the south and southwest have the most.

Because this country is still in the initial stage of a systematic appraisal which will include an inventory and census of turtle populations and population trends, present findings are indicative rather than definitive. Unfortunately, there has been a marked decline in the turtle population, yet there has been a dearth of research work on them. Gomez (1979) cited the need to make known to the international community the existence of some sea turtle literature in the Philippines because reference to them has been lacking in foreign reviews.

Turtles were first recorded in the Philippines during the Spanish period (1521–1898). According to Taylor (1921), Elera (1895) listed 4 species of sea turtles in his systematic catalog of Philippine fauna, namely: *Dermochelys coriacea* Linnaeus, *Chelonia mydas* Linnaeus, *C. imbricata* Strauch, and *Thalassochelys caretta* Linnaeus.

During the American regime (1898–1946), Seale (1917, cited by Gomez 1979) mentioned 3 species of sea turtles as being of considerable commercial importance: the hawksbill (*Chelone imbricata*), the loggerhead (*Thalassochelys caretta*), and the green turtle (*Chelone mydas*).

Domantay (1953) published a paper that was not taxonomic in nature, but he mentioned 3 species of marine turtles that breed around the Turtle Islands: *Chelonia mydas (C. japonica), Eretmochelys imbricata,* and *Caretta olivacea*. His paper presented a preliminary report on the turtle fisheries of the Turtle Islands, emphasizing the ecology of the small island groups and the feeding and breeding habits of the turtles. He also mentioned the value of turtle eggs produced annually, and described the marketing and preserving of turtle eggs. His paper also gave recommendations for conservation of the marine turtles of the Turtle Islands. The decline in turtle egg production compared to prewar production was already noted in his report.

After Domantay's work, turtle research in the Philippines made no progress for more than 20 years. In 1976 the Outdoor Recreation and Wildlife Research Division of the Forest Research Institute initiated a nationwide survey of the distribution of sea turtles. In 1978, Dr. Angel C. Alcala of Silliman University, Dumaguete City commenced a biological study of marine turtles in the Central Visayan waters (Alcala 1978).

Legislation

The green turtle has been listed since 1970 by the then Parks and Wildlife Office as one of the 20 wildlife species in the Philippines on the verge of extinction. Likewise, it has been reported lately that the hawksbill turtle (*Eretmochelys imbricata*) is also on the threatened list.

Marine turtle conservation was, up to the last decade, taken for granted. The responsibility was tossed from one agency to another, *i.e.* the Philippine Fisheries Commission (Fisheries Administrative Order No. 88—Regulations for the Conservation of Turtle, Turtle Eggs and Turtle Shells in the Philippines), then to the now defunct Parks and Wildlife Office (General Administrative Order No. 2 series of 1972—Transferring the Administration and Control of Turtles to the Parks and Wildlife Office and for Other Purposes), then to the Bureau of Forest Development with which the said defunct office was merged (Administrative Order No. 1).

Up to this writing, the only control on harvesting sea turtles is administered by the Ministry of Natural Resources through the Administrative Order No. 1 Series of 1974, implemented by the Bureau of Forest Development. It governs the gathering and disposing of marine turtles, turtle eggs and by-products. This provides a special permit to any individual or company (60 percent Filipino and 40 percent foreign capital) to collect marine turtles and provides a gratuitous permit for research institutions (Fontanilla 1979). The existing regulatory mechanism will be a good regulatory effort

as soon as it is based on measurements of probable annual yield or useful statistics. Enforcement of this law has not been monitored rigorously due to lack of adequate manpower and necessary logistics. Another problem is the lack of cooperation of the permittees and poachers. In Mindanao alone, there are 5 registered traders, all based in Tawi-Tawi, and there are 132 permittees for live turtle collection. Several more applications are being held in abeyance because of the newly approved Executive Order No. 542. Added to these, are the 50 permit holders in other regions of the country. These permittees, however, do not report their catch against their quota of 25 heads a year per permittee. Only apprehended poachers are usually the ones reporting to the BFD Regional Office, after which they think that they have complied with government regulations and are so bestowed with rights and privileges to continue plying their trade.

There are indications of smuggling of live turtles and by-products; the latter are often misdeclared as shells, reptile leather, art crafts and ornaments.

Utilization and Exploitation

The green turtle is one of the most exploited species of wildlife in the Philippines. Since time immemorial, people have gathered this reptile for various economic purposes. The green turtle is a rich source of protein for thousands of Filipinos. Taylor (1921) reported turtle poisoning in 1917 in the central Philippines. He reported that *Chelonia virgata (= Chelonia japonica)* caused the 14 fatalities. Ronquillo and Caces-Borja (1968) reported another case of turtle poisoning in 1954 in the southern Philippines. In this case, ingestion of the boiled meat of a hawksbill caused the incident.

In January 1977, a kilo of turtle meat sold for US$.50 and the bones US$.25 in Zamboanga City. The bones (cartilage) make good turtle soup, a delicacy in some parts of the country. The eggs, both delicious and nutritious, also command a good price in the market. In Palawan, 3 eggs sell for US$.03. In the same place and year, the shell of a hawksbill (tortoiseshell) was sold at US$25 a kilo (Fontanilla and de Celis 1978). Almost all parts of the turtle are important. Even the blood and liver are used by country folk, as a cure for asthma. The high demand for these different products from sea turtles cause the coastal people to hunt them indiscriminately.

In addition to local consumption, hawksbill shells and shell products have been exported to various countries. Taylor (1921) reported the economic value of commerce in 1909 to be US$4,368 representing 2,040 kg of tortoiseshell. Seale (1917) reported that 2,296 kg of shell valued at US$4,369 were exported from the Department of Mindanao and Sulu in the southern Philippines. He estimated that 8,000 kg valued at US$12,500 were gathered in the country annually. In the 1960s, the Philippines exported less than 5,000 kg of raw tortoiseshell (Japan Tortoise Shell Association 1973), while from 1974 through 1978, we exported approximately 22,000 kg per year. Worked tortoiseshell exports have also increased from 425 pieces in 1974 to over 24,000 in 1976. Since then, exports have dropped, but in 1978 we exported 7,800 pieces. Exports went mainly to Japan, but in 1977, 3,000 pieces went to the United States and large numbers to Belgium and Italy. In 1978, over 1,000 pieces went to West Germany (Mack, Duplaix, and Wells, this volume).

Places of collection are nationwide as indicated by issued permits, although some of the major sources are the Philippine Turtle Islands, Lubang Island in Mindoro Occidental, Surigao del Norte, Negros, Antique, Sitangkai, Bungao, Davao, Basilan, Cotabato, Lanao del Norte, Quezon and Sorsogon (from BFD list of Permittees).

There is a full scale cottage industry for stuffing turtles in Cebu City, Mindoro and Zamboanga City. The processing center in Zamboanga City (Sinunoc) was checked by the Forest Research Institute, Philippines (FORI) research team in 1977. Thousands of stuffed green turtles and hawksbill turtles were noted. An average of 2,000 hawksbills and almost the same number of green turtles are processed each year. Negeri and Tow (1977) as cited by Mack, Duplaix, and Wells (this volume) reported that an average of 400 hawksbills and 100 green turtles are processed each year in Cebu City alone.

Historically, the green turtle has been the most abundant species in most parts of the country, while the others have occurred in relatively high numbers. However, a recent survey of the distribution of sea turtles, conducted by FORI, in the Philippines, showed a marked decline in the populations of green and hawksbill turtles as indicated by the decrease in their nest distribution (Fontanilla and de Celis 1978).

The status of the resource and the industry related to marine turtle exploitation has been evaluated recently by Mr. Ceferino P. Datuin (Team Leader of Wildlife Commodity of the Philippine Council for Agriculture and Resources Research) in the southern seas, west and southwest of Zamboanga City towards the southern borders (Datuin 1979). His choice of this survey area was based on the fact that this is one region where there has been heavy harvesting.

Datuin's survey, which included observations and interviews with collectors in the Tawi-Tawi group and the Philippine Turtle Islands, indicated that during the last 5 years, it has been extremely difficult to capture 1 turtle of marketable size (61-cm carapace length), each day for each collector, compared with as many as 4 per collector per day in previous years. This situation

makes the turtle-dependent tribes explore other distant seas beyond their previous abundant hunting grounds, just within and off Cagayan de Sulu and Tawi-Tawi. He further reported that turtle egg gathering is becoming less lucrative, and the discovery of egg-laying spots is now "by luck." He estimated that only 300 eggs per collector is possible, in contrast with the 800 to 1,000 eggs per week per hunter in the early 1970s. In the past, 20 to 30 small islands in the southern seas, with a total of at least 70 to 100 linear km of vegetated sandy beaches were considered favorite nesting grounds for sea turtles. Datuin reported that, nowadays, only 20 km of these are good hunting grounds for eggs in the Tawi-Tawi group.

Local Plans and Strategies to Conserve Sea Turtles

In June 1979, President E. Marcos of the Philippines signed Executive Order 542 creating the Task Force Pawikan. The President sees the urgent need for the conservation of these economically important marine resources.

The Task Force Pawikan was created under the Office of the President to: 1) enforce existing rules and regulations pertaining to marine turtles; 2) conduct field investigations relevant to formulating and updating policies for the economic utilization of the species; 3) conduct information and extension work aimed at making people responsive to the marine turtle conservation movement; 4) conduct socio-economic surveys to be used as a basis in the formulation of substitute avocations for people currently utilizing marine turtles; and 5) coordinate with international agencies concerned with the conservation of marine turtles.

Conclusion

The Philippines' share of the international marine treasure, the sea turtles, shows a definite trend of population depletion as indicated by reports on recent observations, cursory surveys, and preliminary studies. The trend is attributed to the obvious imbalance between local exploitation and natural replenishment rates from both island-hatched and migratory sources. While the island-hatched group is adversely affected by unregulated collection of eggs and hatchlings; the migratory group is jeopardized by habitat disturbances that deplete sources of preferred foods. Poor food resources may discourage migrants which may sojourn here either for feeding or breeding.

The drastic decline of merchantable yields of even-sized or even-aged turtles indicates a resource crisis, an obvious case where the local conservation effort is outraced by harvest. This situation if not halted, will come to a point where the restoration of the population to productive levels may become untenable.

The pressure on the marine turtle resource is attributed to worldwide commercial demand; economic needs of local dependents; and the sociological, cultural and political maturity of the people in the archipelago.

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The Status of Sea Turtle Populations in East Malaysia and the South China Sea

ABSTRACT

This paper confines its comments to sea turtles in the East Malaysian States of Sabah and Sarawak; principally the former. No information is available from Brunei, an independent Sultanate outside Malaysian jurisdiction. Comments are based on the writer's personal observations and experiences, reports from fishermen, islanders and seafarers, and antiquated records. The overexploitation of sea turtles, especially *Eretmochelys*, existed even 50 years ago. The slaughter has since accelerated catastrophically. This paper also describes the acquisition of 3 privately owned island rookeries by government for conservation purposes and their final evolution into The Turtle Islands National Park.

The economic importance of turtle eggs, meat, shell, and other products is discussed, and some export figures are provided. For the first time Sabah data on tagging, long distance recoveries, remigrations, and species are presented. Information regarding the Sarawak egg decline has been provided. Apparently, a similar variation occurs in Sabah, but the smaller Sabah islands yield larger harvests. There are brief notes on the Philippine situation. Finally, it is suggested that an International Marine Sanctuary be established by conservation agencies of both countries to save turtles from extinction. Their future is in our hands.

Introduction

The large land mass known as Borneo straddles the equator. Together the East Malaysian States of Sabah, Sarawak, and the independent Sultanate of Brunei comprise about a third of the island of Borneo. The remainder of the island is Indonesian territory.

The purposes of this paper are to comment on the status of *Chelonia* and *Eretmochelys* populations principally in the East Malaysian State of Sabah. To some extent, comments are made on the Philippine and Sarawak resources. All the Sabah rookeries mentioned in this paper were visited by the writer at various times. Out of the 7 species of marine turtles found in tropical

waters of the globe, only the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) are known to nest in Sabah. In 1964, due to misidentification (Harrisson, personal communication 1969) the nocturnal nesting of loggerhead turtles (*Caretta caretta*) was reported on Pulau Gulisaan by Harrisson and quoted by de Silva (1969a). Another species reported to be found in Sabah waters will be commented on later. Green turtles, hawksbill turtles, and a few ridleys (*Lepidochelys olivacea*) are known to nest in Sarawak. In Philippine territory green turtles, hawksbills, and leatherbacks (*Dermochelys coriacea*) are found. Information regarding the 3 species in the Philippines has been gathered from barter traders and fishermen visiting various islands close to Sabah, but remotely situated from Manila. In this paper, unless otherwise indicated, the writer has drawn heavily from information passed on to him, as he has for various reasons been prevented from crossing the international boundary. On one occasion, pirates fired on the boat in which the writer was traveling. Another time, the writer witnessed the gunning down of a small fishing boat near Pulau Bakkungan Kecil, an island within the National Park. On 9 July 1977 the same island was the scene of a bloody battle between "pirates" and the Sabah police. During the past 2 years, various newspapers have reported several acts of piracy. Although naval and marine police patrols have greatly increased, the seas have to be traveled with trepidation.

Official Conservation Policy

In 1964, an excellent piece of legislation—the Fauna Conservation Ordinance, 1963 came into force. The control of turtle farms and all matters connected with turtle conservation passed firmly into the hands of the Chief Game Warden, and a conservation policy was formulated by the writer who was then Assistant Chief Game Warden. The issue of turtle hunting licenses ceased forthwith, and the closed season in March for turtle egg collection was to be vigorously enforced on the Turtle Farms to counteract the deliterious effects of the unwise use of a valuable natural resource. The former was carried out, but owing to the paucity of staff, inadequate transport, and the threat of piracy, the latter could not be enforced throughout the state. However, when the situation improved in 1966, the closed season was enforced on the Turtle Islands and a hatchery established on Pulau Selingaan. It is unknown why March was decreed under the legislation as the closed season. Only a few turtles nest during March on the turtle farms, and difficulties of enforcement arose due to monsoon conditions.

Turtle Farms

Under the Fauna Conservation Ordinance (Turtle Farms) Regulations of 1964, 8 islands were constituted turtle farms. It was a legacy of the past and only procured revenue. Turtle rookeries or populations were insecure and changes had to be made gradually. On the turtle farms, the exclusive rights to collect turtle eggs could be granted to tenderers. As 5 islands were remotely situated, control was difficult. Control was possible only on the 3 islands near Sandakan.

Turtle Eggs—Native Reserves

Native rights were safeguarded under the Fauna Conservation Ordinance of 1963 to enable natives to collect turtle eggs, without a license from Turtle Eggs Native Reserves, off-shore along the mainland from Tanjong Nosong in Kimanis Bay to Kota Kinabalu Wharf, from Pulau Tiga and Pulau Gaya, from Pulau Sipadan in Tawau, and in the Kudat District. In 1968, native rights were extended to the whole of the Kota Belud District, including the islands of Mantanani Kechil, Mantanani Besar, Pulau Ukusan, Pulau Silar, and Pulau Pandan Pandan. Native rights, zealously guarded, are enshrined in the constitution.

Need for Conservation

In Sabah, millions of eggs have been harvested for several decades. Apart from being considered a delicacy by several ethnic groups, the eggs provide a very important source of food to an impoverished, protein-starved population in remote and underdeveloped areas. Harvests from rookeries close to markets provide a source of income. Along the coast where there is a Malay population professing Islam, turtles are not killed for food as custom forbids it. However, the eggs are eagerly collected. Apart from the eggs, turtle flesh is considered a delicacy among the Chinese, and the pagan Rungus Dusuns of Kudat who openly treat the game laws with utter contempt. The concept of exploiting fully an easily procurable resource is ingrained. At the time of the writer's visit, Sikquati Beach was littered with the skeletal remains of 13 turtles. Skeletal turtle remains were also found on other islands near Kudat. Immigrant Cocos islanders of Lahad Datu were, prior to 1964, issued with licenses to kill turtles as they considered its flesh very essential for their existence. After settling on the mainland, they did not need turtle flesh to satisfy their capacious appetites. According to reliable reports received from Saburi (personal communication 1966) and other islanders, large numbers of turtles were slaughtered by the Japanese militia during the second world war on the 3 islands in the Sulu Sea when food was scarce, and who can blame them for this? A similar situation existed in Sarawak during the same regime and period (Harrisson 1967; Chin 1976a). Indications are that turtles are becoming scarce

on some well-known beaches.

The decrease in Sabah waters can be attributed to: 1) mass egg collection for over 50 years on every rookery, leaving insufficient nests left to hatch; 2) the constant frightening away of breeding turtles approaching the nesting beaches by brightly illuminated fishing vessels; 3) illegal hunting by mechanized fishing vessels in Sabah waters to supply the ever increasing demand on the mainland; 4) increased small boat activity off nesting beaches; and 5) the large scale slaughter of turtles outside the territorial waters of Sabah, in the Sulu Sea, the South China Sea, and the Celebes Sea by Filipino fishing vessels. In 1964, Harrisson indicated that the former policy of collecting only eggs was not being observed in the Philippines and that nesting turtles were being captured for meat. The Japanese, well aware of the demand, are raping the sea outside but near East Malaysian territory. It is, of course, impossible to prevent or control this pernicious slaughter. As nothing could be done about it, maximum care had to be taken to conserve what was presently available in Sabah. Therefore, as far back as 1965 it was decided to set up a turtle hatchery on Pulau Selingaan, but due to lack of funds and personnel it was postponed until 1966. Eggs were purchased from the licensees with great difficulty and there was a time when the government tendered the eggs to collectors at M=/02.5 cents each and purchased them for M=/09 cents each for conservation purposes. This situation went on for several years with protests from licensees to persons of authority. Moreover, the presence of rangers on the islands was resented. The collection of sand and coral for mainland construction projects was encouraged by the islanders for material gain. Sand was taken at all times of the year, and the few wild nests that had escaped the collectors were inadvertently dug up. However, conservation policy was implemented without fear or favor and rigorously enforced. Gradually staff were posted permanently on the 3 islands and hatcheries established. At times, due to security reasons or inclement weather, especially during the months of October to March, staff had to be withdrawn from the islands and hatchery operations discontinued. This took place several times during the period 1969–70.

Other Legislation Since 1964

Since 1966, trawler fishing close to the islands had considerably increased. Hatchlings and adult turtles were sometimes caught in fishing nets. As uncontrolled operations posed a threat to turtles, the Fisheries Department cooperated by banning trawling operations within 1 mile of the island. As in Sarawak (Hendrickson 1958) and elsewhere, in Sabah, turtles have a period of high-density nesting when egg collectors on the turtle farms harvested practically every egg. They refused to concede that the survival of turtles was dependent on mass egg production and concentration. Apart from mass egg collections, their habitat was threatened. Therefore, in 1971 the State compulsorily acquired the islands for M$89,000/= from private ownership. In 1972, the 3 islands were constituted Game and Bird Sanctuaries by the Yang di Pertuan Negeri (Governor).

Marine Turtle National Park

In late 1977, the government converted the 3 game sanctuaries into a 1,700-ha National Park to embrace not only the islands but also the surrounding coral reefs and sea between the islands. The move was essential to protect the coral reefs from commercial exploitation and the surrounding sea from illegal fish dynamiting. Apart from this, small fishing fleets anchor off the islands with bright lights to clean and pack fish for marketing. Their activities had several effects: 1) brightly illuminated fishing vessels frightened away turtles approaching the nesting beaches; 2) discarded fish, offal and edible refuse dumped into the sea, attracted large numbers of sharks and predatory fish to the vicinity of the islands, only to attack hatchlings entering the water after release; 3) survivors of the initial attack became disoriented and swam towards the brightly illuminated fishing vessels and were preyed upon by predators in the vicinity of trawlers; and 4) the foul discharge of bilges, toilets, empty cans, bottles, and plastic containers contaminated to some extent the coral reefs and island beaches.

Turtle Eggs—Economic Importance

The demand for turtle eggs in Sandakan is insatiable. Prior to 1973, the supply was obtained from the 3 turtle farms north of Sandakan, and augmented, seasonally, with harvests from the islands toward Kudat. At times the price of eggs fluctuated. During optimum laying months, the price fell, and the suppliers quickly ceased flooding the market. When the 3 islands became game sanctuaries, the egg supply ceased on 31 December 1972, but Sandakan continued to be supplied by Filipino barter traders with harvests from Bakkungan Besar and Taganak. At this writing, an egg costs M=/ 25 cents in Sandakan. In 1967 and 1969, the egg harvest was 677,275 and 650,930, respectively. During those 2 years an uninterrupted physical check *in situ* could be maintained on egg harvests on the 3 islands. Since 1970, there has been a decline in the egg harvests.

Exploitation

Fortunately, up to now no export avenues for turtle

eggs or turtle products have been investigated by the commercial sector. However, demand for turtle eggs is heavy in Hong Kong's red-light district, although their efficacy as an aphrodisiac has not been scientifically shown (de Silva 1971). Their source of supply is undetermined, but Chinese traveling to Hong Kong from Sandakan take turtle eggs in small quantities as gifts which are highly appreciated in the Colony.

Kota Belud and Kudat get their supply from nearby beaches during the season. The sale of eggs contributes to the welfare of the local people in those places as they have very little or nothing to sell from their remote, barren and unproductive lands. In recent times, the egg supply in the aforementioned areas has dwindled, and fewer turtles come ashore to nest. In both areas, turtles are slaughtered by the local inhabitants for sale. The flesh, shell, and other parts are sold to Filipino barter traders. In Mengatal, turtle meat is obtained from an undetermined source and sold only to known customers. Collection records for the Sandakan islands during the period 1947–64 are very scanty. No records are available prior to 1947. However, it appears that even in 1933, exclusive licenses to collect *Chelonia* eggs for 3-year periods were issued by the Resident, Sandakan.

It is concluded, partly from conjecture, that even 45 years ago, the pressure on *Eretmochelys* was evident and appreciated. Laws were drafted in accordance with the Islamic custom of collecting only the eggs. Table 1 indicates the egg harvests for the period 1965–72 from the 3 privately owned islands. Although the islands ceased to be turtle farms in November 1972; licensees were permitted to harvest turtle eggs until the licenses expired in December. Since 1973, all eggs harvested are destined for hatchery. Table 2 indicates the egg harvests for the period 1973–78. Thieves from Pulau Liberan have, however, stolen eggs.

Revenue and Licenses

During the period 1950–64, the exclusive rights to collect turtle eggs were given by competitive tender, and the price steadily increased until 1964 (Table 3). The very high tender rate indicates that rich harvests were obtained from the islands or harvests from the Philippines were cheaply procured and added to the licensees' harvest. The effects of the licensing system during 1950–64 were: 1) to increase the price of eggs to the consumer; 2) to cause tremendous dissatisfaction to the owners of the islands; and 3) to introduce a number of Chinese middlemen into the business.

From 1965 to 1971 licenses were given at reduced rates to the owners of the islands with a view to ameliorate their economic status. The rights were offered to the land owners of the 3 islands at the rate of M = /02.5 cents an egg multiplied by the island's estimated average yearly output.

Estimated Nesting Populations

Nesting occurs throughout the year on the National Park rookeries, but nesting densities vary monthly. Although attempts were made to record the activities of every nesting turtle, it has been impossible to do so. From available data, the average has been taken and the estimated nesting population for 1967, 1969, and 1973 through 1978 are given in Table 4.

Hatcheries

Since 1 August 1966, hatcheries have been in existence in the area now known as the Turtle Islands National Park. Three hatcheries are now in operation—1 on each island. Hatchery statistics for the period 1966–78 are presented in Table 5. During this period 2,705,903 eggs were transplanted and 1,792,350 hatchlings released.

Barter Traders and Turtle Products

In April 1970, 136 *Eretmochelys* and 126 *Chelonia* carapaces were brought to Sandakan by Filipino barter traders for shipment to Nansi Corporation, Osaka, Japan. In September, another consignment, comprising

Table 1. Egg harvest from privately owned islands

Year	*Selingaan*	*Bakkungan Kecil*	*Gulisaan*	*Yearly total (3 islands)*
1965	284,940	126,930	63,580	475,450
1966	236,191	73,617	55,622	365,430
1967	437,258	128,894	111,123	677,275
1968	175,097	60,052	63,648	298,797
1969	405,345	144,757	100,228	650,330
1970	359,848	97,140	82,605	539,593
1971	262,823	110,814	86,063	459,700
1972	218,847	120,803	66,409	406,059
Total	2,380,349	863,007	629,278	3,872,634

Table 2. Egg harvest from the Turtle Islands National Park

Year	*Selingaan*	*Bakkungan Kecil*	*Gulisaan*	*Yearly total (3 islands)*
1973	271,380	161,416	77,476	510,272
1974	188,684	109,498	70,248	368,430
1975	196,730	105,991	77,573	380,294
1976[a]	(115,171)	(94,390)	(44,318)	(253,879)
1977	138,977	108,030	64,934	311,941
1978	118,407	137,472	66,223	322,102
Total	1,029,349	716,797	400,772	2,146,918

a. Figures for this year are inaccurate.

200 carapaces and 300 plastrons and flippers, was brought to Sandakan for shipment to Osaka, together with a certificate from the Fisheries Officer, Siasi, Sulu, indicating that the turtles were killed in Philippine waters (de Silva 1971). Their activities would certainly have encouraged natives or other interested persons to slaughter turtles when the value of shell was publicized. Furthermore, as investigations revealed that turtles were being slaughtered (within Sabah territorial waters) in the Celebes Sea and sent via barter traders to the Philippines for shipment to Sandakan, the import of *Chelonia* and *Eretmochelys* shell, skin, calipee, and oil was prohibited from all countries including West Malaysia by 2 Federal Gazette Notifications in 1971. The ban was effectively enforced without exception. Present indications are that the trade has gone elsewhere. According to Uchida (1977) over 1,000 kg of hawksbill turtle shells were imported to Japan in 1975 from the Philippines.

When Pulau Belian, which is outside the National Park, was inspected, large quantities of dry fish were found. As no nets were observed on the island or on the fishing boats, which were searched, the writer concluded that all the fish were dynamited. Although the fishermen emphatically denied killing turtles deliberately, they admitted that a few were killed "accidentally" by explosives. The carcasses were sold to Filipinos. Dynamiting fish in this area has adversely affected breeding turtles found there. Explosives are purchased from Filipino fishermen, or from *kumpits* (boats) bringing immigrants to Sabah from the Philippines. Dynamiting has also been observed near Mantanani Besar and Mantanani Kechil and also takes place around other turtle rookeries situated in remote areas. This is impossible to control.

In the past, fish dynamiting frequently occurred in the area now within the jurisdiction of the National Park. Although curbed, this nefarious activity abounds between Pulau Bakkungan Kechil and Pulau Bakkungan Besar in Philippine territorial waters. Occasionally, small Filipino boats cross the border and dynamite fish near Pulau Bakkungan Kechil. These operations kill turtles. When action is taken to apprehend them, they take sanctuary in Philippine territory.

Table 3. Tender prices, 1950–64

Year	*Price (M$)*	*Year*	*Price (M$)*
1950	500.00	1958	7,600.00
1951	500.00	1959	10,600.00
1952	500.00	1960	13,400.00
1953	600.00	1961	15,863.00
1954	1,000.00	1962	15,863.00
1955	2,300.00	1963	15,200.00
1956	2,860.00	1964	20,050.00
1957	4,550.00		

International Tagging Recoveries and Migration

The discussion of the status of marine turtles would be incomplete without some comment on international tag recoveries and migrations. The data from Sabah are made available for the first time but are too limited to determine whether *Chelonia* and *Eretmochelys* are pe-

Table 4. Estimated nesting population on Turtle Islands during 1967, 1969 and 1973–78

Year	*Number of eggs harvested*	*Number of nesting turtles*
1967	677,275	806
1969	650,330	774
1973	510,272	607
1974	368,430	438
1975	380,294	452
1976[a]	—	—
1977	311,941	371
1978	322,102	383

— No data.
a. Accurate figures for 1976 are not available.

Table 5. Hatchery statistics, Pulau Selingaan, Pulau Bakkungaan Kechil, and Pulau Gulisaan, 1966–78

Period	*Number of eggs transplanted*	*Hatchlings released*	*Percentage hatch*	*Remarks and explanatory notes*
1 Aug–30 Sept 1966	21,092	15,005	71.14	a. 1975 total number of eggs harvested = 380,294
27 July–30 Sept 1967	37,493	33,966	90.59	Less Selingaan figures 196,730
4 Mar–4 Nov 1968	137,500	96,951	70.50	Less eggs stolen 34,741
1 Feb–31 Dec 1969	50,053	31,729	63.39	Used for hatchery 148,823
1 Jan–30 Oct 1970	75,362	49,181	65.25	
1 Jan–31 Dec 1971	110,115	59,971	54.46	b. 1976 total number of eggs harvested = 253,879
1 Jan–31 Dec 1972	403,159	232,906	57.77	Less Gulisaan eggs not accounted for in hatchery
1 Jan–31 Dec 1973	510,272	317,410	62.20	(records missing) 44,318
1 Jan–31 Dec 1974	368,430	304,889	82.75	Used for hatchery 209,561
1 Jan–31 Dec 1975	148,823[a]	94,438	63.45	
1 Jan–31 Dec 1976	209,561[b]	114,665	54.71	c. 1978 – Stolen eggs not included
1 Jan–31 Dec 1977	311,941	205,591	65.90	
1 Jan–31 Dec 1978	322,102[c]	235,648	73.15	
Total	2,705,903	1,792,350		

riodic long distance migrants or whether they commute between the National Park and distant feeding grounds in the Philippines and Indonesia. So far 8,980 turtles have been tagged, but only 6 international recoveries have been reported: 4 from the Philippines and 2 from Indonesia (Table 6). The most distant recovery was from Kai Kechil (Indonesian territory). The green turtle had traveled 1,556 km from Selingaan prior to capture. The shortest distance 713 km, was traveled by a hawksbill slaughtered at Culasi. Three of the recoveries were made during the northeast monsoon, and it is unknown to what extent high velocity winds, currents, and heavy seas influenced their speed and direction. Apart from the insufficiency of recovery data to justify conclusions regarding turtle navigation, the period between tagging and recovery in 5 cases was too lengthy to indicate speed of travel. A hawksbill (No. 6634) tagged on Bakkungan Kechil was recovered in Culasi, Philippines after it had traveled 713 km in 40 days or 17 km per day, presuming that it left immediately after its last lay and was captured promptly on arrival. Of the many hawksbills tagged within the National Park since 1970, only 1 has so far been recovered. Carr and Stancyk (1975) record that out of 130 hawksbills tagged at Tortuguero only 7 have been recovered and adds that a female tagged at Miskito Cay, Nicaragua was observed nesting 496 km away at Pedro Keys, near Jamaica.

Available data indicate that 2 turtles tagged north of the equator traveled south of the equator into Indonesian territory. With one exception, all tag recoveries terminated with the capture of the turtles. Four of the international recoveries have been reported from the Philippines. Harrisson (1959) tagged turtles in Sarawak, and a *Chelonia* tagged at Talang Besar, Sarawak in 1953 was recovered 800 km away off Kimanis, British North Borneo (now Sabah), in 1959. Three Indonesians who had gone to Sematan, Sarawak, in August 1959 had reported to Harrisson (1959) that turtles bearing metal tags on their flippers had been observed nesting on the coast around the Sarawak border at Tanjong Datu during July and early August 1959. No other tagging data are available from Sarawak. As *Chelonia* from Sabah and *Dermochelys* from Trengganu (Polunin 1975) have been recovered mostly in Philippine waters, assistance of the Philippine authorities is vital to formulate conservation policy favorable to this region. Indonesia too will have to assist, especially as turtles tagged in Sarawak are said to be observed in Indonesian territory.

Tagging and Remigrations

During the period 1970–78, 8,980 turtles were tagged on the 3 islands. Accurate species records are unfortunately unavailable as some of the files are lost. From 1970–74, 5,000 turtles were tagged. Of these, 19 *Chelonia* returned in 2 years and 83 in 3 years. From 1975 to 1978 tagging was done intermittently. From available information, it is postulated that *Chelonia* remigrates to the National Park every 2 and 3 years with the triennial cycle dominating. Only a few 4-year returns have been recorded. Harrisson (1956) and Hendrickson (1958) record the existence of a triennial cycle in Sarawak. Schulz (1975) has recorded 1-, 2-, 3-, and 4-year returns in Surinam. In Sabah 4-year returns have been recorded only 5 times, and there is the possibility that these may be 2-year cycle returns with the inter-

Table 6. Long-range recoveries of turtles tagged at the National Park

Tag number	*Tagging date*	*Species*	*Tagging place*	*Recovery place*	*Recovery date*	*Distance traveled (kilometers)*	*Time taken (days)*	*Average speed per day (kilometers/day)*
2840	22/8/72	Green	P. Selingaan 6°11'N, 118°04'E	Barrio Alegria, *Caluya*, Antique Philippines. 11°56'N, 121°33'E	18/5/73	740	296	2.7
3429	8/4/73	Green	P. Selingaan	Barrio Libas, *San Julian*, Eastern Samar, Philippines. 11°45'N, 125°27'E	2/11/73	1,056	209	5
3641	13/7/73	Green	P. Selingaan	Barrio Buli, San Augustine, *Rombolon*, Philippines. 12°35'N, 122°15'E	7/3/74	870	237	3
6634	12/2/77	Hawksbill	P. Bakkungan Kecil 6°10'N, 118°06'E	Tubungaan, *Culsasi*, Antique Philippines. 11°26'N, 122°03'E	23/3/77	713	40	17.8
4292	5/9/74	Green	P. Bakkungan Kecil	*Kai Kechil*, Malulucas, Indonesia. 5°45'S, 132°40'E	28/3/77	1,556	934	1.6
6766	10/5/77	Green	P. Selingaan	East Coast of *Cempedek* Island, S.E. Sulawesi, Indonesia. 2°28'S, 110°08'E	10/2/78	1,305	276	4.7

mediate remigration missed by the staff. One *Eretmochelys* remigrated after 2 years and 3 after an absence of 3 years. Again, lack of information precludes comment. Carr and Stancyk (1975) speculate that the 3-year remigration cycle predominates in Tortuguero.

Other Conservation Proposals

Pending is a proposal to convert an area of approximately 8,800 ha in the Darvel Bay area of the Celebes Sea including the islands of Bodegaya, Bokeydulang, Tetagan, Mantuban, Pulau Maiga and Pulau Sibuan including the coral reefs surrounding the islands into a National Park. If this park comes into existence more information on sea turtles in that area could be obtained and hatcheries set up.

Other Species

Although, at the moment, 2 species of turtles are definitely known to occur, there appears to be yet another species inhabiting Sabah waters. In 1969, when the writer investigated the occurrence of turtles on Banggi Island, inhabitants of Kampong Karakit reported that 3 species of turtles visited the beaches of Pulau Patanunan in October and November. One is known locally as *tohongan* (*Eretmochelys*), the other *penyu* (*Chelonia*), and the third *penyu bulu* (species unidentified) which is said to be a "reddish" (?) medium-sized turtle. According to K. K. Magimpat bin Kuyanga (personal communication 1969) of Kg. Minyak, Kudat District, 3 species visit Koromkunjaan beach towards the latter half of December and up to February in small numbers: *sisik pangal* (*Eretmochelys*), *timbau* (*Chelonia*), *morong* (species unidentified). He opined that the *morong* eggs were larger than *timbau* eggs. While in Kampong Sikqati, Kudat District, natives again reported the occurrence of 3 species of turtles. The unidentified turtle was referred to by the Rungus name *raya kaya*. Investigations are difficult, as the unidentified turtle only nests during the northeast monsoon (de Silva 1969b).

The leathery turtle or luth has not yet been recorded

in East Malaysian waters. However, on 13 July 1977, D. V. Jenkins, formerly Director, National Parks, Sabah and the crew of the MV *Sri Taman Negara* observed 2 "massive" turtles swimming about 100 m away from the launch. The writer observed only a large black flipper. From the description furnished by Jenkins and the crew, the animals were definitely *Dermochelys*. The writer has surveyed nesting beaches in the Sulawesi (Celebes) Sea but found no trace of *Dermochelys* even though fishermen and islanders were questioned (de Silva 1978).

Sarawak

The 3 Turtle Islands of Sarawak are situated near the island of Borneo. The 100-ha Satang Besar Island is located at approximately 110°9'E, 1°47'N. Talang Talang Besar (37 ha) and Talang Talang Kechil (12 ha) are located roughly at 109°46'E, 1°55'N. They are larger than any or all of the Sabah Turtle Islands.

Three species of marine turtle—*Chelonia, Eretmochelys,* and *Lepidochelys* (Hendrickson 1958; Harrisson 1969; Polunin 1975) are known to nest on the islands.

Harrisson (1969) indicated that the 3 island beaches are frequented almost exclusively by *Chelonia*, although a few *Eretmochelys* and *Lepidochelys* nest mainly during the early months of the year. Although Satang Besar is the largest of the 3 islands, it has the smallest nesting population and Talang Talang Besar the largest nesting population of *Chelonia* (Hendrickson 1958). Chin (1976b) reports a good *Chelonia* nesting beach between Sematan and Sungai Semunsan. Turtles also nest on beaches at Tanjong Similajan north of Bintulu.

Turtle eggs were harvested on the Sarawak Islands prior to the Brooke era. Harrisson (1962) who made an exhaustive study of turtles in Sarawak speculated that a century ago turtles had been numerous on the islands. Hirth (1971) quotes Banks's report of a 2,119,912 egg harvest in 1927. Of these 70 percent were consumed or sold locally. In 1935, 9 percent of 924,000 eggs collected were consumed locally. According to Harrisson (1962) 929,123 eggs were harvested in 1946 and 708,035 in 1947. This was during the Japanese occupation, and the figures are considered inaccurate. Yields in excess of 3 million eggs were produced in 1934 and 1936; 1950 and 1953 produced yields in excess of 2 million eggs. The records for 1954, 1955, 1957, 1959, and 1961 indicate that over 1 million eggs have been collected yearly. However during 1956 and 1958 the harvest dropped to 600,000 eggs per year. In 1960, only 519,677 were harvested. From 1927 to 1961 the variation from year to year is considerable. Harrisson provides the following information regarding average egg yields during the period 1927 to 1961:

Period	*Number of years with data*	*Average green turtle eggs a year*
1927–36[a]	7	2,184,095
1937–46[b]	—	—
1946–47[c]	—	—
1948–54	7	1,581,132
1955–61	7	1,038,129

a. Excludes 1929–31.
b. No data or unreliable data.
c. Inaccurate data (Japanese occupation).

Harrisson states that "a downward trend seems, on this data, evident. Inside 3 decades, the lay has halved. It appears fairly certain that the main decline began after the late thirties." From data on 1964–70 made available by Chin (personal communication 1979) the writer was able to add information for 1964–77, for the following average per annum green turtle egg yields from 1964 to 1978:

Period	*Years with data*	*Average number per annum*
1964–70	7	324,669
1971–77	7	271,895

These data are reflected in Table 7. The figures indicate that the downward trend continued. The 1964–70 figures indicate that the lay is less then half of the 1955–61 period and the 1971–77 lay is slightly more than half of the 1964–70 period. Harrisson (1967) submitted a lengthy statistical analysis of the egg trends to his Ministry and subsequently summarized it as follows:

1900/1940—slow decline; 1941/1945—serious interference by Japanese including eating turtles and using the exposed rocks off Talang Talang Kecil as a bombing range; 1947/1955—egg yields regularly over 1 million plus extensive conservation and rearing of baby turtles to renew depleted population; 1955/1965—downward trend continues, despite conservation; this is accentuated by the much increased disturbances around the islands, motor boats and large steamers; culminating in the bauxite mining operations at Sematan for 1957. 1966—unprecedented spectacular drop to below 100,000 eggs—or less than 10% of the pre-1955 average yield.

Harrisson (1967) also compares the annual egg lays for 1965—419,066 and 1966—99,307 and concedes "that a drop of 400,000 to 100,000 is unprecedented and runs in contradiction to all known trends and appears to lie outside the range of statistical or logical probability." Chin (1976b) indicates that unconfirmed reports suggest that increasing numbers of turtles nest on the mainland Sematan beaches. The Tanjong Sim-

Table 7. Sarawak egg harvest, including hatchery and hatchling figures, 1964–76

Year 1	Sabah[a] 2	Sarawak 3	Eggs transplanted 4	Percentage of years harvest transplanted 5	Number of hatchlings released 6	Number of eggs sold 7	Total revenue (M$) 8	Expenditure (M$) 9
1964	—	289,691	8,079	2.78	—	243,258	22,074.56	35,567.38
1965	475,450	419,066	8,465	2.01	—	372,768	34,500.26	32,668.85
1966	365,430	98,843	1,554	1.57	—	73,639	8,013.52	28,176.70
1967	677,275	478,622	1,203	0.25	—	431,123	42,370.17	28,314.41
1968	298,797	200,731	707	0.35	—	158,687	31,762.60	20,629.33
1969	650,330	516,581	2,252	0.43	—	469,597	46,749.30	26,841.55
1970	539,593	296,151	2,227	0.75	1,544	227,420	23,278.92	24,348.14
1971	459,700	194,289	180	0.09	127	158,053	17,615.30	24,261.49
1972	406,059	265,525	992	0.37	327	226,109	28,225.24	25,723.77
1973	510,272	323,734	8,535	2.63	8,000	281,551	34,765.88	27,332.20
1974	368,430	204,507	1,191	0.58	785	192,455	29,852.58	32,453.85
1975	380,294	203,140	991	0.48	847	186,249	34,851.26	36,558.53
1976	253,879[b]	299,398	13,159	4.39	12,639	276,578	54,888.52	40,877.18
1977	311,941	159,156	13,134	8.25	11,804	141,600	28,848.10	37,023.50
1978	322,102	253,518	3,003	1.18	14,801	234,331	61,957.75	42,870.60
		4,175,952	80,670			3,673,418	499,753.96	463,647.48

— No data.

a. Sabah figures are given for purposes of comparing harvests.

b. Figure inaccurate due to change of management.

ilajan beaches are also used by turtles, but the nesting density or population is as yet unknown. Eggs are randomly collected or destroyed by predators.

The probable associated reasons for the decline in egg production in Sarawak have been made available by Harrisson (1967). If the collection of eggs is perpetuated by the Sarawak Turtle Board as is now done, then the decline will obviously be accelerated. According to available information, every egg is harvested with only a small percentage left to hatch (Table 7). Chin (1976b) indicates that trawling operations have increased in the South China Sea. Although turtles are not deliberately caught, many are accidentally trapped in the trawling and drowned. He also adds that pollution is becoming a serious problem along the Bornean Coast. Ships of other nations are active in the South China Sea, and they deliberately capture turtles. As the turtles are receiving a very hard battering, it is doubtful if they will survive.

During Harrisson's term as Curator, Sarawak Museum, turtle hatcheries were established on the islands and eggs in varying numbers were transplanted. After his retirement, hatchery work continued under the present Curator Lucas Chin. Hatchery statistics for the years 1964–78 are in Table 7. Chin (personal communication 1979) indicates that the egg decline has been taken seriously, and the Turtle Board of Management has initiated a new conservation program. In 1973, the Fauna Preservation Society of London donated 100 pounds sterling for the purchase of eggs for hatchery purposes. During the period 1976–78 the Turtle Board paid M$2,000 to 3,000 for the purchase of eggs, and decided to improve this conservation program by stages from 1976 to 1980. Unlike in Sabah, the harvesting of turtle eggs within the territorial waters of Sarawak is a government monopoly. A corporate body of trustees manages the industry, and the profits are utilized to finance Malay charities. The legislation will not likely be amended now or in the future.

Philippines

From the Philippines, information regarding turtles is difficult to obtain. The market value of turtles was evident in 1927 but, without the heavy demand in world markets at that time, presumably turtles were not excessively hunted. However, within the last decade Philippine turtle populations appear to bear a heavy burden to meet local and world demands. In 1964, Harrisson indicated that apart from egg collecting, nesting turtles were captured for meat. In 1969, de Silva reported that Filipino fishing vessels hunted turtles in the Sulu and Celebes Seas. Trawler captains informed the writer that their catches could be disposed of within 72 hours in Zamboangao. In 1978, Fontanilla confirmed the plight of turtles in the Philippines and stated that in Zamboangao City, live turtles were sold in 3 sizes—small, medium and large. At Sin-

anoc, thousands of stuffed turtles were available for export—particularly to Japan. Polunin (1975) quotes Kajihara who estimated that 5,000 large *Chelonia* are captured annually in the Sulu Sea.

Trawlers operating near Pulau Bakkungan Kechil are armed. Crews use swimming or copulating turtles as targets and carcasses with neatly punctured carapaces are occasionally found floating near the island. One carcass carried Tag No. 8199. Polunin (1975) indicated that the main rookeries in the Sulu Sea were Pulau Boaan, Pulau Bagnan, Pulau Taganak and Pulau Bakkungan Besar and situated close to the Sabah border. Fontanilla and de Celis (1978) confirmed this and stated that nesting had declined. The authorities concerned with conservation now appreciate the position and have issued several administrative orders. Due to the turbulent situation in the South, a turtle management program is contemplated on Laubang Island at Barrio Kanaway, Looc. The President of the Philippines has formed a task force to prevent the extinction of turtles in the Sulu Sea.

International Turtle Sanctuary

Close to the Sabah territorial boundary and the Turtle Islands National Park are situated the Philippine Islands of Boaan, Bagnan, Taganak, Lihiman, Langaan, and Bakkungan Besar. Together they form a well-defined group of turtle rookeries. All the islands are heavily exploited for eggs and turtles. Most of the eggs harvested on Taganak and Bakkungan Besar are marketed in Sandakan. In addition, fish blasting occurs. Under these conditions, the conservation work undertaken on the Sabah islands is negated within a distance of about 1.5 to 15 km. Preventive action must be taken in the areas involved. Without being presumptious, it is suggested that the Philippine conservation agencies take cognizance of happenings in the pirate-infested southern Philippine islands and consider converting the islands involved into a turtle sanctuary. If this is done, a first International Turtle Sanctuary could be created. We will cooperate in any way possible or appropriate.

It is unknown whether or not all the Philippine islands involved are inhabited or privately owned. If they are, possibly the islands could be acquired and the inhabitants resettled elsewhere. This will probably be the greatest expense of the exercise. Full-time guards would also be needed on each island.

Acknowledgments

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Status and Conservation of Estuarine and Sea Turtles in West Malaysian Waters

ABSTRACT

The majority of Malaysians do not eat turtles, yet a thriving industry has grown up around the collection and marketing of their eggs. Four sea turtles (*Dermochelys coriacea, Chelonia mydas, Lepidochelys olivacea, Eretmochelys imbricata*) and 2 estuarine species (*Batagur baska* and *Callagur borneoensis*) figure prominently in this industry. All of these populations are currently declining due to a variety of factors including over exploitation, development of coastal areas, and expansion of fisheries.

Other than *Batagur baska* on the Perak River, large nesting aggregations have ceased to exist on the West Coast; trawling and conversion of nesting beaches into tourist beaches are important causes.

On the less populous East Coast, large nesting aggregations still occur but are rapidly disappearing. Since 1956, egg yields have been nearly halved with *Dermochelys* and *Chelonia* respectively producing only 34 percent and 43 percent of their former levels.

A variety of conservation programs have been started to stem this decline. The Fisheries Department currently operates 5 hatcheries for all of the major species. The Game Department operates an additional 3 hatcheries for *Batagur*. Several turtle sanctuaries have been proposed; an 8-km stretch of *Dermochelys* nesting beach will serve as a prototype of this concept.

Additional actions are recommended, including intensification of hatchery work, expanding sanctuaries, and prohibiting fishing within an 8-km radius of these sanctuaries during nesting seasons.

Introduction

Harvesting of turtle eggs has long provided an important protein resource to the coastal and riverine peoples of West Malaysia. Today, however, the continued existence of the turtle egg industry is being threatened by a multitude of factors including overexploitation of eggs, development of coastal areas, and expansion of

fisheries. It is the purpose of this report to discuss the effect of these factors on the turtles and to review conservation efforts that are being taken to maintain the resource.

West Malaysia, or more appropriately Peninsular Malaysia, is situated at the tip of the South East Asian mainland. A central range of high mountains divides the land. The sparsely populated East Coast faces the vast South China Sea and receives a strong northeast monsoon in the months of November to February and a milder southwest monsoon in the months of June to September. As a result of these monsoons, the beach, except at the southern end, is sandy and wide, providing excellent nesting grounds for sea turtles. Whereas, the West Coast, facing the narrow Malacca Strait with its heavy sea traffic, is generally flat, muddy, and has mangrove frontage. Although there are a number of islands and a few short sandy patches on the mainland, the beaches are frequently crowded with holiday makers and, therefore, are rarely visited by nesting females nowadays.

The majority of the population are Malays who profess Muslim religion. Though not strictly forbidden on religious grounds (Hendrickson 1958), Malays refrain from eating turtle meat because, in general, animals of amphibious habitat are considered *haram*. Therefore, turtles have been partially protected for the more than five hundred years since the introduction of Islam to Malaysia. However, the consumption of turtle eggs is allowed; eggs are considered delicacies with aphrodisiacal values, and collection of eggs is nearly 100 percent.

Four species of sea turtles and 2 estuarine species figure prominently in the turtle egg industry:

Family	*Scientific name*	*English name(s)*	*Malay name(s)*
Dermochelyidae	*Dermochelys coriacea*	Leathery turtle, leatherback, luth	Penyu Belimbing
Cheloniidae	*Chelonia mydas*	Green turtle	Penyu Agar, Penyu Pulau
	Lepidochelys olivacea	Olive or Pacific ridley	Penyu Lipas, Penyu Rantau
	Eretmochelys imbricata	Hawksbill	Penyu Karah, Penyu Sisek
Emydidae	*Batagur baska*	River terrapin	Tuntong Sungei
	Callagur borneoensis	Painted terrapin	Tuntong Laut, Sutong

The largest species, the leatherback, concentrates its nesting activities on a 19 km stretch of beach at Rantau Abang in Trengganu. The other 3 sea turtle species nest on both coasts but are more concentrated on the East Coast.

River and painted terrapins are estuarine species inhabiting tidal areas of rivers on both coasts. The former nests on sand banks lining the river whereas the latter (at least on the East Coast) usually nests on sea beaches near the river mouth.

Economic Importance

As early as 1937, sea turtles were defined as fish by law (Fisheries Enactment, 1937) and were thus considered a resource to be harvested and managed. Although the majority of the population does not eat turtle meat, and the killing of turtles has long been prohibited on the productive East Coast states, the consumption of eggs is allowed and very much favored.

Hendrickson and Alfred (1961) estimated East Coast egg production at 2 million in 1956 (probably underestimated, see below). Although production has now fallen to just over a million eggs and the price has increased to 5 times the price of a hen's egg, turtle eggs remain a good protein source for the East Coast people. The market value of the eggs amounts to US$240,000. Further, by leasing the egg collecting beaches to the highest bidder, the governments of 3 East Coast states collected another US$98,404 as revenue in 1978 (Kelantan US$985, Trengganu US$96,322, Pahang US$1,097).

The so-called turtle industry is made up of people involved in patrolling beaches to collect eggs, and others involved in transport and marketing of the eggs. An estimated 110 jobs were created by this industry.

Rantau Abang in Trengganu State is a small village, but annually an estimated 50,000 tourists, both local and foreign, flock here in the months of June to August to observe the leathery turtles lay their eggs. The economic activities generated by the influx of tourists benefits many people especially those in the village. To cater to the needs of these tourists, the Tourist Development Corporation has started a US$2.2-million tourist complex project around Rantau Abang. In Pahang, a motel at Chendor advertises turtle-watching to attract tourists. Also, pictures of turtles appear on many other travel and hotel brochures.

Other than the *Batagur* population on the Perak River, West Coast turtle populations are too depleted to be of much economic significance. In a good year, the Perak *Batagur* may still lay some 25,000 eggs having a market value upwards to US$4,800 thus provid-

ing important income to the local economy. Although Perak licenses egg collectors, the charge is minimal, and state income from this resource is insignificant.

Turtle management in Malaysia may thus be viewed as important not only from the conservation standpoint but also from an economic one.

Legislation

The first legislations concerning Malaysian turtles were promulgated in 1915 in Perak and Pahang. The "River Rights Enactment" of Perak prohibited the killing of turtles of the genera *Orlitia, Callagur, Batagur* and *Hardella* (which is not known to occur in Malaysia) and made collection of turtle eggs on a large portion of the Perak Rvier, the perogative of the Sultan.

In the Pahang State Enactment No. 3 or Turtles' Eggs Enactment, the Resident (Chief Administration Officer of the State) was given power to control the collection of turtle eggs, and turtle was defined as any reptile of the genera *Chelone, Thalassochelys, Dermochelys, Orlitia, Callagur, Batagur* or *Hardella*. Subsequently, the whole Pahang beach was controlled, and egg collection was under license.

The legislation was revised by State of Pahang Fisheries Rules 1938 made in 1938 under the Fisheries Enactment, 1937 in which turtle was first classified as fish. Under the Rules, which are still enforced, no person shall capture, kill, injure, sell, or have in his possession any turtle unless authorized, and no person shall in any way prevent or hinder turtles from laying their eggs.

Similar legislation was promulgated in the State of Kelantan under its Turtles and Turtles' Eggs Enactment of 1932 which was amended by the Enactment No. 8 of 1935 to give firmer control.

It is interesting to note that Trengganu, the state with the largest turtle population, waited until 1951 to promulgate the Turtle Enactment of 1951 to prohibit the killing of turtles and to control the collection of turtle eggs. Perhaps before then, the state was too sparsely inhabited.

In 1975, the Fisheries Department reviewed existing legislation and drafted new legislation to: 1) streamline existing legislations into a uniform law for the country; 2) transfer enforcement authority and responsibility to the Fisheries Department, and 3) impose stricter control on the turtle industry to ensure maximum utilization of the resource without endangering the turtles' survival.

This legislation has been submitted to various states and has already been adopted by a few.

Status of Populations

Malaysia achieved independence on 31st August 1957. Since then, the development both of land and of fishing has been very rapid.

Development Trends

Towns in the coastal region have expanded and continue to grow. More houses are being built on beaches. Due to a better road system, more tourists are visiting once undisturbed beaches. More beach areas are being turned into tourist resorts.

Fish landing has increased from 112,860 metric tons in 1956 (Malayan Fisheries 1957) to 564,898 metric tons (Malaysian Fisheries 1979) in 1978. This gain has resulted from intensification of fishing, improved efficiency due to mechanization, increased use of monofilament drift nets, and the introduction of prawn trawling in 1965 (Siow and Gan 1970). These activities, particularly prawn trawling, have taken a heavy toll on turtles.

The above, in addition to continued exploitation of eggs, have exerted a growing pressure on the turtles of Malaysia, resulting in a general decline of populations.

West Coast

Reports concerning past abundance of sea turtles are few. Cantor (1847) observed that green turtles were "at all seasons plentifully taken in fishing stakes in the straits of Malacca," and that the ridley occurred only rarely on Pinang Island. Flower (1899) thought the ridleys to be less common than either greens or hawksbills on the West Coast. Boulenger (1912) reported green turtles to be very common, especially on the Sembilan Islands, but that hawksbills were rare.

Nesting on the mainland is rare today. On 13 April 1975, a local newspaper published the discovery by the late Governor of Melaka of turtles nesting at Tanjong Kling, a 0.8 km beach 11 km west of Melaka town. On investigation, Kiew (1975) found that both the green turtle and hawksbill nest on the beach and on the nearby islands, Pulau Besar and Pulau Upeh. The number of hawksbill turtles nesting at Tanjong Kling was found to be larger than that of the green turtles which had been more abundant in the past. Kiew encountered 5 hawksbills in 6 nights nesting on the beach during peak season. Unfortunately the beach has since been developed into a well-lighted tourist and industrial area, thus destroying the last known nesting site in the southern part of the West Coast. Kiew (personal communication) considers attempts to save the turtles there to be fruitless.

Pangkor Island like Pulau Sembilan and a few other islands off the Perak coast have small stretches of sandy beaches previously frequented by green turtles, ridleys, and hawksbills. But with more than 1,600 prawn trawlers operating on 171 km of coastline, and with

hotels built on the beach, only rarely do turtles nest nowadays. Similarly, the 2 big islands to the north, Pulau Pinang and Pulau Langkawi, have sandy beaches, but due to trawling and a highly developed tourist industry, nesting is sporadic.

The estuarine species, though not uncommon, are believed by West Coast fishermen to be much reduced from former times. The decline of the *Batagur* population on the Perak River has been documented (Loch 1951; Mohamed Khan 1964; Moll 1978). Prior to the second world war, some 375,000 to 525,000 eggs were laid a year. Today only 20,000 to 30,000 eggs are laid in a good year. The decline apparently began during the japanese occupation when large numbers of adults were killed for food. Resurgence of the population has since been inhibited by a variety of factors including heavy egg exploitation, habitat destruction, and poaching.

East Coast

Hendrickson & Alfred (1961) conducted a survey on the nesting populations of sea turtles on the East Coast of Peninsular Malaysia in 1956. They omitted the West Coast because, although turtles were found nesting on the limited sandy beaches and a few islands to the north, the number of eggs marketed was small, compared to the East Coast production. Much of the shore in East Johore, like that of the West Coast, is unsuitable for sea turtle nesting and was also not inlcuded. The remaining 3 states—Pahang, Trengganu, and Kelantan—have individual legislation regulating the collection of the eggs. They assumed, after investigation, that the license fees paid by collectors to the Government was half the total values of the eggs marketed. Therefore, they estimated the egg production of the exclusive leathery turtle beach by dividing the license fees by a constant 0.04 which was half the market price (M$0.08) of the leathery turtle eggs. For other beaches they used the constant of 0.03 being half of the market price (M$0.06) of the green and ridley turtle egg. A predetermined ratio of ridleys to green turtles was used to separate yields contributed by each species. Turtle populations were assumed to have remained fairly constant since the last world war. Figure 1 depicts their findings.

In 1978, the authors together with Dr. Leong Tak Seng of Universiti Sains Malaysia again conducted a survey of the turtle populations on the East Coast. A set format was prepared, interviews were conducted in villages with most of the licensed egg collectors, and government records were examined.

We stress that collection of completely accurate statistics was impossible because: 1. licensed collectors for the main beaches tended to give unreasonably low estimates due to fear of inquiry by tax collectors and to keep potential competition in the dark in the following year's bidding for license areas; 2. most of the collectors on other beaches do not keep careful records. Thus the figures given are often unreliable.

Therefore, in analyzing the data, information such as license fees paid by collectors over the past 5 years, number of egg collectors employed by each licensee, other occupation and income of the licensee, and local price of eggs were taken into account. No single formula was utilized. The results (Table 1 and Figures 2 and 3) are thus no more than the authors' best estimate of the present status of the East Coast nesting populations.

Figure 1. Sea turtle egg production of the East Coast, 1956.

Estimated annual yields of sea turtle eggs

Species	*Kelantan*	*Trengganu*	*Pahang*	*Totals*
Dermochelys coriacea	Negligible	853,700	Negligible	853,700
Chelonia mydas	40,200	770,200	118,500	928,900
Lepidochelys olivacea	4,500	40,500	13,200	58,200
Totals	44,700	1,664,400	131,700	1,840,800

Source: Reproduced from Hendrickson and Alfred, 1961.

Table 1. Estimate of annual yield of turtle eggs on the East Coast

	Kelantan	*Trengganu*	*Pahang*	*Johore*	*Total*
Dermochelys coriacea	—	294,000	300	—	294,300
Chelonia mydas	400	298,000	91,000	12,000	401,400
Lepidochelys olivacea	21,000	240,000	34,000	10,000	305,000
Eretmochelys imbricata	—	10,700	5,400	2,500	18,600
Callagur borneoensis	800	13,500	1,200	500	16,000
Total	22,300	856,200	131,900	25,000	1,035,000

Our findings deviate from Hendrickson and Alfred (1961) in that: 1) egg yields of *Dermochelys* and *Chelonia* have been reduced to 34 percent and 43 percent, respectively, of their 1956 levels; 2) conversely, *Lepidochelys* shows a great increase (500 percent) over 1956, and 3) *Eretmochelys* and *Callagur* provided a small but significant contribution to the East Coast egg industry.

We feel the drastic decline in egg yields indicated for *Chelonia* and *Dermochelys* is mostly real (see below). Nearly all those interviewed reported drastic drops in the egg yield over the past 10 years. Increases in fishing activity, especially trawling and drift netting, were blamed for the growing number of dead turtles on the beach every year. One collector reported 25 dead ridleys in a year. In 1973 fishermen operating a bottom long line for rays caused a massive kill of ridleys at Setiu, Trengganu. The senior author, being a fisheries officer, imposed a ban on that type of fishing. But no officer can ban fishing as fish are necessary food for the people.

The increase indicated for ridleys was not supported by our interviews. Again, egg collectors generally reported continual decline in numbers. We feel Hendrickson and Alfred (1961) underestimated ridley numbers (and possibly overestimated green turtles).

Due to time constraints, Hendrickson and Alfred did not do a detailed survey. Rather, they used findings from 5 licensed, major egg-producing areas (unfortunately the names were not given) to estimate yields and species ratios in the remaining areas. Due to the small sample size, it is highly possible that their study areas had atypically large numbers of green turtles and resulted in the skewed ratios (1 ridley to every 10 or 12 green turtles) used in other calculations. This also explains why *Eretmochelys* and *Callagur* egg production was overlooked.

Another source of error resulting from using license fees to calculate area productivity was that accessibility to many coastal areas was difficult at that time. Hence, low tender price was sometimes an indicator of accessibility rather than productivity.

The production in Johore, though not reported by Hendrickson and Alfred, is reported here for reference. It is, as expected by them, smaller than that of Pahang.

Conservation

Hatcheries

The leathery (leatherback) turtle program in Trengganu is the oldest turtle conservation effort in West Malaysia. First proposed by the Malayan Nature Society in 1960 (Wyatt-Smith, 1960), a hatchery was set up at Rantau Abang in 1961. This hatchery, 1 of 5 operated by the Fisheries Department, has operated every year since then (Table 2).

The Fisheries Department next began a green turtle hatchery at Dalam Ru, State of Kelantan, in 1964 (Balasingam 1967a). The hatchery was inactive in some years due to lack of funds or changes in administration (Table 3).

Table 2. Rantau Abang Leathery Turtle Hatchery Results

Year	*Number of eggs planted*	*Number hatched*	*Percentage hatched*
1961	8,366	3,699	44.2
1962	11,654	6,300	54.0
1963	9,956	5,580	56.0
1964	11,535	3,803	32.0
1965	10,071	7,199	71.5
1966	31,250	16,477	52.7
1967	15,650	9,215	58.9
1968	40,000	18,332	45.8
1969	38,008	15,930	41.9
1970	31,050	17,089	55.0
1971	47,391	30,260	63.9
1972	60,000	37,193	62.0
1973	72,260	30,699	42.5
1974	91,147	42,616	46.8
1975	85,922	40,565	47.2
1976	69,480	44,480	64.0
1977	7,803	4,578	58.7
1978	34,391	14,878	43.3
Total	675,934	348,893	51.6

Note: Work on the hatchery in 1979 is in progress.
Source: Fisheries Department, State of Trengganu, Malaysia.

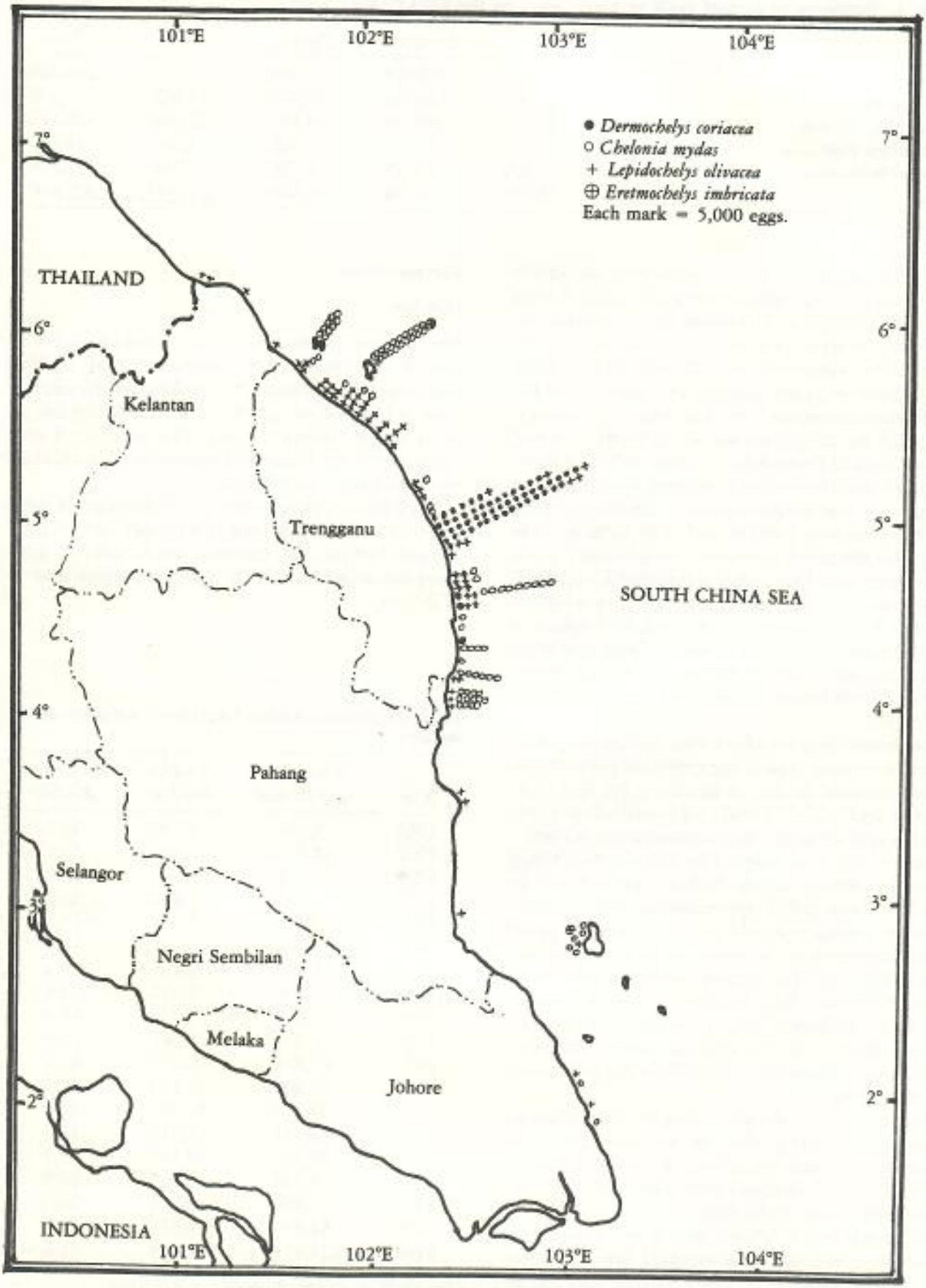

Figure 2. Egg production of sea turtles on the East Coast of Peninsular Malaysia, 1978.

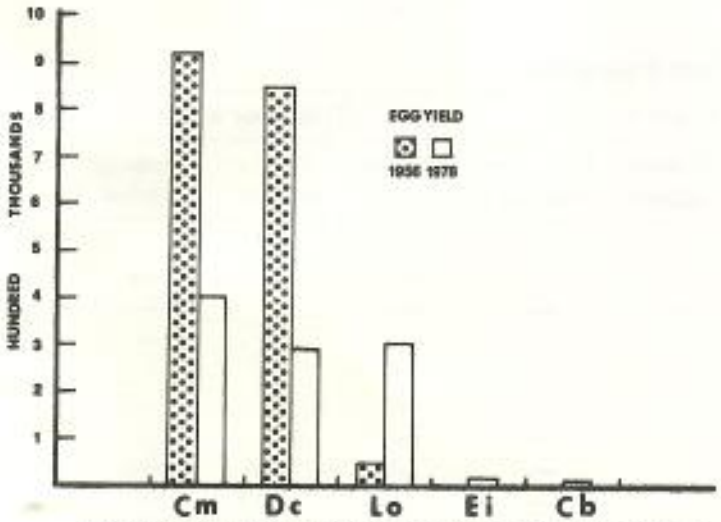

Figure 3. Comparison of estimates for egg yield on the East Coast of Penisular Malaysia in 1956 (Hendrickson and Alfred, 1961) and 1978 (this study). Abbreviations Cm, Dc, Lo, Ei, and Cb stand, respectively, for *Chelonia mydas, Dermochelys coriacea, Lepidochelys olivacea, Eretmochelys imbricata* and *Callagur borneoensis*.

The third hatchery was set up in 1971 at Chendor, State of Pehang for all coastal nesting species. The results are shown on Table 4.

The fourth hatchery was set up in 1978 at Kg. Mangkok, Trengganu chiefly for ridleys and painted terrapins. Out of 5,180 ridley eggs planted, 3,080 hatched out, of which 2,447 were released in Semerak, State of Kelantan at the request of the Director of Fisheries Kelantan. Comparative study on hatchery techniques was conducted by Moll on *Callagur* (Table 5). Work on the hatchery in 1979 is in progress.

This year a fifth hatchery was begun at Pulau Perhentian mainly for green turtles. A total of 10,000 eggs of green turtles have been planted. Hatching has not been completed at the time of this writing.

The Game Department operates conservation programs for *Batagur* in 3 states—Perak, Kedah, and Trengganu. In addition to a hatchery, these programs include "head starting" whereby young turtles are raised for a year in captivity prior to release. Table 6 summarizes these hatchery results.

Attempts were made to operate a hatchery at Tanjong Kling, State of Melaka, by Dr. B. H. Kiew of the University of Malaya in 1976 and another at Muka Head, State of Penang, by Dr. K. H. Khoo of University Sains Malaysia in 1978. Neither materialized due to poor landings of sea turtles. Arrangements are being made to send green turtle eggs by air from Trengganu to Penang for hatching by the Fisheries Department there in 1980.

Sanctuaries

Certain areas of beach are being considered for turtle sanctuaries. Once designated, development of the beach and intrusion of tourists will be stopped. Licensed egg collection will continue with a cetain proportion being replanted in an artificial hatchery. Predation of eggs and hatchlings is very heavy in natural nests (Hen-

Table 3. Dalam Ru Hatchery Results

Year	*Number planted*	*Number hatched*	*Percentage hatched*
1964	3,704	1,971	53.6
1965	9,056	4,558	50.3
1966	9,817	4,080	41.6
1967–68	Nil	Nil	—
1969	12,307	2,395	19.5
1970	12,492	5,226	41.8
1971	11,198	5,237	46.8
1972	7,036	2,605	37.0
1973–77	Nil	Nil	—
1978	—	2,447[a]	—
1979	2,080	1,366	65.7
Total	67,690	26,072	

Note: Data include Ridley turtles.
a. Hatchlings supplied from K. Mangkok Hatchery in Trengganu.
Source: Fisheries Department, State of Kelantan, Malaysia.

Table 4. Chendor Turtle Hatchery Results

Year	*Number planted*	*Number hatched*	*Percentage hatched*
1971	4,138	3,514	84.9
1972	14,000	10,619	75.9
1973	6,140	4,341	70.7
1974	5,008	4,511	90.1
1975	Nil	Nil	—
1976	14,595	13,227	90.6
1977	Nil	Nil	—
1978	10,155	8,094	79.7
Total	54,036	44,306	81.9

Note: Work on the hatchery in 1979 is in progress.
Source: Fisheries Department, State of Pahang, Malaysia.

Table 5. *Callagur* hatchery results, 1978

Incubation method	*Number planted*	*Number hatched*	*Percentage hatched*
Outdoor in sand on beach	633	419	66.2
Indoor in sand in plastic buckets	224	195	87.1
Indoor in styrofoam boxes	201	155	77.1
Total	1,058	769	72.6

Table 6. *Batagur* hatchery results for Perak, Kedah, and Trengganu

	Perak R.			*Kedah R.*			*Trengganu R.*		
Year	*Number planted*	*Number hatched*	*Percentage hatched*	*Number planted*	*Number hatched*	*Percentage hatched*	*Number planted*	*Number hatched*	*Percentage hatched*
1969	500	184	39	—	—	—	—	—	—
1970	1,896	86	05	—	—	—	—	—	—
1971	1,140	218	19	—	—	—	—	—	—
1972	2,940	507	17	—	—	—	—	—	—
1973	1,780	168	09	—	—	—	—	—	—
1974	1,380	395	29	—	—	—	—	—	—
1975	2,420	914	38	—	—	—	—	—	—
1976	2,412	1,245	52	—	—	—	36	36	100
1977	1,953	964	49	—	—	—	141	112	79
1978	3,220	1,412	44	152	114	75	629	429	68
1979	1,440	588	41	325	283	87	1,644	1,232	75
Totals	21,081	6,691	32	477	397	83	2,450	1,809	74

Source: Game Department of West Malaysia.

drickson 1961), and the high market value of the egg encourages heavy poaching. Small clutches of 50 eggs in artificial hatcheries were found to have greater hatching success than larger natural nests (Balasingam 1967b).

A memorandum for setting up a leathery turtle sanctuary and research laboratory at Rantau Abang was submitted to the Government of State of Trengganu in 1975 (Siow 1975). At Rantau Abang, the turtle beach runs parallel to the main trunk road. Fortunately, a 45-m ditch separates the road and the beach, serving as a natural barrier to protect the turtle. It was proposed that 8 of the 19 km of beach be set aside as a turtle sanctuary and fenced in to prevent unauthorized persons from entering. *Casurina* trees were proposed to be planted on the ditch side of the beach to prevent light from shining onto the beach. The project has received financial support from the World Wildlife Fund Malaysia.

A survey of the flora and fauna of Pulau Redang (a major green turtle nesting island off the coast of Trengganu) was completed. Recommendations are that the island be turned into a national park including a marine park. If accepted, the survival of green turtles and hawksbills can be assured (Green 1978).

The Penang State Government is currently studying the proposal of setting up a national park on the northwest side of the island with a fine beach. This would enable the Fisheries Department to conduct a hatchery to regenerate diminishing turtle populations there.

Kuala Baru is a major ridley and *Callagur* rookery in northern Trengganu State. The beach is in fact a long stretch of wide sand dune separating the sea and a large estuary. The senior author will study this area, and if found feasible for a turtle reserve, will submit a memorandum to the State Government suggesting this designation.

The Outlook

Hendrickson and Alfred (1961) estimated that as little as 2 or 3 percent of the nests, handled properly, could provide sufficient recruitment to the wild population to maintain present levels, provided that other circumstances remain unchanged. Unfortunately, other circumstances, mainly man-made, are changing, and changing rapidly. The intensification of fishing activity has resulted in high mortality of adults which under natural conditions face little predation and hazard. Continuous development of coastal areas has reduced and will further reduce the number and length of beaches suitable for nesting of sea turtles. Such development seems unavoidable; without immediate action, turtle populations will continue to decline.

We suggest the following courses of action as being most practical to conserve turtles in West Malaysia: 1) intensifying hatchery work (i.e. increasing the number and size of present hatcheries with a goal of hatching at least 15 percent of the eggs laid by each species); 2) setting aside a portion (for example 20 percent) of the total beach area as sanctuaries; and 3) prohibiting fishing within an 8 km radius of sanctuaries during breeding seasons.

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Marine Turtles in Indonesia

ABSTRACT

Indonesia consists of approximately 13,677 islands. Marine turtles can be found along beaches of many of the islands. Five of the 7 known species of marine turtles can be found in the Indonesian Archipelago: *Chelonia mydas, Eretmochelys imbricata, Dermochelys coriacea, Lepidochelys olivacea,* and *Caretta caretta*. Fishermen come to areas where the turtles are abundant, especially on Sukomade (East Java), East Kalimantan, and Flores Sea. The turtles are caught by harpoons and nets. Bajo fishermen are well-known turtle hunters, who build their homes near shallow waters. Other groups of fishermen are Benoa and Buginese. Turtle eggs are liked very much in Indonesa, and they bring higher prices than chicken eggs.

Besides governmental restrictions on turtle catching and egg collection, priority has been given to habitat and population development within the framework of the Indonesian turtle preservation program.

Introduction

Indonesia, an archipelago consisting of 13,677 islands, is situated in the Equatorial Zone. It stretches 5,100 km from east to west and 1,883 km from north to south. Its total area is 1,904,345 km^2. Indonesia lies between the Pacific and Indian Ocean. Indonesia has a wet tropical climate with a minimum temperature of 18°C and a maximum of 34°C. According to the 1971 census, the population of Indonesia is 130,000,000. About 75 percent of the people live in Java, Madura, and Bali.

Indonesia is rich in natural resources. The diversity of species in Indonesia must be safeguarded, because they are the very elements that build mankind's ecological environment. These natural resources should be utilized for the people's economic development through management based on the principles of nature conservation.

Marine Turtles as an Indonesian Natural Resource

One marine resource that has recently attracted serious attention in Indonesia is the turtles. Of the 7 species of marine turtles in the world, 5 species live in Indonesia. Research into nesting areas in Indonesia has been carried out by Suwelo and Kuncoro (1969), Sumertha Nuitja (1973, 1975 and 1976) and Polunin (1975). Because different names are given for a single species of turtle, a study of what species exist in Indonesia is imperative. For this purpose, Abdurahman, Sumertha Nuitja, and Suwelo (1977) and Sumertha Nuitja (1977) compiled an Indonesian taxonomic list. Since then, more knowledge has gradually come to light concerning the turtle species and their distribution in Indonesia (see Polunin and Sumertha Nuitja, this volume).

The green turtle, *Chelonia mydas* (local names: *penyu sala* in Sumbawa Island, *penyu daging* in Bali, and *penyu nijau* in West Java) is the most commonly caught turtle in Indonesia.

The hawksbill, *Eretmochelys imbricata*, is the second most common turtle. *Penyu sisik* is a local name in Indonesia, and its shell is very popular for ornaments. The storage centers of tortoiseshell are in Palembang, Jakarta, Surabaya, Pontianak, Denpasar, and Ujung Pandang. The carapaces are exported to Singapore, Hong Kong, and Japan, and occasionally to Brussels.

There is also the already rare *Dermochelys coriacea*, popularly known as *penyu belimbing*. This species is legally protected by the Agriculture Minister's Decree No. 327 of 29 May 1978.

The other 2 turtle species are *Caretta caretta* and *Lepidochelys olivacea* (local name *penyu abu-abu*). Their total populations and breeding grounds in Indonesia have not been ascertained. Sumertha Nuitja discovered 2 carapaces of *penyu abu-abu* in Bali in August 1977, so it is probable that this species lives in Nusa Tenggara islands. Although no data are available and their population levels cannot yet be determined, these 2 species need immediate legal protection similar to *D. coriacea*.

Marine Turtle Utilization

Fishermen usually catch turtles with traditional gear such as harpoons and also with modern gill nets. Bajo fishermen know the breeding grounds of the turtles. They catch turtles in Flores Sea, Timor, and Southeast Sulawesi. They build their homes near shallow water. Other groups of fishermen who hunt turtles are Buginese and Benoa. Owing to the vast extent of the Indonesian seas, it is very difficult to control exploitation of marine turtles. Many parts of the turtle are used. This is apparent during visits to Ujung Pandang, Bali, and other places. Turtle eggs are also eaten by the people and can cost more than chicken eggs.

Turtle exports must be authorized. Recent export licenses, issued by the Directorate of Nature Conservation covered: 6,071 carapaces in 1975, 4,870 carapaces in 1976, 6,779 carapaces in 1977, and 6,659 carapaces in 1978.

Population Development Based on Preservation Principles

Because of the growing demand for meat and eggs for consumption within the country and for carapaces for export, the government of Indonesia needs both to utilize and to conserve marine turtles. In addition to the government restricting turtle catching and egg collection, priority has been given to habitat and population development within the framework of a preservation program. Since 1977, the Directorate of Nature Conservation has undertaken the development of turtle populations using the Suwelo method (below). Turtle-raising is also being considered for some locations near marketing centers. Sumertha Nuitja (1970 and 1975), investigated the possibility of using Serangan Island, Bali, and Sumbawa Bay for raising hatchling turtles to maturity. The Governor of Bali supported the idea and asked Sumertha Nuitja to survey Serangan Island for the main site of turtle culture in Indonesia. Other regions also raise turtles, especially on the Seribu islands and near Ujung Pandang. In the rearing facilities on the Seribu islands, however, many young turtles have died of dermatitis, helminthiasis, and tuberculosis.

Efforts like those sponsored by the Governor of Bali should be expanded, particularly the culture of hawksbills, considering the increasing price of tortoiseshell and the difficulty of catching hawksbills. In this way, it will not jeopardize their existence in natural habitats.

Development of Turtle Populations

Taking as an example the development of *Dermochelys coriacea* in Malaysia and taking into account the experience acquired from the turtle egg hatching trials at Sukabumi 10 years ago, techniques can be formulated for developing the turtle population on hatching beaches in Indonesia as follows.

It is recommended that the development efforts be carried out in cooperation with the Provincial Administration and be contracted to a third party.

1. A sufficient number of eggs should be provided by the Provincial Administration free of charge. If this is impossible, eggs should be purchased from the contractor. The number of eggs required is 15 percent of the harvested eggs, although this number is not a necessary condition at the initial stage.

2. The eggs are buried again in the sand. Each hole

is 50 cm deep and filled with 50 turtle eggs. The nests should be made as natural as possible. Nests should be located on sandy beaches in the same nesting area.

3. Each nest should be enclosed with wire netting (30 cm diameter, 30 cm high) and marked with the date of planting and the number of eggs. The wire netting protects the eggs against predators.

4. After incubation in the sun for 50 days (common turtles) or 55 days (*Dermochelys coriacea*), the young turtles emerge.

5. The hatchlings are very active and try to get out of the enclosure and to the sea. They should be counted to determine how many eggs have hatched.

6. The young turtles should be released immediately on the tide line. They will move towards the sea by themselves.

7. They are carried on the waves into the sea and start their lives among the community of turtles and search for their own food.

8. When the turtles have become adults, the females lay eggs on the same beach.

Summary

Indonesia still has very rich populations of sea turtles, particularly *Chelonia mydas* and *Eretmochelys imbricata*. Carapaces are exported to many countries. The eggs and turtle meat are consumed by Indonesians. A well-planned conservation and management program, which would control the exploitation of the turtle populations, would insure that this resource can be exploited continuously in the future.

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Sea Turtle Populations of Indonesia and Thailand

Introduction

Sea turtles and sea turtle products have long been an important commercial resource in many parts of Southeast Asia. In spite of extensive exploitation of both eggs and adults, large populations still survive in several areas. We wish to summarize here what is known of the history and present status of these populations and so to provide a background to the efforts which are being, and must continue to be, made to conserve them.

Thailand and Indonesia are combined in this paper for reasons of space, and because intervening Malaysia is dealt with elsewhere in this volume. In Thailand, surveys—if only somewhat superficial ones—have covered the ground reasonably well, while in Indonesia, a number of important areas such as Irian Jaya, parts of Maluku, and Kalimantan, have barely been looked at. Consequently, our information is at present fragmentary. It is clear, however, that Indonesia, with some 13,500 islands and 81,000 km of coastline, is far richer in sea turtles than is Thailand; most of this account therefore deals with Indonesia.

Historical Background

The first European accounts of sea turtles in the region date back to the mid-sixteenth century, when Portuguese Jesuit missionaries came to the Moluccas (Jacobs 1974); subsequent observations include those of Nieuhoff (1666), Valentyn (1724), Forbes (1885), and Cabaton (1914). However, it is established from early Chinese records (Wheatley 1959; Meilink-Roelofsz 1962) that tortoiseshell was an important trade commodity from much earlier times. Further, the hunting of sea turtles was obviously part of the subsistence of many indigenous peoples (Pelras 1972; Loeb 1972; Polunin 1975), and their expertise was important in the development of the turtle trade then (Fox 1977), as it still is today (cf. Sumertha Nuitja 1974).

Anthropological anecdotes about sea turtles in the region include the description by Loeb (1972) of the tabus surrounding turtle hunting on Siberut in the Mentawei Islands, the account by Covarrubias (1937) of the importance of turtles in Balinese cuisine and cosmogeny, and Kolff's brief mention (1840) of a superstitious aversion to turtle hunting in one of the Moluccan islands. No doubt there are many more such fragments in the region's literature. The discussion of Hendrickson (1958) on the position of turtles in Khoranic law can be taken to apply also to Islamic communities in southern Thailand and Indonesia, but in many areas these rules seem to be loosely adhered to. No such regulations apply to non-Moslem people such as the Balinese, who are predominantly Hindu.

A further element in this background picture is the role played by adat law (cf. Visser 1979) and tabus (cf. Endicott 1970) in traditional Malay and Indonesian life, which often served to regulate use of natural resources. Such regulation probably prevailed among the maritime people who hunted and traded in sea turtles. Notable among these people are both the Buginese of Southwest Sulawesi (Anonymous 1918) and the "sea gypsies," who are variously known as *Moken*, *Moklen*, and *Urak Lawoi* in Burma and western peninsular Thailand (Hogan 1972), *Orang Laut* in Malaya and the Straits of Malacca (Pelras 1972), and *Bajo* or *Sama-Bajau* in Sulawesi, Nusa Tenggara and the Moluccas (Fox 1977). It is regrettable that so little has been written about these people, especially the sea gypsies, who have for long been involved in the sea turtle trade (Vosmaer 1839; Freijss 1859; Forbes 1885). Although the picture is complicated by the fact that while the Bajo in some areas were almost exclusively engaged in this trade (cf. Crawfurd 1856), in other cases they apparently do not hunt sea turtles at all for semi-religious reasons (J. J. Fox, personal communication, 1978).

Traditionally turtle meat and eggs were used as food, while tortoiseshell, especially from *Eretmochelys imbricata*, has been fashioned into ornaments and utensils (Loebèr 1916; Sumertha Nuitja 1974). Meat from sea turtles, normally *Chelonia mydas*, is consumed heavily in Bali and the Manado area of northern Sulawesi; in Bali particularly, ceremonial uses are common (Suwelo and Kuntjoro 1977). In some places *Dermochelys coriacea*—although the species is now officially protected, (Abdullah and Suwelo 1978) is eaten: Irian Jaya and the Mentawei Islands (Sumertha Nuitja, manuscript); Lembata in East Nusa Tenggara (R. H. Barnes, personal communication, 1979); the Kei Islands (A. Compost, personal communication, 1979). Sometimes *Eretmochelys* is eaten in Irian Jaya (van Hasselt 1922) and Pulau Seribu off Jakarta, from individuals that have been raised on fish (K. Kvalvågnaes, personal communication, 1979). The export market is large, and Indonesia is currently among the world's greatest exporters of tortoiseshell. This trade is of long standing, but is evidently increasing.

Local governments regularly give annual concessions on important nesting beaches to individuals for collecting eggs (Somadikarta 1962; Polunin 1975; Food and Agriculture Organization (FAO) 1977a); often the concessionaires are subject to regulations with respect to seasons and the hatching of some of the eggs collected, but such regulations are hard to enforce. Subadult and adult turtles are traditionally caught in nets, turned on beaches, and harpooned in the sea; in central Indonesia large handmade elastic-powered spear-guns are now widely used. The magnitude of the take incidental to other forms of fishing, notably trawling and long-lining in modern times, has not been quantified. Catch rates for single trawlers in the Java Sea (Losse and Dwiponggo 1977) and southern China Sea (Sudradjat and Beck 1978) appear low, but the effect of the entire fishing effort could be large.

General Ecology

Most data on distribution in Southeast Asia are based on the occurrence of turtles on nesting beaches, and even there the information on the rarer species is usually imprecise. Very little is known about non-nesting animals, with the exception of the data which have been gathered on the main fishing-grounds for *Eretmochelys* in Indonesia (Kajihara 1974). No tagging has yet been carried out in Indonesia, although sea turtles tagged elsewhere have turned up there. These include *Chelonia mydas* from Sabah and Queensland, and *Dermochelys coriacea* from Trengganu. No work has been done on feeding ecology, although it is probable that the algae are as important as seagrasses in the diet of *Chelonia* in central Indonesia.

Five species have been recorded in local seas, namely *Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea, Caretta caretta*, and *Dermochelys coriacea*.

The most abundant and best known species is the green turtle, *Chelonia mydas*, which nests intensively at a number of sites (Figure 1); it is probable that several other sites remain to be located. For a few of the documented places some recent data on egg yields are available (Pangumbahan in Java, the turtle islands off the Berau River's mouth in East Kalimantan, and Ko Khram in the Gulf of Thailand), while in another case (Sukamade in Java), the number of turtles nesting has been reported. These data are presented below. In other cases (the Sambas area of West Kalimantan, and the Riau Islands) there are some old data for the early 1960s. For the remaining localities in Figure 1, no information is available. Some data are also presented below for a minor turtle site, Phangnga Province in peninsular Thailand.

As yet *Eretmochelys imbricata*, the hawksbill turtle, has been reported to nest intensively only on the is-

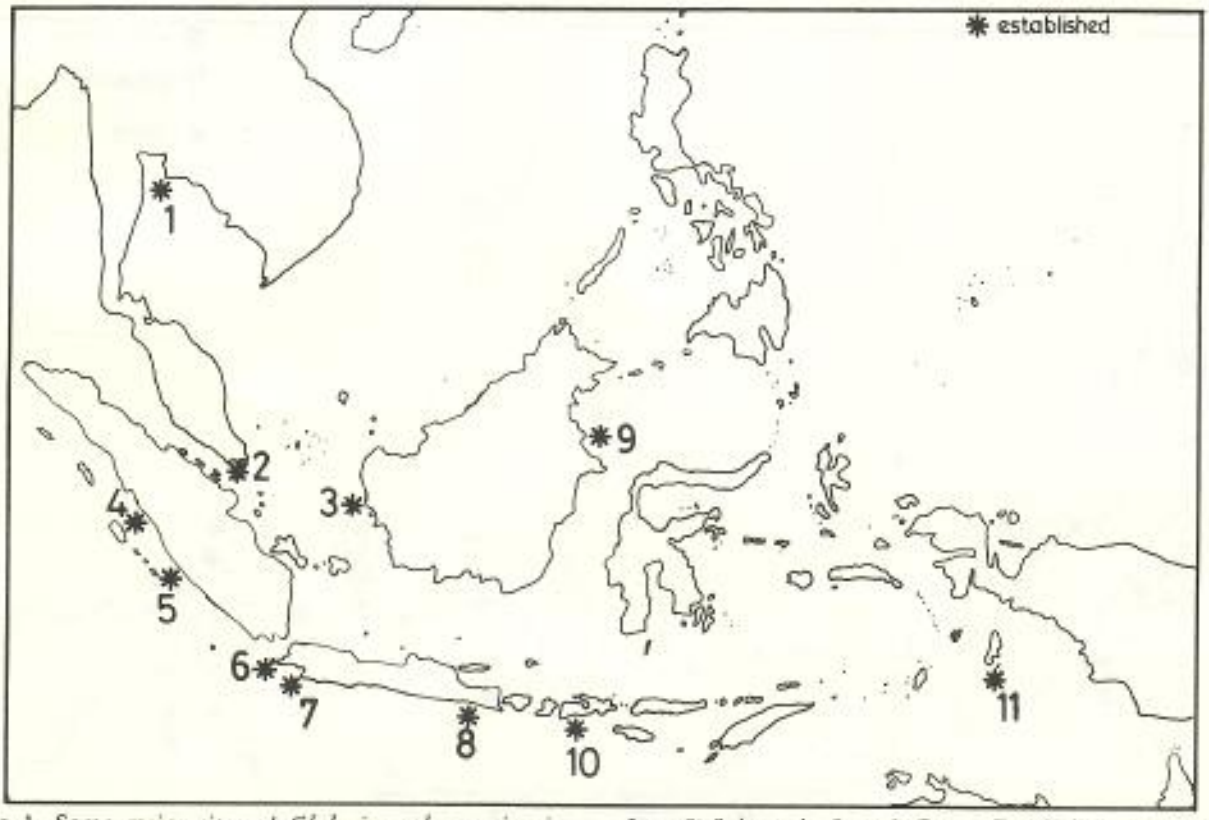

Figure 1. Some major sites of *Chelonia mydas* nesting in Thailand and Indonesia, excluding Malaysia: 1) Ko Khram; 2) Riau Islands; 3) Karimata, West Kalimantan; 4) West Sumatra; 5) Bengkulu; 6) Ujung Kulon, Java; 7) Pangumbahan, Java; 8) Sukamade, Java; 9) Berau, East Kalimantan; 10) Ai-Ketapang, Sumbawa; 11) Pulau Enu, Aru Islands (from Polunin 1975; Sumertha Nuitja 1979).

lands of Nangka and Namperak off Belitung, and on a few beaches in the Ai-Ketapang district of South Sumbawa (Figure 2); however, Kajihara (1974) has also estimated the extent of the main fishing-grounds for this species in Indonesian waters.

Dermochelys coriacea, the leatherback turtle, nests intensively in at least 4 localities: Phuket in Thailand, West Sumatra and Bengkulu Provinces in Sumatra, and on the North coast of the Kepala Burong (Vogelkop) part of Irian Jaya (Figure 3). There may also be some nesting in the Savu Sea area. In addition, a few *Dermochelys* nest occasionally on beaches, such as those on the south coast of Java, where *Chelonia* is dominant. *Dermochelys* nesting occurs typically at localities close to deep ocean.

Apart from sporadic records, almost nothing is known of the status of *Caretta caretta*, the loggerhead turtle, and *Lepidochelys olivacea*, the ridley turtle, in these areas. The former reputedly nests in West Sumatra and occasionally on the Javanese beaches, while the latter probably nests in Nusa Tenggara.

Although all 5 species of sea turtles have been recorded on some nesting beaches, it appears that certain locations are preferred by certain species. Sumertha Nuitja, Eidman, and Aziz (1979) have presented some evidence that species may to some extent be segregated on different nesting beaches in Sumatra, Java and Sumbawa.

Population Trends and Exploitation

It is regrettable that the data on populations, let alone their variations in time, are so scant, for where we have little basis on which to estimate population changes, we have even less chance of establishing a solid connection between any trends and exploitation. Although the reliability of the data may often be in question, an overall downward trend is nevertheless suggested by the egg yields reported for some Thai and Indonesian beaches (Figure 4). The Spearman Rank Correlations are statistically significant at the 5 percent level for Pangumbahan, Berau, Phangnga, and Ko Khram, but not for Sukamade.

That the nesting beach figures indicate declines in breeding populations at least in certain areas is supported by some other circumstantial evidence. It is generally accepted that there has been a reduction in the number of important nesting beaches in Java at least (WWF 1976; FAO 1977b), and the turtle fishery for the Balinese market (although the market is probably expanding) is evidently covering a larger and larger area. Sumertha Nuitja (1974) reports that local turtle populations around Bali were seriously depleted by 1950. In North Sulawesi, turtle nesting is now rare in the Mas Popaya Raja Nature Reserve which was originally established for turtles, and nesting on many other beaches in the area has declined (J. MacKinnon, personal communication, 1979). Turtle nesting seems also

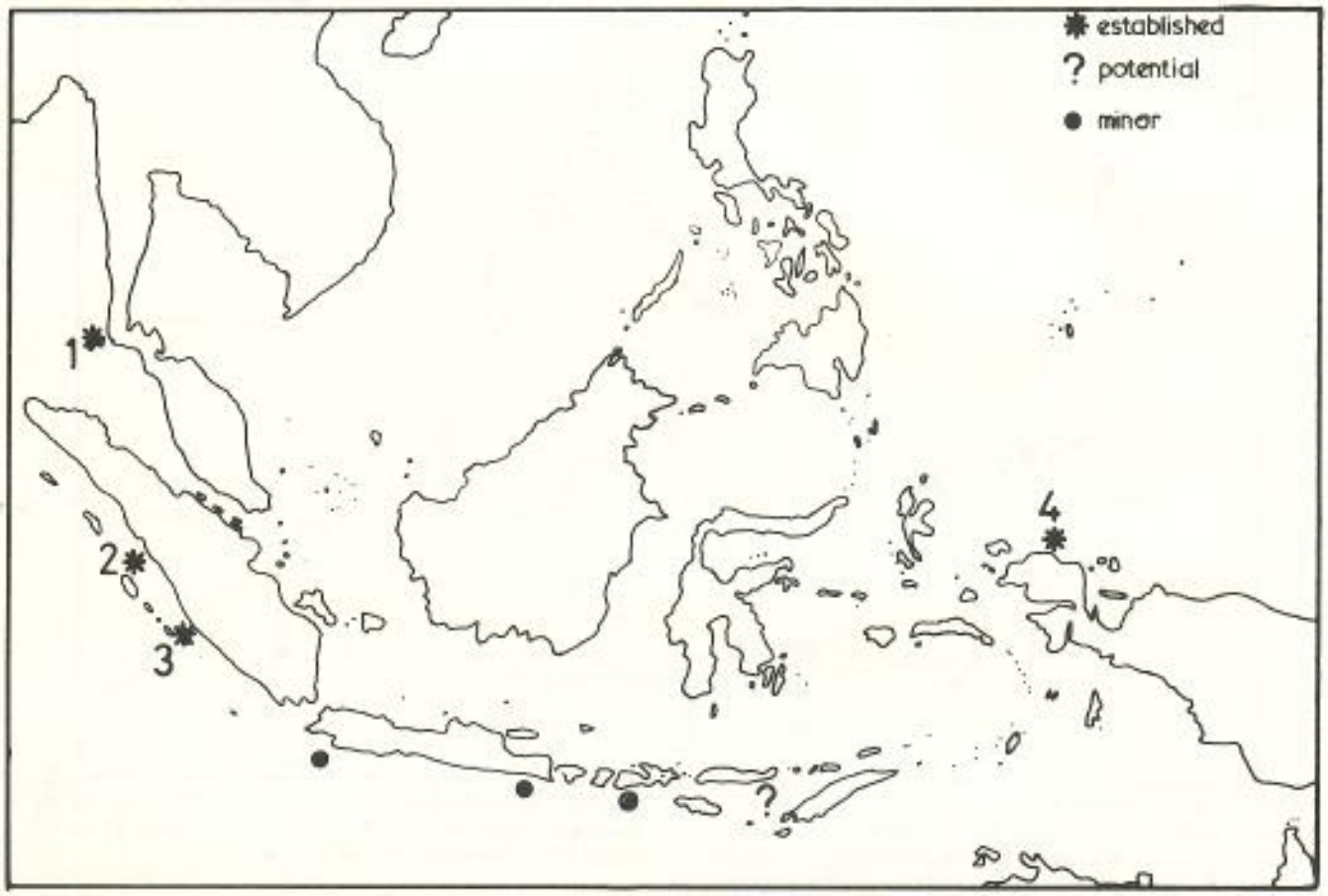

Figure 2. Important nesting sites of *Dermochelys coriacea* in Thailand and Indonesia, excluding Malaysia. 1) Phuket, Thailand; 2) West Sumatra; 3) Bengkulu, Sumatra; 4) North Kepala Burong, West Irian (from Sumertha Nuitja 1979; Polunin 1975; FAO/UNDP 1978; Anonymous, 1978b).

to have decreased recently in the Maumere district of Flores (D. Lewis, personal communication, 1979).

The production of turtle products (in particular shell, meat and eggs) for human consumption, both domestic and foreign, is high, and in the case of tortoiseshell is certainly greater than it used to be. Although such data could probably be found in The Hague, in the archives of the Vereinigde Oostindische Compagnie and Dutch governmental departments which subsequently took its place, we have as yet been unable to find any extensive early data on annual tortoiseshell export from Indonesia, apart from occasional mentions in the literature such as Temminck's report of some 2,650 kg of shell exported in 1836 (Temminck 1846). For the early part of the present century, Dammerman (1929) summed up the data for the years 1918–27, while the period 1968–78 is covered by Indonesian Directorate General of Fisheries (Direktorat-Jendral Perikanan) statistics (Anonymous, 1978a).

Figure 5 shows that recorded exports have been higher in recent years than they were previously. The Indonesian fishery statistics (Anonymous, 1978a) also show (Table 1) that between 1971 and 1976 from 348,504 to 1,110,539 kg of sea turtle have been reported caught each year. Of the 999,040 kg for 1976, 95 percent were from 4 areas of the country as follows: East Nusa Tenggara 58.5 percent, North Sulawesi 24.4 percent, Bali 6.9 percent, and Irian Jaya 5.1 percent. Data from export permits issued by the Indonesian Directorate of Nature Conservation (Direktorat Perlindungan dan Pengawetan Alam) show that over 6,000 turtles have been exported annually in the years 1975–78 (Table 1), but these were exclusively from the Medan and Palembang areas of eastern Sumatra. Some 70 percent of the turtles exported in 1978 went to Japan and 21 percent to Singapore. All of the individuals exported live, some 150 in that year, went to the United States. The main tortoiseshell dealers are based in Medan, Palembang, Jakarta, Surabaya and Bali.

Sumertha Nuitja (1974) has reported that in the Kuta and Kesiman districts of Bali 28,800 turtles were consumed in the 3 years 1968–70. In 1973 the Sinar Laut Company of Bali often exported 5,000 to 6,000 stuffed sea turtles and 3,000 sets of turtle leather each month (Polunin 1975). Some 323,509 kg of turtles were reported from the Badung district of South Bali in 1978 (Dinas Perikanan Propinsi Bali, unpublished data). It has been estimated that 2,000 to 3,000 turtles are sold each month in the Denpasar market in Bali (FAO 1977b), while other data indicate that more than 20,000 turtles are consumed annually (M. Halim, personal communication, 1979). It is probable that the

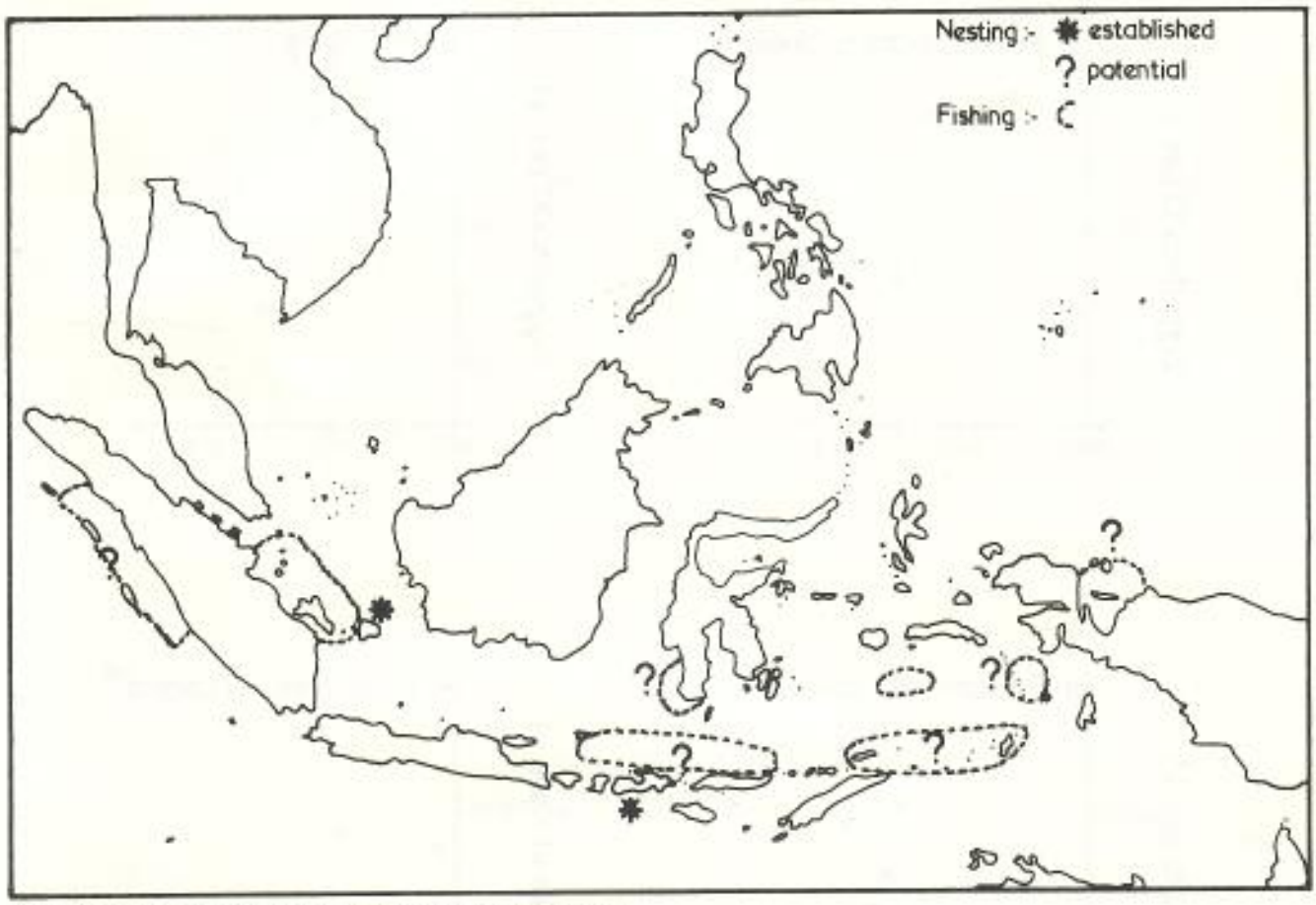

Figure 3. Some important areas for *Eretmochelys imbricata* in Thailand and Indonesia, excluding Malaysia (from Kajihara 1974; Sumertha Nuitja 1979).

Balinese trade is expanding, partly to meet the tourist demand for meat and curios. The number of Bali-based dealers in turtles and turtle products has probably not increased, nor has the number of boats registered in South Bali in the 3 years 1976–78, but participation by boats from other provinces is likely to have increased. In Sumbawa between 5,000 and 9,500 turtles (Table 1) have been reported caught each year (Sumertha Nuitja 1979); most of these were for the Balinese market. The Balinese turtle fishermen include those based at the villages of Tanjung Benoa and Serangan in South Bali, Buginese and Bajos from Sulawesi, and fishermen from Timor, Flores and Sumbawa. The fishery covers areas such as southern and eastern Kalimantan, Sulawesi, Sumbawa, and Flores. In places such as Sumbawa, turtles are often caught by local people, kept alive, and later sold to fishermen traveling to Bali.

Kajihara (1974) has estimated the take of young *Eretmochelys* from the main fishing grounds in Indonesia; some 10,000 and between 15,000 and 20,000 are caught annually in the Ujung Pandang district of South Sulawesi and in Sumatra, respectively. Kajihara (1974) further suggested that the annual take of large *Eretmochelys* from central and eastern Indonesian waters (eastern Java, Flores and Banda Seas) was approximately 5,000 and 30,000 individuals before 1971 and after 1972, respectively.

The above figures clearly indicate very high levels of exploitation of sea turtle stocks. The information on population trends does not overwhelmingly point to consistent decline, but unfortunately we have little data, and it may also be that levels of catch have only recently begun to be critical. Traditionally, at least for *Chelonia* in most of Indonesia, sea turtle utilization was confined to egg collecting and a comparatively low adult take. The conflict between the collection of eggs on nesting beaches and the hunting of adults and subadults is likely to have had a particularly severe impact on sea turtle populations. Further, because of the nature of marine turtle life cycles and our lack of information, it might be awhile before any widespread decline in numbers were detected.

In many places turtle populations have been affected in indirect ways. In several localities in Indonesia (such as the north coast of Java, and the south-facing coasts of Bali) and Thailand (for example Pattaya), beaches that were once turtle nesting sites are now heavily used by people. More subtle forms of nesting habitat alteration may also affect turtles; much of the beach at the small island of Ko Kra in the Gulf of Thailand is now rubble, apparently derived from the blasting of the

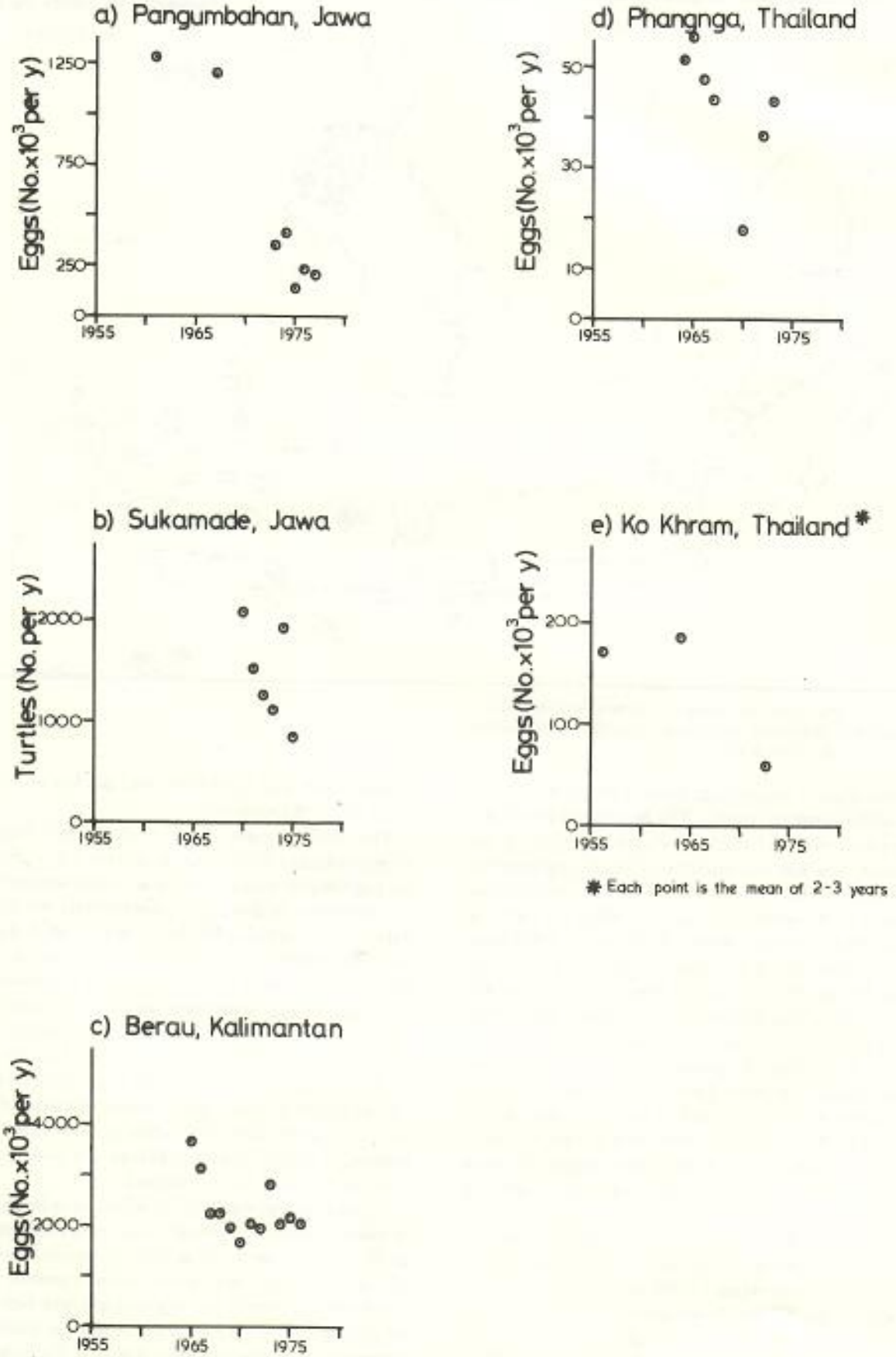

Figure 4. Data reported from some Thai and Indonesian turtle nesting beaches. Source of data: a) Somadikarta 1962; K. Ikrasaputra, personal communication, 1974; Sumertha Nuitja 1979; b) WWF 1976; c) FAO 1977a; d) Polunin 1975; e) Penyapol 1957; Polunin 1975.

adjacent reef by fishermen.

Estimates of absolute population sizes are bound to be vague, but if we work back from the egg production figures available for some of the important beaches, we conclude that at least 25,000 female *Chelonia* are breeding annually in western Indonesia. For Thailand the figure is a small fraction of this; probably some 1,000 female turtles nest each year (Polunin 1975).

Conservation Measures

Sea turtle conservation measures for the region have been discussed for many years (Anonymous 1919; Meer Mohr 1927; Rappard 1936). It could still be argued that the available data do not show a consistent downward trend and that the populations of *Chelonia* and *Eretmochelys* at least are still sizeable. But it is clear that our data are few and that in some places, such as around Java and Bali, and in the Gulf of Thailand, sea turtle populations have already been seriously depleted, while the pressure of direct and indirect impacts is high and increasing.

Within Indonesia a number of steps can be taken to conserve turtle populations. To begin with, in the critical area of Java, all the main nesting beaches are within (Ujung Kulon and Sukamade) or partly within (Pangumbahan and Citirem) established nature reserves. Efforts must be made to ensure that turtles are fully protected there. In addition, an adequate basis exists for the governmental control of the use of sea turtle resources, both egg collection and the catching of large turtles. Bulk export of turtles and turtle products is officially regulated by permits from the Directorate of Nature Conservation, while, at least in Bali, turtle merchants obtain licenses which are issued by the local fisheries office. Additionally, concessions for egg collecting on most major beaches in Thailand and western Indonesia are dealt with by local governments. In West Nusa Tenggara, because of the impact on nesting turtles, the catching of adults is officially prohibited in the months of January to April.

More effort should be made to monitor present turtle populations and the extent of their exploitation in order to assess more precisely the impact of human activities. Emphasis should be put on a country-wide assessment of sea turtle resources, with detailed studies in problem areas such as Java, Bali, and North Sulawesi. With a better background of appropriate information, management criteria could be decided on; quotas could be set, and other conditions such as closed seasons and size limits could be stipulated in licenses. At Sukamade in Java, turtle egg collecting has been officially halted. The ban is at least partially effective for the present (W. Angst, personal communication, 1979), and the nesting beach is becoming a focus for tourism in the Meru Betiri Nature Reserve. At Ujung Kulon in Java, nests are being protected from large predators (Anonymous 1979). Both of these are a useful beginning to conservation action but should be more widely extended.

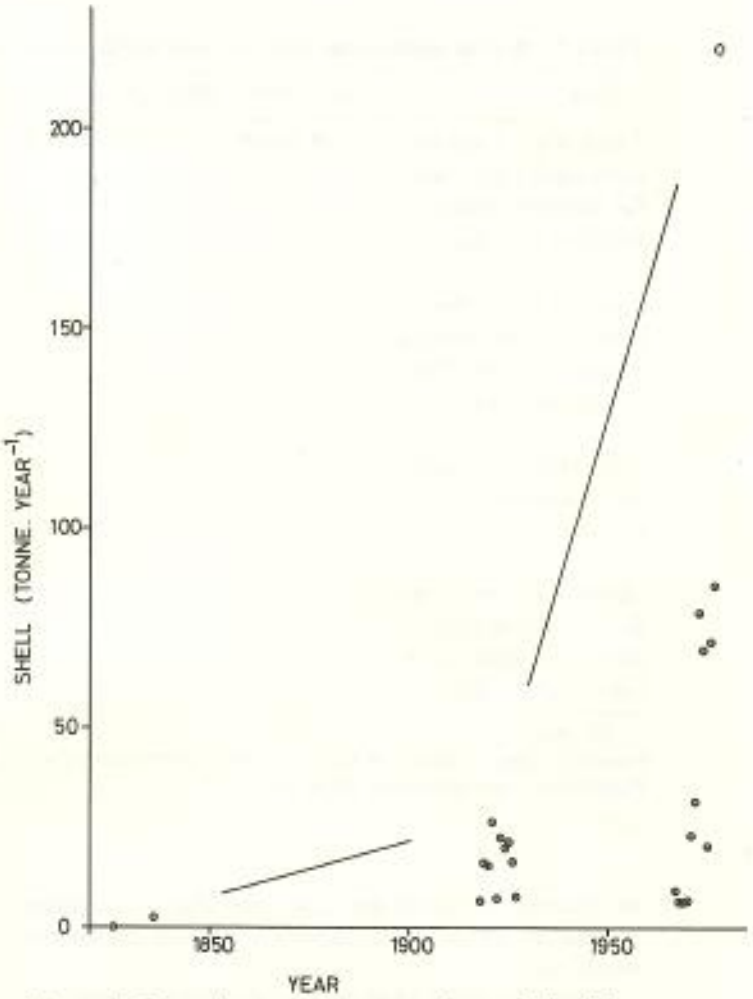

Figure 5. Some data on the export of tortoiseshell from Indonesia (from Temminck 1846; Dammerman 1929; Anonymous, 1978a).

Regulations, if possible, should not seriously restrict traditional subsistence exploitation, but in most areas true subsistence hunting and egg collecting is probably not under governmental control anyway.

Measures must also be taken in importing countries to reduce the international commerce in turtles and turtle products. This would be in line with Indonesia's recent signing of the Convention on International Trade in Endangered Species (CITES).

A study should also be made of the feasibility of turtle rearing, ranching, and farming methods as a possible aid to conservation. Some preliminary work has been carried out in Thailand (S. Rongmuangsart, personal communication, 1977), and in Indonesia (at Pulau Serangan, Bali). Any projects of this kind would initially be dependent on wild populations and should therefore be linked with measures such as protection of nesting beaches. They would also require substantial

Table 1. Some additional data on sea turtle exploitation in Indonesia

Year	*1965*	*1966*	*1967*	*1968*	*1969*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*
Catch of adult and sub-adult turtles reported for Sumbawa Island (number per year)	5,248	6,048	6,820	7,790	8,156	8,059	7,923	9,263	7,946	5,418	—	—	—	—
Catch of sea turtles reported for the Badung district of South Bali (tonnes per year)	—	—	—	—	—	—	—	—	—	—	212.4	30.5	130.3	318.4
Total reported catch for Indonesia (tonnes per year)	—	—	—	—	—	—	464	381	343	1,093	986	446	—	—
Licensed export of turtles and turtle carapaces and skins (number of turtles per year)	—	—	—	—	—	—	—	—	—	—	6,362	7,974	9,129	6,659

— No data.

Sources: Sumertha Nuitja 1979; Reports of the Dinas Perikanan Propinsi Bali, Denpasar; Anonymous 1978a; Unpublished data in the Direktorat Perlindungan dan Pengawetan Alam, Bogor.

investment of capital and time, and should therefore receive guidance from experienced and competent workers.

In the Javanese shadow-puppet theater there is a song about *lamahcai*. In Sudanese language the word merely means "land-water," for these people believe that the terrestrial and aquatic environments are part of a single system, their homeland. Perhaps through the sea turtle, which is unusual among large animals in its dependence on both land and water habitats, this traditional concept can be incorporated into conservation action.

Summary

Indonesia still has large populations of *Eretmochelys* and *Chelonia*, and some important nesting sites for *Dermochelys*. Knowledge of the size of these populations is poor, but exploitation is high and generally increasing. There is evidence of local depletion of turtle stocks. At the same time there is a basis for conservation within the country, which, fortified with more precise information on the populations and their exploitation, would be sufficient to regulate human use of the turtle resource. Outside the country stronger measures can be taken to curb international trade and also provide expertise for turtle management. The region remains rich in turtles and turtle-related lore, and efforts should be made to keep it that way.

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Status of Sea Turtles in the Eastern Indian Ocean

ABSTRACT

Five sea turtle species have been reported from the eastern Indian Ocean. Their populations are believed to be declining steadily everywhere. Although sea turtles in India and in Sri Lanka have been accorded total legal protection, many difficulties beset enforcement. These result from the remoteness of nesting beaches; the resistance to protective governmental statutes among traditional exploiters of sea turtles; widespread poverty in the region which makes sea turtles, their eggs and derived products an attractive source of income and which precludes the use of adequate staff and facilities to control poaching and illegal trade; and the paucity of knowledge relating to the locations of nesting beaches and feeding areas where detrimental human activity occurs.

One of the largest olive ridley breeding populations in the world is being depleted by the thousands off the coast of Orissa, India, for meat. Human overpopulation has resulted in the colonization of many sea turtle nesting beaches, especially on islands.

Mainland India

The September 1977, Amendments to the Schedules to the Indian Wildlife (Protection) Act, 1972, accord total protection to all sea turtle species excepting the locally unreported *Chelonia depressa*.

The export of sea turtles and derived products was banned in August 1975. India is among the signatories to the Convention on International Trade in Endangered Species.

Between 1963 and 1974 India exported 102,022 kg of sea turtle products valued at roughly $100,880. The products included sea turtle meat, oil, and tortoiseshell (Salm 1976; Murthy and Menon 1976).

The price of 1 kg of tortoiseshell increased from Rs. 0.26 in 1967 to Rs. 20 in 1969 and to Rs. 185.60 in 1975 (Jacob, communication to R. Whitaker, 1977).

Gujerat and the Gulf of Kutch

About 300 km southeast of the Pakistani rookeries at Sandspit and Hawke's Bay lies the Gulf of Kutch (Figure 1) where the green turtle and the olive ridley occur (Bhaskar 1978b). The leatherback is sighted rarely, but unlike the others is not known to nest in the Gulf.

Four fresh olive ridley nests were found on 10 km of beach west of Mandvi in Kutch on 6 July 1978. Suitable nesting beach extends for 60 km. The eggs are preyed upon by jackals, dogs, wild boar, and humans of the Wagir community who sell the excess locally.

Of about 15 islands near Saurashtra's northern coast substantial nesting occurs on uninhabited Bhaidar Island. Nesting also occurs on Beyt, Nora and Chank Islands.

The 3-km nesting beach at Bhaidar was, at places, littered with a profusion of sea turtle egg shells during a survey visit on 15 June 1978. Year-round nesting reportedly occurs on the island and 3 ridleys nested that night. A visiting fisherman also inadvertently netted 3 adult green turtle females whch had entered a creek at flood tide. All were released unharmed as turtle meat is rarely consumed in northern Gujerat. Turtle fat is sometimes used in caulking boats and as protection against marine borers; the salted flipper-hide is on occasion converted into rough shoes for use on jagged coral.

Calcareous, sandy beaches suitable for nesting have, on some islands, been literally trucked away for construction purposes.

Green turtles feed on seagrass pastures between the Gulf Islands. About 10 turtles were sighted at sea in a half-hour near uninhabited Karumbhar Island during a sailboat survey on 15 June 1978.

Green turtles and olive ridleys nest in concentrations still to be determined, but likely to be substantial, along 60 km of beach between Okha and Okha Madhi. Sandy beaches extend far to the south and are likely nesting habitats also.

Turtles were visible at sea close to shore south of Dwarka on 22 June 1978, 10 days after the onset of that year's early monsoon.

Maharashtra

The green turtle and the olive ridley are known to nest but concentrations appear to be low. Recent nesting by ridleys have been recorded at Gorai, Kihim, Manowrie and at Versova. Nesting by green turtles occurs at Back Bay (Mhasawade in Salm 1976) and by unrecorded species at Fort (Mhasawade in Salm 1976) and at busy Chowpatty Beach, but detailed surveys have yet to be undertaken. Nesting turtles and eggs are often taken by humans. Nesting by a green turtle occurred at Salsette Island (Mawson 1921).

Goa

The beaches at Goa today are popular tourist resorts. *Lepidochelys* appears to be the most common turtle nesting on India's west coast south of Goa and a ridley nested at Calangute Beach in February (Salm 1976).

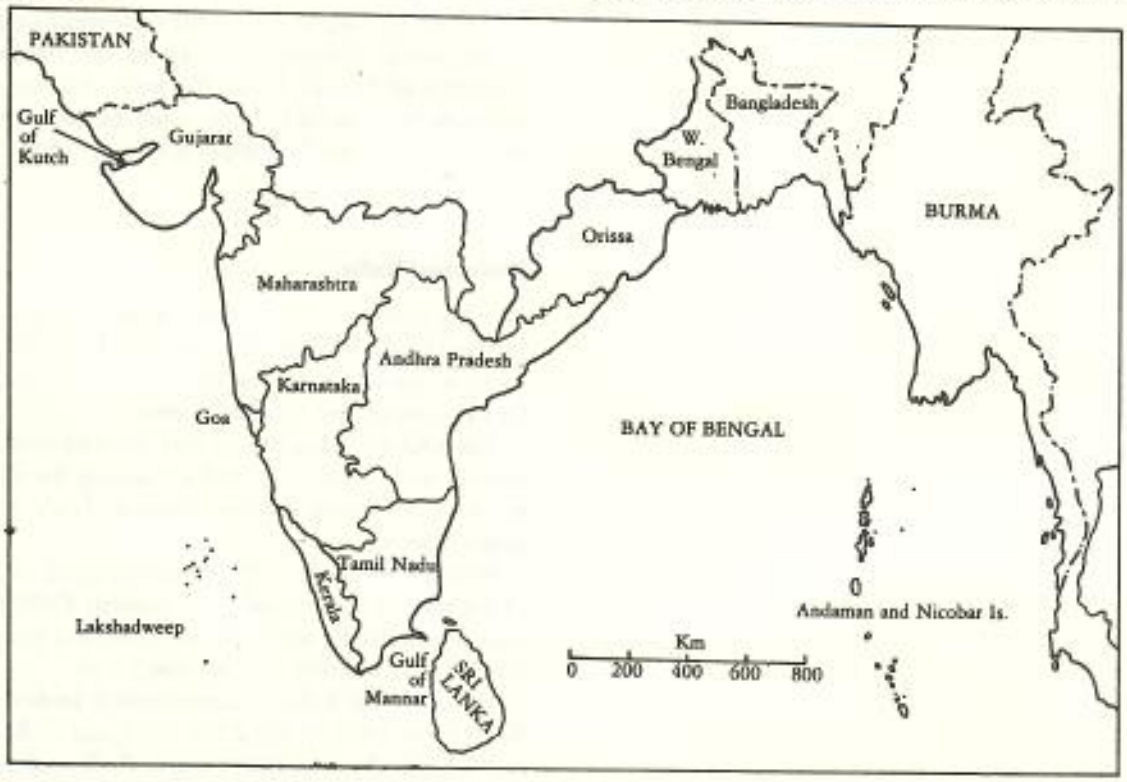

Figure 1. Sri Lanka, Bangladesh, Burma and the maritime states of India.

Many turtles of this species are netted by Goa fishermen for consumption. A leatherback was also caught at Baga where infrequent nesting by this species has been reported (Salm 1976). An ovigerous leatherback was taken on 1 November 1933 (Deraniyagala 1939).

Karnataka

Much of the coast is rocky. In the absence of surveys no data are presently available.

Kerala

This state has the highest density of human population in India. Sea walls meant to control erosion preclude nesting along parts of the coast. While only the ridley has been recorded as having nested in Kerala in recent years (Lal Mohan, personal communication, 1979) nesting is reported at Kasargode in the north (Silas, personal communication) and at Kovalam near Trivandrum in the south (Salm 1976). Green turtles occur along the entire coast extending south from Quilon (Shanmugasundaram 1968).

Turtles nest on a 3 km beach at Calicut fishing harbor and at Marad Beach 8 km to the south. Fishermen of the Mukkuvar community collect the eggs for sale and for local consumption. Nesting turtles are also taken. Nesting peaks during September to November, but fishermen report sporadic year-round nesting.

In July 1956, a leatherback nested at Calicut (Jones 1959). Cameron (1923) refers to "giant turtles" that visited the Quilon coast yearly for a period of 1 or 2 months. Fishermen informed him that up to the turn of the century leatherbacks were quite common near Quilon, and that about 40 were caught annually when attempting to come ashore or at sea in special nets. By about 1915 they were seen only occasionally, and about 2 were caught annually. They appeared to frequent the outskirts of Tangasseri reef about 3 km offshore (Smith 1931).

Tamil Nadu

Five species of sea turtle—the ridley, green turtle, hawksbill, loggerhead, and leatherback—are known from the eastern coast of the state. Populations of the first 4 species frequent seagrass and coral reef areas in the Gulf of Mannar and the Palk Bay. Ridleys nest on the predominantly sandy coast north of Point Calimere.

The following data are from Jones and Fernando (1967) and from Valliappan and Pushparaj (1973). Twenty to 25 turtles were sold weekly at the Sunday market at Tuticorin in 1975, but numbers occasionally exceeded 150. Hawksbill meat sometimes poisons those who eat it (Deraniyagala 1939), as happened more recently in August 1979 when 9 persons died at Manapad.

Olive ridleys nest on suitable stretches along the entire east coast of India (Chacko 1942; Jones and Fernando 1967; Daniel and Hussain 1973; Valliappan and Pushparaj 1973; FAO 1974).

Between 4,000 and 5,000 turtles were caught annually in southern Tamil Nadu. The catches were heaviest from October to January. Green turtles constituted about three-quarters of the total catch. Olive ridleys and loggerheads, together formed about one-fifth. The hawksbill was caught occasionally, the leatherback rarely.

Captured green turtles were usually stored alive in pens constructed in shallow water (Kuriyan 1950) to await shipment by rail to coastal markets. Most common at the market were green turtles weighing 50 to 60 kg, although young turtles below 24 cm in plastron width were also caught. The price of live green turtles of various sizes increased twofold to sevenfold between 1967 and 1973.

Recorded ridley nesting sites in Tamil Nadu include 11 of the 21 islands in the Gulf of Mannar (CMFRI 1977) and the coast south of Tuticorin. (The few green turtles occurring off the Tamil Nadu coast do not nest there.) Olive ridleys nest at Point Calimere and on at least 50 km of coast south of Madras. It is the only turtle species known to nest commonly on the Indian coast north of Point Calimere. A proposed Marine National Park, encompassing the islands in the Gulf of Mannar and Nallatanni Island, where nesting is reportedly most common, may help to protect local feeding and breeding sea turtle populations.

A conservative estimate puts the nesting intensity of the ridley along a 50-km stretch south of Madras at 100 nests per km per season, from December to March. Jackals, village dogs, and humans remove about 90 percent of these nests (Whitaker 1977). Itinerant tribals and villagers collect these eggs. Fishermen do not, holding the sea turtle sacred (Valliappan and Whitaker 1974). Nevertheless, turtles drowned offshore in shrimp trawlers sometimes wash ashore.

In 1973–78, the Madras Snake Park Trust and the Central Marine Fisheries Research Institute collected 33,083 eggs for their hatcheries and released 18,475 hatchlings (55.6 percent) into the sea.

Andhra Pradesh

The common species of sea turtle, particularly in the northern half of the state, is the ridley. The green turtle is uncommon, and the leatherback and hawksbill are rare.

While local fishermen on catamarans catch olive ridleys incidentally from about October to February, the proliferation of mechanized fishing trawlers probably was responsible for the larger incidental catch of ridleys in the 1978–79 season than in past years.

The deliberate killing of a leatherback that had come

ashore to nest was reported in 19 May 1979.

At Visakhapatnam, the number of turtles captured per day does not exceed a dozen, although the town was once a trading center where tortoiseshell was processed into ornaments and sold. Turtle eggs are occasionally sold in the town from October to February indicating this to be the nesting season and that nesting must occur nearby (S. Dutt, personal communication, 1979). Some segments of the local population eat turtle meat. Large numbers of sea turtles were transported from Andhra to Calcutta markets during the 1977–78 nesting season (Davis and Bedi 1978), and an unknown volume of this illegal practice continues.

Orissa and West Bengal

Sandy stretches occur along roughly 250 km of coast extending southwest from the Wheeler Islands to the Andhra Pradesh border. Villages are scattered thinly along the coast.

Arribadas of the olive ridley occur along a 35-km stretch called Gahirmatha Beach and possibly elsewhere (Bustard 1976). Personnel of the Gahirmatha Marine Turtle Research and Conservation Unit of the Orissa State Forest Department, who tagged over 1,700 nesting turtles in 1979, estimated the numbers that nested per season as in excess of 150,000 in 1976, 150,000 in 1977, 200,000 in 1978, and 130,000 in 1979.

Prior to 1975, eggs were being taken by private parties from the Gahirmatha Beach under license from the Orissa State Government for sale locally, regionally, and in Calcutta. The estimated legal take in the 1974–75 season was 800,000 eggs (FAO 1975). Following the advice of H. R. Bustard, FAO consultant, the Government ceased issuing licenses to egg collectors in 1975. The Bhitar Kanika Wildlife Sanctuary, which includes the entire 35-km stretch of Gahirmatha Beach, was established that year to protect the nesting turtles, their eggs, the salt-water crocodile, and other wildlife. Since then, nesting turtles and eggs have been effectively protected on shore. However, turtle eggs are still illegally being taken from nesting beaches on the Wheeler Islands and near Astaranga, Chandravhaga, Puri, and Gopalpur-on-Sea.

The gravest threat to the survival of India's east coast olive ridleys is the illegal fishing of turtles off the coast of Orissa (Davis and Bedi 1978) from bases in West Bengal, Orissa, and Andhra Pradesh. Considerable numbers are also taken off the West Bengal and Andhra Pradesh coasts. About 500 ridley carcasses are washed ashore annually on the 20 km of beach being studied at Gahirmatha. The frequency of ridley carcass strandings is about the same along an additional 60-km of beach to the southwest. This number represents a tiny fraction of the illegal offshore catch. Of a random sample of 172 stranded ridley carcasses, 106 (61.6 percent) were females. Adult and hatchling turtles are also caught incidentally in fishing nets.

Digha and Junput on the West Bengal coast are important landing centers from which turtles are transported to the Calcutta market. The numbers of turtles landed at these 2 places alone between 15 October 1978 and 15 January 1979 totalled 21,361 (Biswas, personal communication, 1979). Of late, the increasing numbers of mechanized fishing trawlers result in even higher catches.

Turtles were also being dispatched overland from coastal landing centers in Orissa, West Bengal, and Andhra Pradesh. From November 1974 to January 1975, 6,190 turtles were dispatched alive by rail from Puri to Calcutta (Biswas, personal communication, 1979). The Calcutta market was also being supplied from many other coastal railheads. The transport of turtles by rail from towns in Orissa has largely been controlled since early 1979, but turtles are still being trucked from these and other towns in neighboring Andhra Pradesh and West Bengal.

The first indication that sea turtles occur and are being exploited in the Sunderbans in West Bengal is Biswas' report on the sale of turtle meat at Namkhana.

At Puri, fishermen sell turtles to middlemen at Rs. 20–25 each. These in turn are sold to wholesalers at Calcutta for Rs. 57–60 each. Retailers sell at Rs. 5 to Rs. 6 per kg at Calcutta (Biswas, personal communication, 1979). The turtles weigh 43.4 kg on an average (N = 291).

Turtle meat is also consumed by economically poorer communities in Orissa and is sold in many towns, as at Bhadrakh.

Lakshadweep (India)

Lakshadweep includes the Laccadive, Amindivi and Minicoy Island groups. Four species—the green turtle, hawksbill, olive ridley, and leatherback—nest on the islands, though *Dermochelys* is rare (Gardiner 1906; Bhaskar 1978a).

Nesting is heaviest on 6 seasonally uninhabited islands—Suheli Valiakara, Suheli Cheriakara, Tinnakara, Bangaram, Pitti, and Parali II—where, respectively, 202, 13, 45, 15, 8, and 10 green turtle nests were made during the southwest monsoon (June through September).

Fishermen, coconut harvesters and in the case of Bangaram Island, scuba-diving tourists from abroad, visit the islands during the 6 months between successive monsoon periods. Of the inhabited islands, nests were found on Kadmat (4), Androth (4), Agatti (2) and Minicoy (1) during visits between October 1977 and January 1978 averaging 4 days at each island. Of these 11 nests, 10 had been made by ridleys and hawksbills

and 1 by a green turtle.

The ridley, though relatively common near the remaining islands, has not been recorded from the waters around Minicoy. Green turtles and hawksbills are commonly observed feeding close to shore at Minicoy and could be the subject of valuable underwater research.

Sea turtles are avidly harpooned around all the islands but Minicoy for their fat, used in caulking boats. Turtle meat, on rare occasions used as shark bait, is not commonly eaten. More often, the eggs are consumed. Hawksbills are killed and, prior to 1978, tortoiseshell was sold to middlemen on the Indian mainland.

Traditional methods of hunting sea turtles are giving way as motor launches replace sailing craft. Speargun shooting of turtles by tourists around Bangaram Island, though forbidden by law, remains unmonitored.

Enforcement of the law protecting sea turtles is already inadequate, and human population pressures on the islands may soon result in the colonization of the 2 important nesting islands at Suheli.

The Andaman and Nicobar Islands (India)

Four species—the green turtle, olive ridley, hawksbill and leatherback—are known to nest in these islands (Man 1883; Bonington 1931; Davis and Altevogt 1976; Bhaskar 1979b). Sea turtles are killed illicitly for their meat in many parts of the Andamans, and turtle meat is eaten everywhere in the Nicobars. Eggs are also assiduously collected. There was once a regular trade in green turtles between the Andamans and Calcutta (Maxwell 1911). Sea turtles and their eggs are an important traditional item of food for the Onge and Great Andamanese tribals. The influx of refugees and settlers from the Indian subcontinent introduced a new factor in the conservation of turtle stocks in the islands.

Known nesting areas of importance are listed below.

Great Nicobar Island

About 160 old leatherback excavations were found in April 1979, near the mouths of the Alexandria and Dagmar rivers. Nesting by other species also occurs, particularly by hawksbills near Pygmalion Point. Rats prey on hatchling turtles.

Little Andaman Island

About 70 fresh leatherback excavations were present at West Bay in January 1979, and about 10 at South Bay. Above 80 percent of the nests are preyed upon by monitor lizards (*Varanus salvator*). The beaches at Little Andaman and Great Nicobar constitute the only known important leatherback rookeries in India.

The Twin Islands

These 2 uninhabited islets lie off the western coast of Rutland Island. Thirty fresh excavations, probably all made by hawksbills, were found in October 1978 (Bhaskar 1979a).

Rutland Island

Four species nest on the western coast south of Woodmason Bay. Ten recent hawksbill nests were present in October 1978, on the southern coast where monitor predation on the eggs is heavy.

Middle Andaman

Nesting by 4 species occurs on about 10 km of the eastern coast near Betapur where poachers and their dogs take many eggs.

Katchal Island

At least three species—the green turtle, leatherback and either the ridley or the hawksbill or both—nest at South Bay.

South Sentinel Island

Green turtles nest on the island which is uninhabited, rarely visited by humans and is girdled by 6 km of sandy beach. Monitor lizards prey on the eggs (Davis and Altevogt 1976). Other species of sea turtles probably also nest here.

South Reef Island

Year-round nesting occurs perhaps mainly by green turtles.

Treis Island

This island is visited every year by Malays who remain there for six or eight months and collect turtle shells (Government of India 1857).

Many of the islands in North Andaman and in Southern Nicobars have yet to be surveyed for sea turtle habitats.

Turtle hunting by the Great Andamanese and rituals related to sea turtles have been described by E. H. Man (1883).

Sri Lanka

Data from Deraniyagala (1939 and 1953), Salm (1976), Hoffmann (communication to R. Whitaker, 1978) and Jayawardhana (personal communication, 1979).

Five species—the green turtle, olive ridley, loggerhead, hawksbill and leatherback—are known from Sri Lanka. In addition, Deraniyagala (1939) suspects that the flatback strays into Sri Lankan waters.

Turtles and their eggs are totally protected by law—*Dermochelys* since 1970, the 4 remaining species since 1972. Sri Lanka is a signatory to CITES.

Lepidochelys olivacea

The olive ridley is the most common Sri Lankan sea turtle both as regards occurrence and nesting. In the Gulf of Mannar, it is commonly captured in nets set for green turtles and is not infrequently liberated.

A large concentration of ridleys in December 1978, apparently migrating to nest on Indian coasts, was reported by Hoffmann. Oliver (1946) and Deraniyagala (1953) reported similar migrating concentrations in the months of September and November, respectively.

The school of sea turtles seen by Deraniyagala occupied about 100 km of sea, the individuals keeping about 200 m apart. Hoffmann writes "the fishing boat I was on went due west from Kalpitiya and then drifted south at the end of a 2-mile long drift net. We crossed another boat coming in which had caught 24 turtles in a similar net. The following day, boats which went due west from Kudirimalai Point caught similar numbers. Two days later, 78 were caught in a single net and the skipper reported the sea as teeming with turtles. In each instance, the turtles were released. Almost all were olive ridleys, the remainder being leatherbacks. The schools were headed north."

Caretta caretta

Fishermen from the Gulf of Mannar where the species is most common quote nesting in June, July, and August. Shells scattered around fishing camps indicated a 1:20 proportion of loggerhead to ridley catches (Deraniyagala 1939).

Chelonia mydas

In the Gulf of Mannar where a green turtle population is actively hunted, the species has been declining steadily. Hundreds of families in the Jaffna district depend on turtle fishing for subsistence. Fishermen using special nets catch the species on both the west and east coasts of Sri Lanka (Salm 1976). Each Sunday, 20 to 30 are slaughtered at Jaffna (Parsons 1962).

Eretmochelys imbricata

Around 1843, hawksbills nested so freely on parts of Sri Lanka's southern coast that the government farmed the right to capture them. Hawksbill scutes were used for ornamental purposes and for inlaying. The flesh was eaten usually by the poorer class of Tamil fishermen in Sri Lanka, and there were occasional cases of poisoning.

Dermochelys coriacea

The leatherback nests on the coast of the Yala National Park in southern Sri Lanka where 3 areas of concentrated nesting totaling 10 km in length were identified by Salm. Both the remoteness of the Yala coast and law enforcement by Park rangers ensure that leatherback eggs remain safe from humans within the Park boundary. Nest predators include wild boar (*Sus cristatus*) and jackals (*Canis aureus lankae*) and possibly leopard and monitor lizards. Salm counted 173 leatherback excavations and 28 nests of smaller turtle species on the 50-km coast of the Park during 9–13 June 1975.

Turtle eggs can be bought from most stalls around the southern part of Sri Lanka and are dug from nests during the day in full view of the public at Bentota, a tourist resort (Salm 1976).

Turtle hatcheries have been established by the government and by the Wildlife and Nature Protection Society.

A proposal to extend the Wilpattu National Park on the northwest coast to include an additional 1,300 km² of coastal waters, if implemented, will benefit turtles (Jayawardhana, personal communication, 1979).

Bangladesh

Four species—the olive ridley, green turtle, hawksbill and leatherback—are reported from Bangladesh (Reza Khan, personal communication, 1979). On the Khulna section of the railways, large numbers of chelonians were seen by Dr. S. L. Hora (Acharji 1950).

Burma

The Burmese exploit turtles for their eggs rather than their meat (Parsons 1962). From Diamond Island alone, the annual take of eggs was 1.6 million or more—about 1.5 million from loggerheads (almost certainly olive ridley—authors) and about 10,000 from hawksbills. The green turtle lays year-round but chiefly from July to November. The loggerhead (olive ridley—authors) nests from September to December, and the hawksbill from June to September. Egg harvesting took place under license from the government but the taking of live turtles was illegal (Maxwell 1911). This ban has apparently been periodically violated as when British ships restocked with nesting turtles (Parsons 1962). The extent of the present egg harvest in Burma, if any, is not known.

"The shores of Little Coco Island swarm with turtles" (Government of India, 1857).

Nesting by leatherbacks has been recorded from the coast of Tenasserim (Pritchard 1963).

Recommendations

1) Detailed surveys to locate sea turtle nesting beaches are urgently required along the coasts of mainland India and nearby islands.

2) The establishment of sanctuaries at nesting and feeding grounds of turtles will help conserve local populations. Suggested locations are: Bhaidar Island in the Gulf of Kutch for nesting olive ridleys; the waters around all Indian islands in the Gulfs of Kutch and Mannar to protect the green turtle feeding populations; Suheli Valiakara, Tinnakara and Minicoy Islands in Lakshadweep, primarily for nesting and feeding green turtles; the Wheeler Islands and the coast extending southwards from the turtle sanctuary of Gahirmatha Beach, to include Hukitola Island and terminating near the port of Paradwip, for nesting olive ridleys; the Twin Islands in the Andamans for nesting hawksbills; the nesting beaches at West Bay on Little Andaman and at the mouths of the Dagmar and Alexandria rivers in Great Nicobar Island to protect the leatherback.

3) A 3 km wide strip of coastal waters extending from Latitude 20°47'N to 20°16'N should be declared off limits to all fishing activity during the months September to March and a speedboat should be acquired by the Orissa State Forest Department to monitor the waters off Gahirmatha Beach and to control the poaching of adults at sea which at present is rampant.

4) The law protecting turtles needs to be rigidly enforced in the state of West Bengal, the main market for turtle meat.

5) Coastal lands need to be initially surveyed for degrees of nesting before being allotted for settlement by humans. Where nesting beaches cannot be adequately protected, settlement should be discouraged. The foregoing has immediate relevance in Suheli, Little Andaman and Great Nicobar Islands.

6) Wide publicity about the plight of sea turtles through the medium of documentary films needs to be taken up.

7) Funds and facilities for conducting field studies and research on sea turtles in India have to be procured. As an example, exact *arribada* populations can only be monitored and tagged with the help of adequate staff and equipment.

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Review of Sea Turtles in the Arabian Area

ABSTRACT

We review sea turtles and populations in the Arabian Gulf, South Arabian coast, and the Red Sea, noting major nesting and feeding grounds. We estimate population sizes and discuss threats to sea turtles.

The green turtle, *Chelonia mydas*, is the most common turtle in the region. Extensive feeding grounds are in the Arabian Gulf, on the coasts of Oman and the Peoples Democratic Republic of Yemen (PDRY), and in the Red Sea. Large nesting grounds are at Karan Island (Saudi Arabia), Ras al Hadd (Oman) and east of Mukulla (PDRY), each with several thousand turtles nesting each year. However a feature of this area is the large number of small nesting grounds. Small numbers of turtles and turtle eggs are consumed in coastal Oman and in the Gulf, however this exploitation is local and of low intensity. An exception is PDRY where turtle meat has been exported for some years.

Hawksbill turtles, *Eretmochelys imbricata*, generally occur in small numbers throughout the area. Small nesting groups and single nestings often occur but major nesting grounds are found on Hormuz and Larak Island (Iran), Shetvar and Lavan Islands (Iran), Masirah Island (Oman), Jebel Aziz and Perim Island (PDRY) and the Suakin Archipelago (Sudan). Between 100 and 500 turtles nest at each of these locations each year. There is a small trade in hawksbill curios and constant predation of eggs by people, but no systematic exploitation.

A single large nesting ground of loggerhead turtles, *Caretta caretta*, is on Masirah Island, Oman. An estimated 30,000 loggerheads nest each year. Loggerheads are rarely seen elsewhere in the region.

Olive ridley turtles, *Lepidochelys olivacea*, nest in small numbers (150 a year) on Masirah Island. Their distribution may be limited because areas of low salinity and mangroves that this species favors are scarce in the region.

Leatherback turtles, *Dermochelys coriacea*, are seen occasionally but are not known to nest in the area.

Most leatherbacks seen in Oman are subadults. Leatherbacks are caught and rendered for oil on Masirah (Oman) and Larak (Iran) but the level of exploitation is low.

Turtle populations of all species are threatened by the increasing subsistence exploitation that is facilitated by the improved mobility of the people with vehicles and outboard motors. Other threats are coastal development and industrialization which are degrading nesting and feeding habitats.

Further research in the Arabian region should concentrate on coordinated survey and education projects. The opportunity exists to assist local authorities to establish conservation programs before the developing threats reduce the turtle populations from their present healthy levels.

Introduction

This review outlines the current state of knowledge of sea turtles in the area from the Iran-Pakistan border in the east to the horn of Africa (Cape Guardifui) in the west, taking in the shores of the Arabian Gulf and the Red Sea. Information from the region is scarce and fragmentary. Major breeding grounds and feeding aggregations of sea turtles are identified and their population size and current status are evaluated. Present and potential threats to the survival of sea turtles are assessed. A general assessment of sea turtle populations in the area is given to aid in the better understanding of sea turtle populations world wide.

Published works other than taxonomic references on turtles in the Arabian area are restricted to papers by Hirth with various colleagues (Hirth (FAO) 1968; Hirth and Carr 1970; Hirth and Hollingworth 1973; and Hirth, Klikoff and Harper 1973) and the monograph by Basson et al. (1977). We have added various unpublished reports made available by personal communications to the authors. The personal experience of both authors in the area and in particular the extensive survey of sea turtles in the Sultanate of Oman supported by WWF/IUCN has provided additional information. The detailed information on turtle biology obtained over a 3-year interval in Oman has been used to evaluate and extrapolate the information from elsewhere. To augment these sources, letters to the heads of fisheries research organizations in the area were sent with a questionnaire reproduced as Table 1. Answers, received from 4 out of 5 enquiries, are incorporated in the report. Coastline lengths are approximate straight lengths of coast excluding offshore islands.

Table 1. Questionnaire sent to fisheries departments in the Gulf region, spring 1977

1. What species of turtles are seen in your country?
2. What are the common names for turtles in your country?
3. a) Do turtles come ashore to lay eggs in your countries?
   b) Which species?
   c) Where? (Latitude and Longitude, if possible)
   d) How many each year (even rough estimate is useful); e.g. a few, dozens, hundreds, etc.?
   e) Which months of the year do they lay eggs?
4. Are there large numbers of turtles in your countries, even though they do not lay eggs? What sorts; where and how many?
5. a) Are turtles caught by people on nesting beaches in your country?
   b) Are turtles caught in the sea in your country?
6. Do people in your country eat turtle meat?
7. Does your country export any turtles or their parts? If so, where to? How many each year?
8. How many turtles are killed in your country each year?
9. What laws and regulations apply to the catching of turtles?
10. Are the numbers of turtles in your country increasing, decreasing or stable?

Turtle Biology in the Arabian Area

The locations of important turtle feeding grounds and nesting beaches are shown in Figure 1. Two species predominate in the turtle fauna of the Arabian area, the green turtle and the hawksbill. The loggerhead is known only from the breeding beach on Masirah; its wider distribution remains unknown. Loggerheads are not recorded within the Arabian Gulf, but 1 unconfirmed report suggests they may occur in the Red Sea and nest in the Sinai region. The very small population of ridley turtles nesting on Southern Masirah is the only known occurrence of that species. The relationship of this small population to the much larger nesting colonies of the Indian coast is unknown. Rough estimates of the total population of these species in the region are given in Table 2. Leatherback turtles are reported occasionally throughout the area but are not known to nest there. Data from Oman (Table 3) suggest that many of the leatherbacks observed there are quite small.

The pattern of nesting green turtles and their distribution from nesting grounds to feeding grounds remains incompletely known but appears to be rather complex. There are large concentrations of turtle nesting at Ras al Had in Oman (6,000 ♀/y) and coast of Mukalla in the PDRY (10,000 ♀/y) of the sort seen in the Caribbean. However, there are also widespread small nesting grounds supporting populations of up to

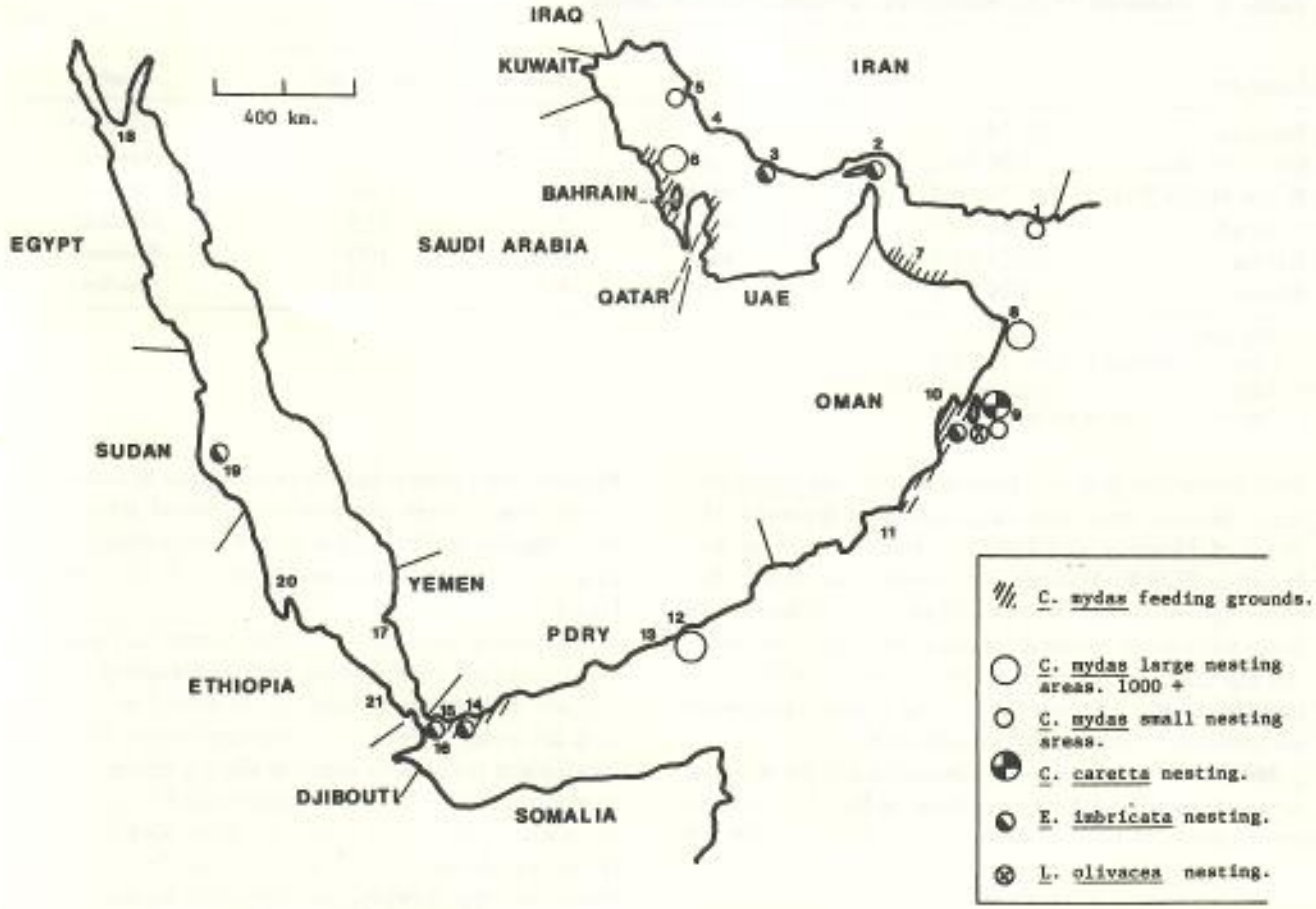

Figure 1. Sea turtle nesting and feeding grounds in the Arabian area, numbered locations: 1) Beris; 2) Hormuz, Larak, Queshm Islands; 3) Lavan, Shetvar Islands; 4) Jabrin Islands; 5) Bandar Bushr; 6) Karan Islands; 7) Batina coast; 8) Ras al Hadd; 9) Masirah Island; 10) Amhawt Island; 11) Kuria Muria Bay; 12) Ithmun, Sharma, Shihr; 13) Mukulla; 14) Jebal Aziz; 15) Khor Umaira; 16) Perim Island; 17) Kamran Island; 18) Sinai; 19) Suakin Archipelago; 20) Dahlak Archipelago; 21) Assab.

Table 2. Annual breeding populations of sea turtles in the Arabian area, rough estimate

Country	*Green turtles*	*Hawksbills*	*Loggerheads*	*Ridleys*
Iran	500	1,000	—	—
Saudi	500	100	—	—
Qatar	—	100	—	—
Oman	7,000	100	30,000	150
PDRY	10,000	500	—	—
Yemen	200	—	—	—
Total ♀♀/yr.	18,200	1,800	30,000	150
Total population[a]	54,600	5,400	90,000	450

— No data.

a. Using Carr, Carr, and Meylan 1978 estimate that total population (green turtles) = 3 × Annual ♀♀.

a few hundred females each year. For example, in Oman which is well surveyed there are small nesting grounds on almost every isolated beach and island (Figure 2). The movements between these nesting grounds and local or distant feeding grounds are unknown. However, it is notable that in the few records of long distance migrations we do have individual turtles bypass several other nesting and feeding grounds on their migration (Figure 3). A feature of the migrations of green turtles in the area is the regular occurrence of large "fleets" of migrating turtles of the sort described in historical sources in the Caribbean (e.g. Lewis 1940) but not seen there for over 200 years.

Hawksbills are widely but sparsely distributed

Table 3. Records of *Dermochelys coriacea* around Oman

Location		*Date*	*Sex*	*Straight carapace length (cm)*	*Notes*
Masirah	21°N,59°E	Jun 73	F	126	flotsam[a,b]
Gulf of Oman	24°N,60°E	Apr 77	—	—	trawler[c]
Kuria Muria Bay	17°N,56°E	Mar 78	M	80	trawler
Masirah	21°N,59°E	Sep 78	F	133	flotsam
Batina	24°N,56°E	May 79	—	100	flotsam
Batina	24°N,57°E	Jun 79	F	150+	trawler

— No data.
a. Flotsam = washed up dead on beach.
b. Reported in Hirth and Hollingworth 1974.
c. Trawler = caught by fishing trawler.

throughout the region, often in association with coral reefs. Several large nesting grounds are reported; the Strait of Hormuz and Lavan in Iran, Jabal Aziz and Perim in PDRY, Masirah and possibly the Suakin Archipelago in the Red Sea. In addition, single hawksbills seem to nest on isolated beaches and islands throughout the area, a dispersed pattern common to this species elsewhere. The amount of long distance migration undertaken by hawksbills is unknown.

Many of the populations of sea turtles in the Arabian area are large and have not been reduced in size by exploitation by people. Most people in the region are Muslims who have religious prohibitions against eating turtle meat. There are however several areas where this religious prohibition is no longer operative, and a small amount of local consumption of turtle meat is found.

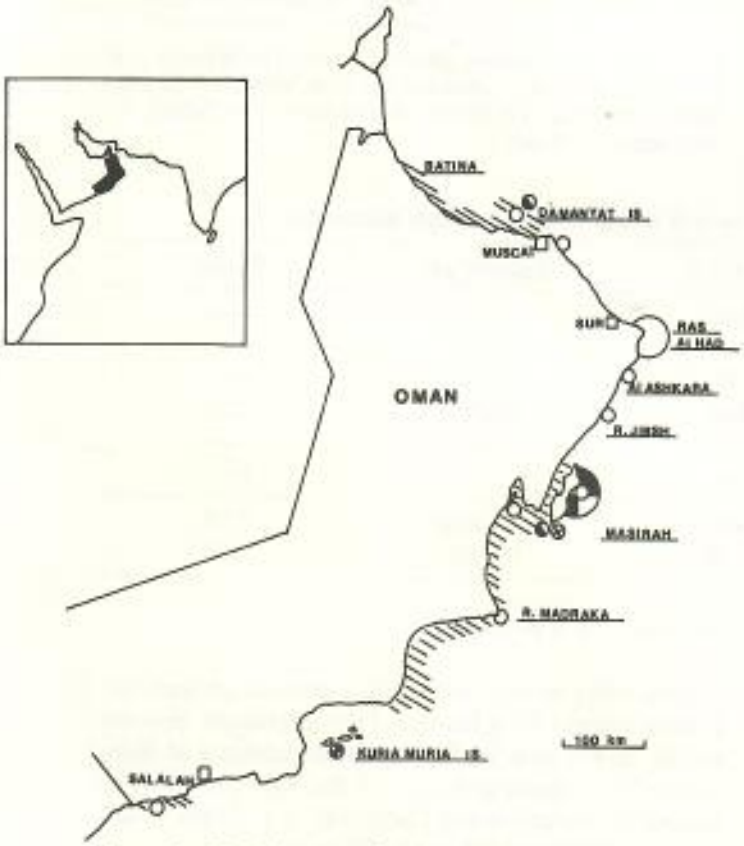

Figure 2. The Sultanate of Oman, showing sea turtle nesting locations. Symbols as in figure 1.

Additional mortality of adult turtles is caused by accidental capture in fishing operations aimed at other species. Turtles are caught and drowned in large pen nets for pelagic fish and in shrimp trawls. There are insufficient records to evaluate the significance of this mortality. Answers to our questionnaire suggest that the number of turtles killed by these means is small. However, Ross (1979b) showed that in the United States shrimp trawling industry the apparently low mortality of 0.03 turtles/trawl/hour results in the death of a significant number of turtles. There are approximately 125 shrimp trawlers operating in the Arabian Gulf (Feidi 1979) and the potential mortality of sea turtles is considerable. Coastal people throughout the region make subsistence use of turtle eggs but there are no reports of organized commerce in eggs. The significance of predation by people must be evaluated in relation to other natural mortalities. Observations at Masirah Island, Oman, show that early in the loggerhead season when nesting density is low, a high proportion of nests are found and robbed. However, when nesting reaches its full density of more than 50 turtles/km/night the proportion of nests robbed by people stabilizes at 6 percent. In comparison the number of nests destroyed by turtles averages between 1 percent and 9 percent of nests laid—for both green turtles and loggerheads in Oman (Table 4). Some authors have argued from computer simulations that the destruction of nests by nesting females acts as a population regulation mechanism (Bustard and Tognetti 1969). It is apparent from the data in Table 4 that at the high nesting densities observed in Oman this effect is small. Most mortality of the loggerhead nests in Oman is due to flooding by the sea (Figure 4). Similar data are shown by Schulz (1975) from Surinam.

Most countries in the Arabian area have numbers of

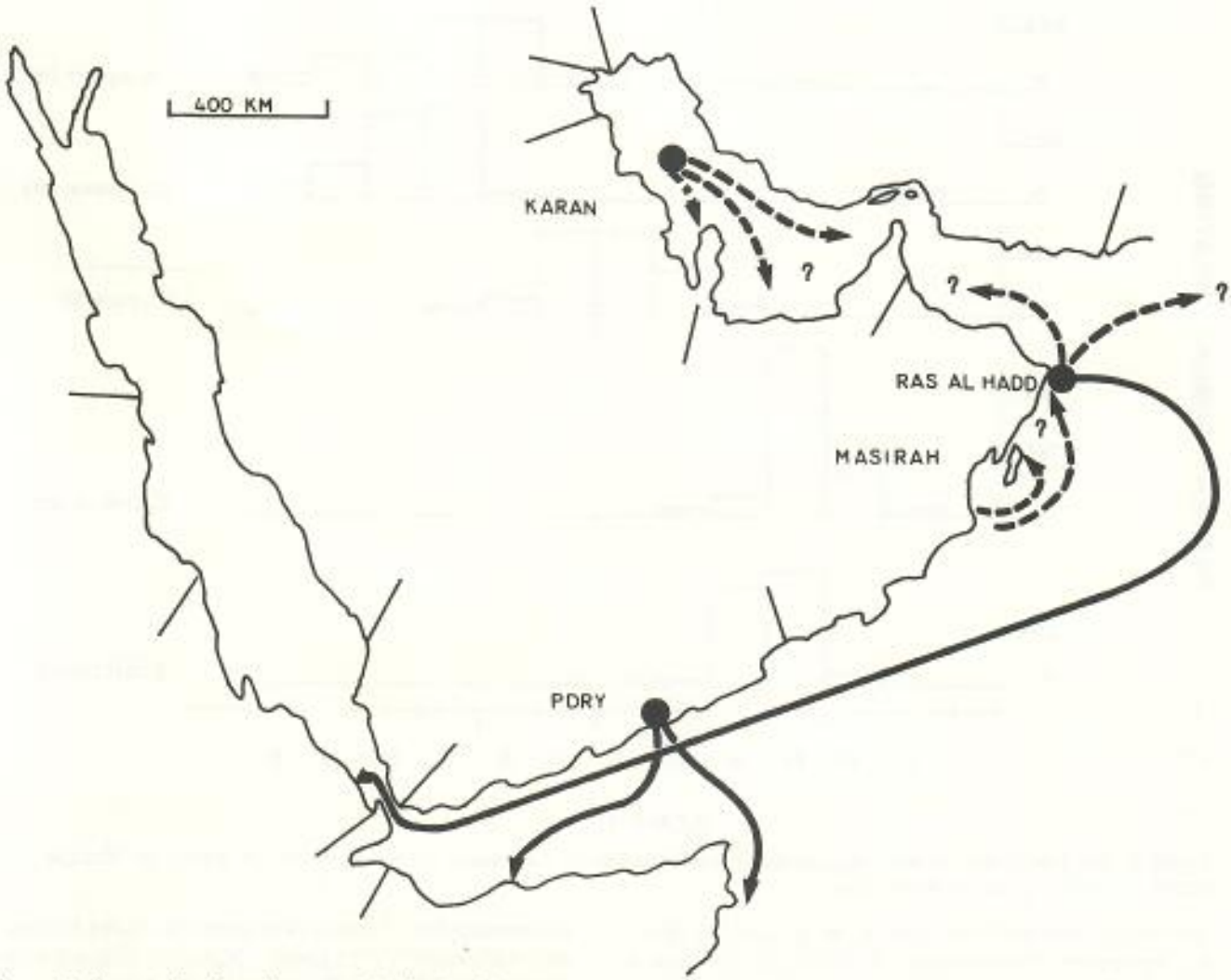

Figure 3. Sea turtle migration routes in the Arabian area. Dotted lines represent speculated or uncertain migration routes. Solid lines are confirmed by tag recoveries.

Table 4. Nest destruction by nesting sea turtles

Species	$\bar{x}$ *(percentage)*[a]	*Range*	*Number*	*Nesting density*
Ch. mydas Oman	5.6	(3.4–8.5)	246	32 turtles/km night.
C. caretta Oman	3.5	(1.1–7.6)	1,000	50 turtles/km night.

a. The proportion of females nesting that dig up previous nests.

relatively poor people living near the sea. They have hopes of providing protein resources or cash income from the exploitation of sea turtles, particularly green turtles. While the feeding areas for green turtles in the region are extensive in area, the quality and productivity of the feeding grounds are relatively low. Data from Hirth, Klikoff, and Harper (1973), Basson et al. (1977) and Ross (1979a) suggest that the high temperature, high turbidity, and high salinity of the Arabian Gulf waters restrict productivity of the seagrass meadows. The major components of the seagrass meadows are *Halophila* and *Halodule* species which are hardy pioneer species present in low biomass. Therefore the productivity of green turtles is likely to be low and calculations of the carrying capacity and protein production by green turtles such as those in Basson et al. (1977:107) are overestimates. Ross (in press) has argued that the south Arabian coast is suboptimum habitat for hawksbill turtles due to periodic cold upwelling resulting in smaller size and reduced clutch size in hawksbills from the Oman and PDRY.

Mortality due to human activities is small at the present time in the Arabian region. However the turtle populations there will not remain at their present large

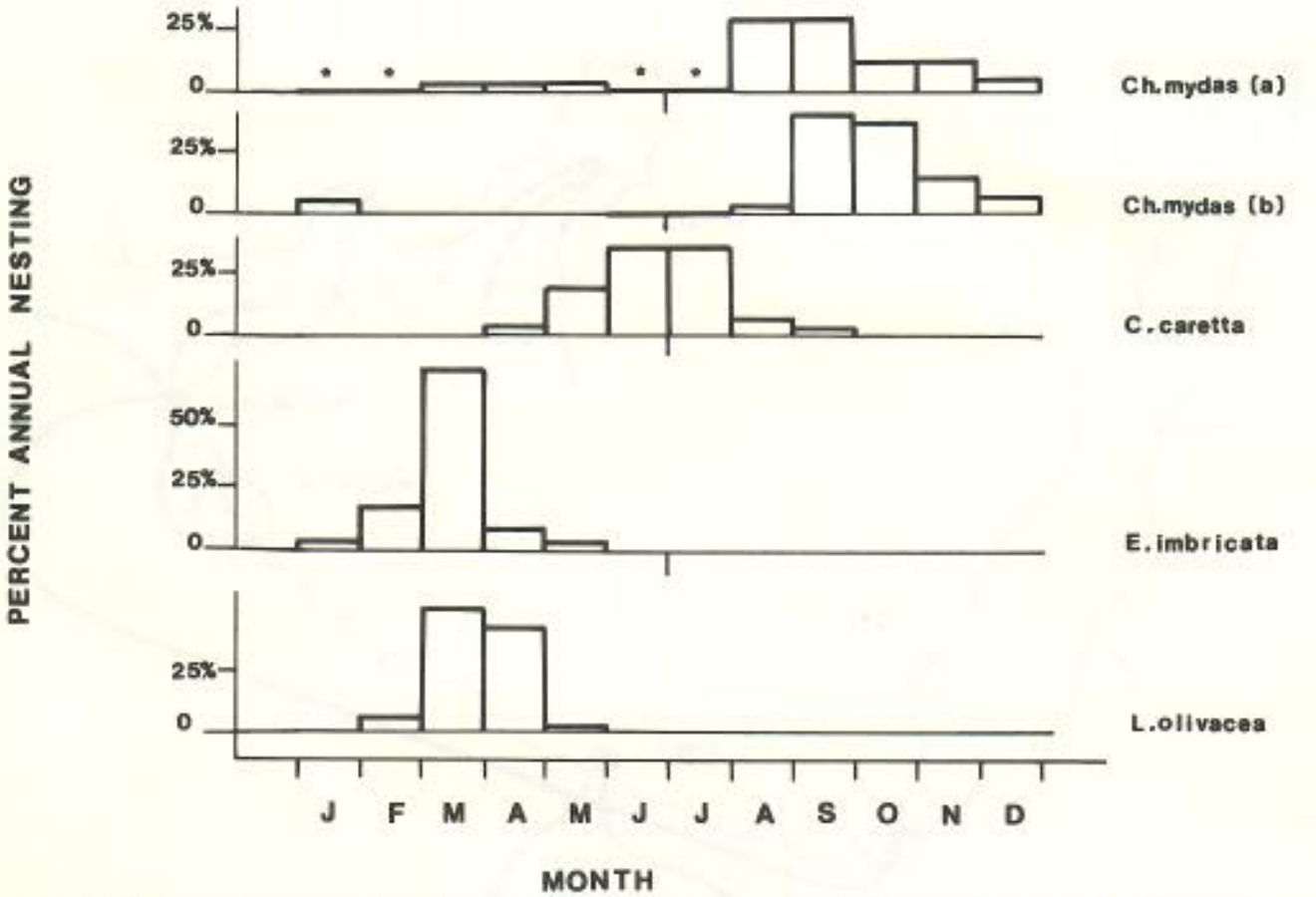

Figure 4. Nesting seasons of sea turtles in the Sultanate of Oman. *Ch. mydas* (a) Ras al Had, *Ch. mydas* (b) Masirah Island. All other species Masirah Island.

size under sustained commercial use for local marketing or export. Conservation strategies in the region must be formulated with this in mind.

National Accounts

Iran

The major source of information from Iran (coastline 2,050 km) are the reports of O. Walczak and W. Kinunen to FAO and the Iran Game and Fish Department. Supplemental information was obtained from J. Frazier (mimeo 1975) and personal communications. Walczak and Kinunen surveyed the coast from Gowater near the Pakistan border to Chah Bahar, from Charak to Bandar Abbas and in the area of Moghum and Bandar Bushr. Isolated nesting grounds are reported in the region of Beris and Bandar Bushr. *Chelonia mydas* (green turtle) and *Eretmochelys imbricata* (hawksbill) are reported to be present. Although the surveyed areas are reported to be "excellent nesting habitat" the number of turtle nests seen was small (<50). The surveys were carried out in spring 1971, and no indication of seasonal variation in numbers of nesting turtles was given.

Anderson (1979) gives records of sightings of *Ch. mydas* and *E. imbricata* and includes precise locations of nesting grounds. Minton (1966) reports green turtles nesting from June to November in nearby Pakistan and Anderson (1979) reports Kinunen-Walczak's observations of hawksbill nesting in April to June.

The main nesting areas reported in Iran occur on islands in the Arabian Gulf. Hormuz, Quesham, and Larak, situated at the eastern end of the Gulf, support nesting populations of hawksbills estimated to be in the order of a hundred females during April and May. A smaller number of *Ch. mydas* nest on the same beaches, and *Ch. mydas* feed offshore. There is predation on turtle eggs by humans, dogs and foxes. On Larak, leatherback turtles are reported to be rendered for oil to treat boat timbers, a common practice throughout the Gulf when the favored source of oil, shark liver, is in short supply.

The islands of Shetvar (= Shotur) and Lavan (= Sheykh Sho'eyb) support a large nesting population of hawksbill turtles estimated at over 500 nests seen in June 1971. Indications from Oman (Ross 1981), and Cousin Island in the Seychelles (Diamond 1976) suggest that this represents at least 300 females nesting, making this a significant nesting ground. A smaller number of green turtles also nest on these islands. Both species are harvested for their shells, and the meat is discarded. Hawksbills are also reported to nest on Jabrin Island (Anderson 1979).

Sea turtles of undetermined species are reported from the waters around Sirri Island in the central Gulf.

The beaches in Iran are largely without protection, and exploitation is occurring at an unknown level.

Iraq

There is little information on sea turtles in Iraq (coastline 25 km). The coast is restricted to the estuary of the Tigris and Euphrates and is unlikely to be of importance for sea turtles.

Kuwait

In reply to our questionnaire the director of Fisheries of Kuwait (coastline 200 km) said that 1 green turtle had been caught in 3 years by the Fisheries research vessel, and that no other information was available.

Saudi Arabia Gulf Coast

The only information of the Gulf coast of Saudi Arabia (coastline 500 km) is from Basson et al. (1977). They report *Ch. mydas* nesting on Karan, Jana, Kurayn and Jurayd Islands with 80 percent of the population, estimated at several hundreds, nesting on Karan. Occasional nesting by green turtles on other islands and the mainland are reported but are apparently discouraged by interference from people and other nest predators. Hawksbills are reported to nest infrequently with green turtles from April to July. Green turtles nest in the summer months during May to September. Leathery turtles are recorded as present but uncommon and are not known to nest.

There are extensive feeding areas for green turtles on the seagrass meadows throughout the area. Important areas are near Abu Ali Island, Tarut Bay, between the island of Bahrain and the mainland, and around Jazirat as Samamik. There is in excess of 1,000 km² of suitable feeding area. Three species of seagrass, *Halodule uninervis, Halophila ovalis* and *Halophila stipulacea*, predominate and reach an annual productivity of 128 g dry weight per m². No estimate of the population of green turtles using this resource is given. Nevertheless it is clear that this area represents a major feeding ground within the gulf. Basson et al. (1977) speculate that turtles from Karan may migrate to India and Pakistan, but data are lacking.

No analysis of threats to sea turtles is given, but several can be inferred. There is a large shrimp fishery in the area; accidental mortality of sea turtles is inevitable. A factor currently minimizing this effect is the high productivity of the fishing ground which enables large catches to be made with short trawls around an hour long. However, Basson et al. report a decline in recent catch, and it is likely that as the fishery declines, trawl time will increase and mortality of accidentally caught turtles will increase. A further factor that could threaten these feeding grounds is the rapid establishment of industry along the coast. Increased mobility of local people will lead to more extensive disturbance of nesting turtles. Turtle meat is not known to be consumed in any significant amount in Saudi Arabia, probably owing to religious prohibitions.

Bahrain

Gallagher (1971) reported green turtles feeding near Bahrain (coastline 60 km), and the results from the adjacent coast of Saudi Arabia by Basson et al. (1977) confirm this report. In reply to our questionnaire the Bahrain Fisheries Research Bureau reported that occasional dead green turtles (an estimated 1 or 2 a year) are washed up on Bahrain, but green turtles are not caught or consumed. There are no regulations affecting turtles, and no information on nesting or population sizes.

Qatar

Information from Qatar (coastline 300 km) was obtained from the answer to our questionnaire and from conversation with Peter Hunnam, a marine biologist consultant, who has done underwater survey work in the area. Five species of turtle are reported from Qatar: green turtle, hawksbill turtle, leathery turtle, loggerhead turtle, and flatback turtle. Of these, the identification of loggerheads and flatbacks is doubtful and should be disregarded pending confirmation. The common name for all turtles is *Hemssa* except the leathery turtle which is called *Geldia*.

Nesting of green turtles once occured in small numbers on mainland Qatar at Ras Laffan and Umm Said, but no longer occurs probably due to increased human disturbance. The islands of Sharaawh and Dayinah have nesting hawksbills, and hatchlings are reported during early July. The nesting populations are estimated as "a few only." Aliya and Safaliyah islands are heavily disturbed by people, and no nesting is thought to occur at present. Jazirat Habul has no suitable nesting beaches.

Seagrass flats where green turtles feed are located off the east coast. Turtles of all sizes are caught in trawl nets in this area, but most are said to be returned alive to the sea. Information on the exploitation of sea turtles is conflicting. One informant said turtle is not a common food in Qatar, while the other said green turtles are often seen in fish markets and estimates the annual catch at no more than "a few hundred" per year.

Hawksbill meat and eggs are eaten whenever found. A further threat is the development of a port at Ras abu Khamis which has already led to a degradation of coral reefs in the area and the disappearance of much of their fauna including hawksbill turtles. There is no

systematic information on turtles from Qatar and no protective regulations. However, the Department of Fisheries has expressed interest in obtaining more advice and information.

United Arab Emirates

In reply to our questionnaire, the Ministry of Agriculture and Fisheries of the UAE (coastline 600 km) expressed regret that they have not studied their turtle fauna and expressed a desire for more information from us. In the course of the Sultanate of Oman turtle survey we were reliably informed that green turtles from the Ras al Had nesting ground are transported by small truck to Abu Dhabi where they command a high price in the fish market (approximately US $6 a kg). The volume of this trade is small at present, involving at most a dozen vehicles and no more than 100 turtles per year, but it is an ominous beginning. It is likely that there are green turtle feeding grounds along the Emirates coast and green turtles are probably caught for food there but data are lacking.

Oman

A survey of sea turtles was carried out by WWF/IUCN and the Oman government in 1977–79. During the survey, most of Oman's coastline (1,700 km) was surveyed from the air with the help of the Sultan of Oman's Airforce. Further surveys were carried out by boat and Landrover to evaluate remote beaches. The major nesting beaches and feeding areas of sea turtles in Oman have been identified. Local counterparts were hired and trained to carry out intensive studies of turtle biology at 2 main nesting areas: Masirah Island and Ras al Had. From the information obtained from surveys and from the intensive study, recommendations for the conservation of sea turtles in Oman were formulated.

Four species of sea turtles nest regularly in Oman. These are the green turtle, *Chelonia mydas*; the loggerhead, *Caretta caretta*; the hawksbill, *Eretmochelys imbricata*; and the olive ridley, *Lepidochelys olivacea*. Table 5 gives the body sizes and clutch sizes of these species. A fifth species, the leathery turtle, *Dermochelys coriacea* is encountered occasionally in coastal waters but is not known to nest in Oman.

Two of the species have large nesting grounds in Oman which are of international significance because of their size and because they are relatively undisturbed. The green turtle population at Ras al Had is estimated at a minimum of 6,000 adult females nesting each year. Other smaller aggregations of this species are shown in Figure 2. The loggerhead nesting aggregation on Masirah Island is estimated at a minimum of 30,000 females nesting each year. This is the only large nesting colony of loggerheads in Oman and is the largest known aggregation of this species in the world.

A small population of hawksbills estimated at 90 to 125 females a year nests on the southern tip of Masirah Island, and some hawksbills are resident around Masirah. A small population of olive ridleys, estimated at 150 females nesting each year also nests around the South of Masirah. The seasonal distribution of nesting seasons of these four species is shown in Figure 4.

The only turtle commonly seen away from the nesting beaches in Oman is the green turtle. Feeding areas are in Sawqira Bay, the Gulf of Masirah, and scattered along the Batinah coast. The relationship between the turtles nesting in Oman and those seen on the feeding grounds is not clear. Many of the turtles that nest in Oman may feed as far away as the coasts of Africa and India. A major activity of the survey was to place over 5,000 numbered metal tags on turtles. The only international return to data is a tag put on a green turtle at Ras al Had (Oman) that was returned from Assab (Ethiopia) in the Red Sea. This represents a migration of 2,220 km in 3 months.

The green turtle is eaten by people on Masirah, Amhawt Island and other small villages on the southern coast. A minimum of 1,000 green turtles are captured each year from the feeding grounds and used as food. The value of this resource to the coastal people is greater than US$30,000 per year. All the turtle meat is eaten directly and not sold. The killing of nesting turtles has been banned on Masirah where the excessive killing of nesting turtles has caused the number of turtles to decline.

Table 5. Body size and clutch size of nesting female sea turtles in Oman

Species (occurrence)	*Mean straight carapace length ± 2 SE*	*Number*	*Mean clutch size ± 2 SE*	*Number*
Ch. mydas (Ras al Hadd)	97.1 ± 1.2	(62)	103.5 ± 8.0	(58)
Ch. mydas (Masirah)	93.2 ± 1.4	(90)	97 ± 5.6	(16)
C. caretta	91.2 ± 1.0	(1,378)	107 ± 3.0	(161)
E. imbricata	73.3 ± 1.6	(48)	97[a] ± 16.0	(9)
L. olivacea	71.5 ± 0.6	(100)	118 ± 7.2	(22)

a. Masirah hawksbills also lay an average of 11 small yolkless eggs (range 0–30).

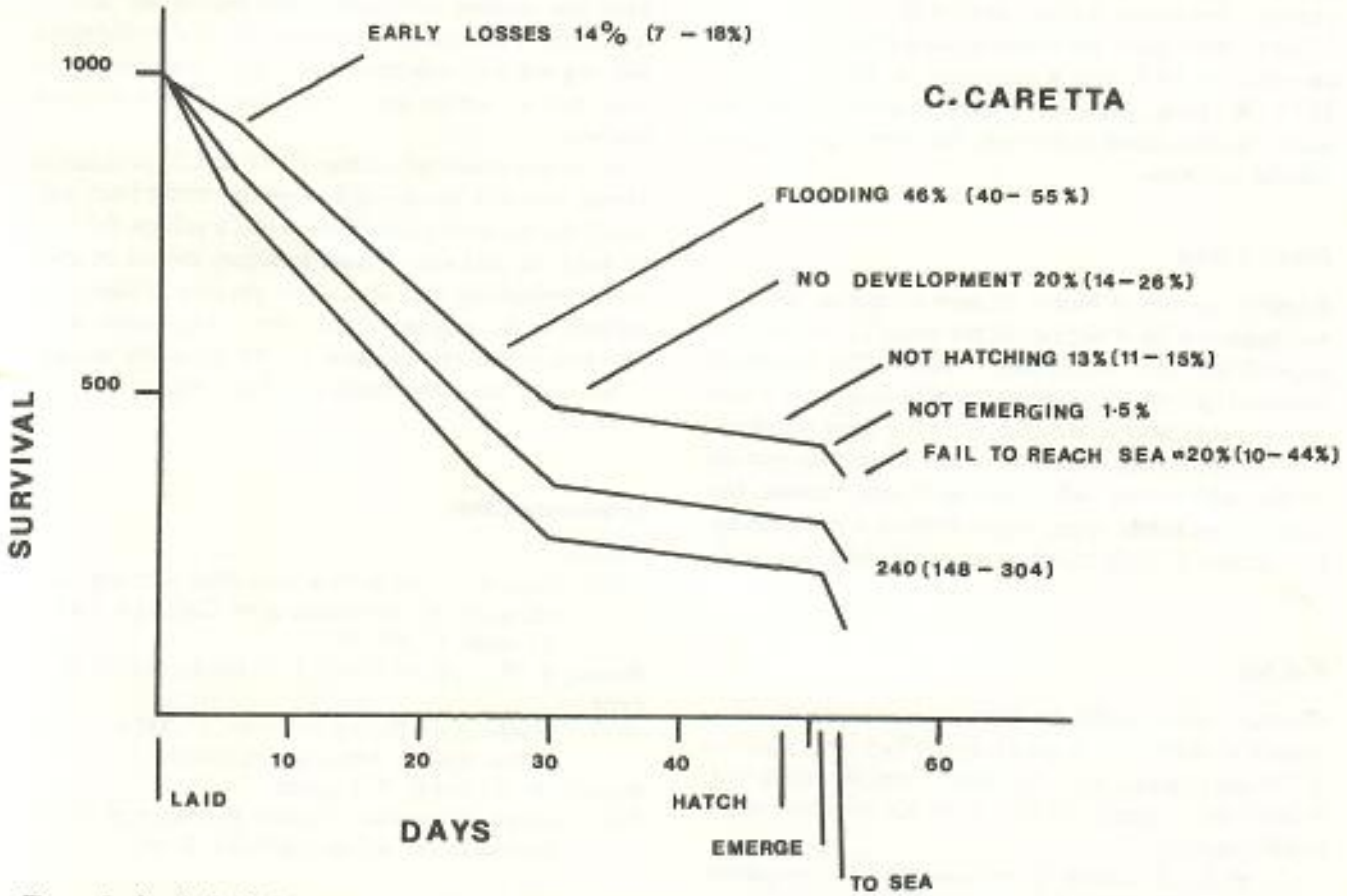

Figure 5. Survival of *C. caretta* eggs and hatchlings from laying to entering the sea. Upper, lower and median estimates are shown.

The major cause of death of loggerhead eggs on Masirah is the sea which unpredictably washes away about 40 percent of the eggs laid each year (Figure 5). People on Masirah take only a small proportion of the eggs to eat. Of greater concern is the rapid development of the village near the main nesting beach. There is some evidence that lights and disturbance from development are causing hatchling turtles to become disoriented and not find the sea. The small populations of hawksbill and olive ridley turtles which nest at the south of Masirah are subject to occasional taking of eggs by people.

Proposals have been put before the Oman Government to protect the nesting beaches in national parks or marine reserves and to control strictly the capture and trade of green turtles. The government has been advised not to promote any commercial development of the turtle resource but to preserve it for controlled traditional use. Further studies are in progress.

People's Democratic Republic of Yemen (PDRY)

All the information on PDRY (coastline 1,200 km) is taken from Hirth and Carr (1970) and Hirth and Hollingworth (1973) in which the results of Hirth's surveys during 1967–72 are presented.

Major nesting grounds of green turtles are reported at Ithmun, Sharma, Musa, Shihr, and Shuhair in the area east of Mukulla. Nesting density is high (reported as approximately 30 turtles/night/km) and the total length of beach available is approximately 13 km. If the nesting parameters of this population are similar to that at Ras al Hadd, an estimated 10,000 females nest in this area during the peak of the season. Other scattered nesting grounds occur along the coast. Hawksbills nest at Jabal Aziz and Perim Island in significant numbers during January–February. The data preclude any estimation but the population is likely to be in the order of several hundred females a year.

Feeding grounds of green turtles are found in the western part of the country. One concentration at Khor Umaira is the site of some useful surveys on seagrasses and their utilization by turtles (Hirth, Klikoff, and Harper 1973).

At the time of Hirth's surveys exploitation of green turtles on both the nesting beaches and feeding grounds

was estimated to be between 800–4,000 turtles a year (1964–74). Hirth proposed a limited quota of 1,000 a year but this quota is often exceeded.

No recent figures are available but 4,000 turtles were exported in 1970 and a minimum of 400 to 700 in 1973 (W. King, personal communication). If exploitation has continued at this rate, the nesting population may be depleted.

North Yemen

A partial survey of North Yemen (coastline 500 km) was reported by Walcezak in the early 1970s but it is unpublished and not available. A reliable informant reported (personal communication to Ross) that 3 species of turtle nest at Kamran Island in large numbers. Only green turtles were identified. People do not eat turtles, which they call *Zuqar* in North Yemen, but they do eat turtle eggs, which implies some nesting. No details of turtle numbers or exploitation are available.

Red Sea

We have been unable to discover much useful information about turtles in the northern Red Sea (coastline 2,700 km) except for a personal communication to J. Frazier from Israel (1978). With his permission we briefly report:

Ch. mydas, C. caretta, E. imbricata and *D. coriacea* are all reported from the Sinai region, and there is an unverified report of *L. olivacea*. *Ch. mydas, C. caretta* and *E. imbricata* are said to breed in the area of Sinai. The whole of the Red Sea is inadequately surveyed but is likely to support both breeding and resident populations of *Ch. mydas* and *E. imbricata*. All species are said to be in decline in the Israeli administered area (1978) due to human disturbance.

Hirth (1980) reports a recent preliminary survey of sea turtles on the Sudan coast and reviews historical sources. Hawksbill turtles nest in good numbers in the Suakin archipelago. Some protection is accorded by the Sudanese Wildlife Conservation Act, but there is concern that tourist development will pose future problems. Hoofien and Yaron (1964) report *Ch. mydas* and *E. imbricata* from the Dahlak Archipelago without giving details of nesting or feeding areas.

Summary and Conclusion

From the rather sparse information we have assembled here it is evident that a significant population of green, loggerhead and hawksbill turtles occurs in the Arabian region. The opportunity to preserve these species at their present high densities is a current challenge. It should be possible to protect the major nesting grounds particularly as, with the exception of PDRY, there is very little commercial pressure on sea turtles. However the nations throughout the region are well financed and pursuing a course of rapid development. We require a coordinated educational program to ensure that sea turtles are not the victims of this development.

Programs modeled on the WWF-IUCN program in Oman where a survey and scientific study both provided the necessary information and a vehicle for public relations and educational activities should be initiated throughout the area. The present affluence of nations in the regions means that conservation funds invested in this region show a most generous "return" in terms of matching funds and final results.

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Status of Sea Turtles in the Central Western Indian Ocean

ABSTRACT

The 7 territories of the Central Western Indian Ocean include some of the best known turtle areas in the world. All 5 of the pantropical species are recorded, but only *Chelonia* and *Eretmochelys* are common. Numbers of both species seem to be below former levels, and it is unlikely that marine turtles remain the important resource they once were.

Background

The Central Western Indian Ocean (CWIO) is here defined as: British Indian Ocean Territory (BIOT), Seychelles, Comores, Mayotte, Tanzania, Kenya, and Somalia (Figure 1). Each of these territories has a colonial history, and all are now sovereign states except BIOT, an uninhabited British colony, and Mayotte, a French Department.

This roster includes some of the world's most famous territories for marine turtles. The Seychelles are renowned for their turtles and turtlemen who kept much of Europe supplied with turtle soup and tortoiseshell over the last hundred years. Zanzibar was one of the most important centers in international trade of tortoiseshell. The Bajun of the northern coast of Kenya and southern coast of Somalia are expert turtlemen, with sophisticated techniques for catching turtles at sea, and Comorians, including those from Mayotte, once had similar customs, including the use of sucker fish.

With the exception of Somalia, all of these territories have been surveyed by the author over the past decade. This report is a synopsis of more complete studies, many of which are unpublished (Frazier 1970, 1971, 1975a, 1975b, 1976, 1977, in press) and also complements other reports on adjacent areas of the Indian Ocean (Kar and Bhaskar, this volume; Hughes, this volume; Ross and Barwani, this volume; Sella, this volume). For a discussion of subsistence hunting in the Indian Ocean, see Frazier (1980, this volume).

Note: Revised April 1980.

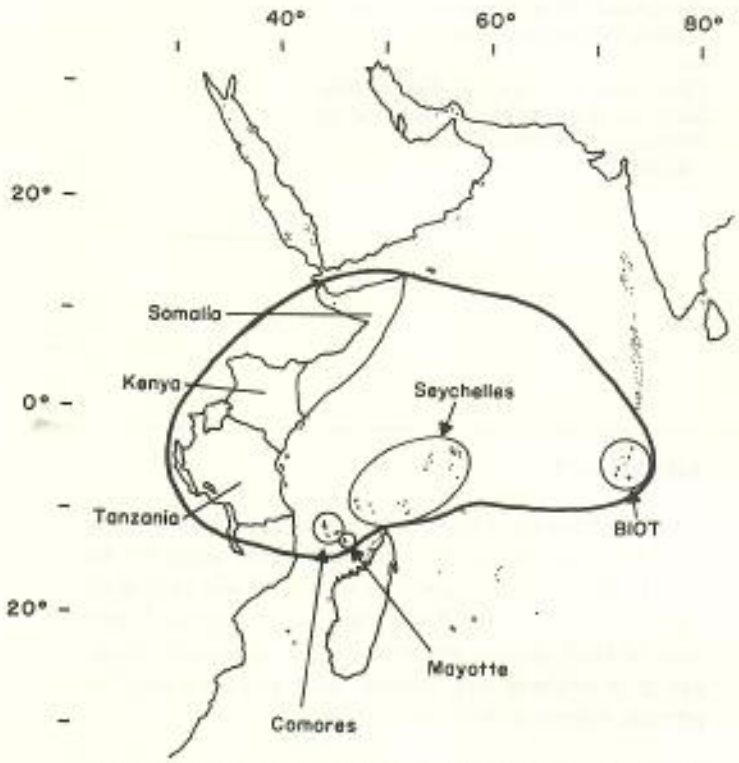

Figure 1. The Central Western Indian Ocean, showing the 7 territories under consideration.

The 5 species of sea turtles that are recorded in the CWIO include all those that are known from the Indian Ocean: green turtle, *Chelonia mydas*; hawksbill, *Eretmochelys imbricata*; loggerhead, *Caretta caretta*; olive ridley, *Lepidochelys olivacea*; and leathery turtle, *Dermochelys coriacea*.

British Indian Ocean Territory

The BIOT now includes only the Chagos Archipelago, the southernmost islands of the Laccadive-Maldive Ridge. There are vast areas of beach and shallow water among the 65 major islands. Possibly because of the Archipelago's remote oceanic position, only *Chelonia* and *Eretmochelys* are recorded, although *Dermochelys* probably pass through deep, offshore water. *Chelonia* and *Eretmochelys* are likely to occur at all the islands and many of the reefs, but documented records are few.

Concentrated nesting occurs at YeYe Island, westernmost and remotest of the Peros Banhos Atoll (Dutton, in press) and Nelson Island. Nests and tracks are large and thought to be from *Chelonia*. This species is reputed to nest from June to September, and the numbers involved are not likely to exceed 300 in a year. The lagoons of some atolls are reputed to have large numbers of immatures, but there are no other reports of nonbreeding or feeding concentrations. Despite the vast shallow water areas, marine pastures are not extensive.

Eretmochelys, as is common in this region, is a dispersed nester, often laying in full daylight. Nesting is reported from only Peros Banhos and Diego Garcia but probably occurs throughout the territory. The main season for nesting is said to be from November to February. Perhaps 300 nest in a year. Rich coral reefs abound and are likely to provide feeding habitat and shelter for sizeable numbers of *Eretmochelys*.

Both species were exploited regularly while the islands were inhabited, and relatively small amounts of tortoiseshell, turtle oil, and meat were exported to Mauritius. The Chagos were known as the "oil islands" from the coconut oil produced and have never been famous for marine turtles. Mating and nesting animals probably took the brunt of exploitation, and reproduction may have been reduced as a result.

Hunting *Chelonia* has been banned completely since 1968, and the inhabitants were evacuated in the early 1970s. No areas are legislated as reserves, but the entire territory is functionally a reserve, for it is uninhabited, except Diego Garcia, now a naval base (Frazier 1977).

Seychelles

The Republic includes a tremendous portion of the western Indian Ocean with 50 major islands. *Caretta* and *Dermochelys* have been reported, but only *Chelonia* and *Eretmochelys* are common, and occur throughout the territory.

Chelonia nests in all island groups but is most numerous on the Aldabras. Nesting is year-round but most active from May to September, during the southeast trade winds. An estimated 1,000 nest annually on Aldabra, and 2,500 are estimated to nest in a year over the Seychelles. Large pastures of algae and phanerograms are in lagoons such as Aldabra and shallow water as on the Seychelles plateau. Feeding animals are common in these areas.

Eretmochelys nest on all island groups, possibly all islands. Cousin Island, in the Granitic Group, has the most concentrated nesting, with 30 to 40 females a year. This is a primary nesting ground for the species in the western Indian Ocean. Nesting, often diurnal, is recorded in all months but June and is most intense from October to January. The numbers estimated to nest annually over the territory are 600. Extensive coral reefs occur throughout Seychelles, providing rich feeding habitats. Some bays in the Granitic Islands have several resident *Eretmochelys*.

Exploitation of sea turtles in Seychelles has been intense for 150 years, since the islands were inhabited. Mating and nesting animals have been especially disturbed, so reproduction has been severely reduced.

Annual production of *Chelonia* has fallen to a fraction of former levels, indicating that populations have been destroyed. The animal is not as common in the main iwslands as it was once. Curiously, there is little evidence for a decline in *Eretmochelys*, despite ever increasing pressure from soaring prices of tortoiseshell. Increasing human disturbance to beaches and reefs in the Granitic Islands, the center of abundance, adds to problems of increasing direct exploitation. The fate of this turtle is in question.

Chelonia was protected by a total ban from 1968 to 1976, but widespread poaching nullified any chances of populations recovering. This turtle is now insignificant as a resource. Various laws protect the 2 common turtles, but enforcement is rare. There are National Marine Parks and Reserves, at Bai Ternay and St. Anne, but they are not of prime importance to nesting turtles. The future of sea turtles in Seychelles rests on reserves such as Aldabra, Cousin, and Aride Islands (Frazier, in press).

Mayotte

A degraded volcano encircled by barrier reef, this island has the most extensive coral reefs in the region. Though geologically one of the Comoro Islands, its history and political status separate it. Only *Chelonia* and *Eretmochelys* are recorded, but the other 3 species are likely to occur.

There are some 140 beaches on Mayotte and satellite islands, and *Chelonia* nesting spoor was recorded on 17 of these. Most activity is on Saziley in the south and Pamanzi Island in the northeast. Moya and Papani beaches on Pamanzi have an estimated 300 nesting annually; the total for Mayotte is 500. Nesting increases during the southeast trade winds, from June to July, but probably occurs round the year.

Eretmochelys nesting spoor was recorded on one beach only. Perhaps 25 nest in the territory in a year. In contrast to the exposed beaches where *Chelonia* concentrate, this turtle is more commonly on protected beaches of the lagoon. Nesting may occur around the year, but if it is like other territories in CWIO, there is more activity from November to December. Feeding habitat and shelter seem to be abundant with the area of active coral reef that is available.

Human predation concentrates almost exclusively on nesting females, and at Moya beach in 1972 there was little chance that a female could survive the nesting season. Turtle populations seem to be below the carrying capacity of the nesting and feeding habitats, but there are no baseline data for estimating population trends. With increased human density, decreased availability of fish, and increased pressures on food resources, turtles are probably under heavy pressure.

There are no reserves and evidently no protective legislation. An awareness of the need to manage natural resources is not conspicuous in either the populace or the government (Frazier 1972).

Comores

Ngazidia, or Grand Comore, has an active volcano and, like Anjouan, dense human populations. Moheli, oldest and smallest of the 3 islands in the Republic, is the most important for turtles, with its dozen satellite islands, large areas of shallow water, and 89 sandy beaches. *Chelonia* and *Eretmochelys* are recorded from all 3 major islands, and a rare, unidentified turtle has been reported at Moheli. Probably all 5 species occur.

At Moheli, 33 beaches have *Chelonia* nesting, but 81% of nesting is on six beaches. Fourteen females may beach in a night on Mtsanga N'yamba, Itsamia, and the annual total for the island is estimated to be 1,850. Perhaps 50 nest at Grand Comore and Anjouan. Nesting activity increases in June and July, during the southeast trades. Marine pastures are of limited size at the 2 large islands, but Moheli has a considerable area, where even dugongs feed. Immature turtles are regularly caught at the north end of Grand Comore, which may be a nursery area.

Eretmochelys nesting is recorded only from 16 beaches on Moheli. The annual number nesting may be 50, and the main nesting season is probably from November to December. Nesting is dispersed, but may not be diurnal. All islands have active coral reefs, but the small islands south of Moheli have profuse fringe reefs.

Some small turtles are netted, but most human predation concentrates on nesting females. Feral dogs, perhaps more destructive, destroy nests on Moheli. Although females are regularly killed and some meat is traded, turtle populations are large and do not seem to have diminished.

There are no protective laws and no marine reserves. Chissoua Ouenefou, in the south of Moheli, has been suggested as an island reserve. There is little consciousness of resource management, and the more affluent people of Grand Comore and Anjouan are involved in exploitation of food resources on Moheli. The fate of the turtles there is, thus, in question (Frazier 1977).

Tanzania

The marine shore, dissected by several large rivers, is rather sparsely populated. Three inhabited major islands lie offshore: Mafia, Zanzibar, and Pemba. Dozens of small cays and raised reef limestone islands dot the inshore waters. All 5 species of sea turtle are recorded.

Dermochelys is reported infrequently, but may occur regularly in deep water, possibly in migrations to and from the rookery in Natal. *Caretta* has been caught

from Zanzibar south. These females were tagged while nesting in South Africa, and some have traveled 2,600 km in 2 months. To date, 4 tagged *Caretta* have been recovered in Tanzania (Hughes, this volume), and the territory seems to be an important nonbreeding area for *Caretta* that nest in Natal.

Lepidochelys has been recorded from much of the coast, although only singly. Several nest yearly on Maziwi Island, and others probably nest in the vicinity of large river mouths farther south, where estuarine habitats may provide requisite feeding habitats.

Chelonia is common, and nesting concentrates on cays around Mafia Island and especially on Maziwi Island. There is also nesting at Ras Dege, one of the more remote headlands on the mainland. Most laying is from June to October. Less than 200 are estimated to nest on Maziwi and the annual total for all of Tanzania is 300. Reef flats provide a large area of shallow water with marine pastures, and there may be resident breeding populations in this territory (Frazier, in prep.). Tanzania may also provide feeding habitat for migrants from the island nesting populations, such as Aldabra and Comores.

Eretmochelys is also common and is thought to nest widely. On Maziwi 20 may nest in a year, and 50, in the Territory. Diurnal nesting is common.

Human exploitation is not organized, but dates back centuries. Turtles are caught on feeding grounds while nesting and are also killed accidentally by dynamite "fishing." Although Zanzibar was a major exporter of tortoiseshell, mainland Tanzania has not been a major supplier, and the shell came from other territories in the region. The populations of all turtles have probably been reduced since prehistory.

The hunting of sea turtles is forbidden in the 7 Marine Fisheries Reserves, most important of which is Maziwi Island. All exploitation of turtles is to be carried out under license, but these laws are seldom enforced. Both the populace and government display vigorous and widespread concern for resource management (Frazier 1976).

Kenya

More arid, with fewer islands, and denser coastal settlements, Kenya also has less marine shore than Tanzania. Some reef flats are so scoured for food that few consumable organisms remain. All species except *Caretta* have been documented, but this turtle is described by Bajun fishermen.

Dermochelys is occasionally seen at some distance offshore. As in Tanzania, these animals may occur regularly in migrations to and from the Natal rookery. *Lepidochelys* are known from Ungwana Bay and near the Tana River, Kenya's largest; sand bars in the area are suspected to have nesting.

Chelonia is common, with nesting concentrated on the near islands of Lamu and Manda, the small island of Tenewi and remote stretches of coast at Ras Biongwe and Ungwana Bay. Most nesting activity occurs after August. An estimated 200 turtles nest annually. Marine pastures grow along the coastal reef flats, and migrants from other nesting populations may feed here.

Eretmochelys is common along the entire coast, nesting on island and mainland beaches, even in populated areas. nesting is not concentrated, 50 turtles may nest in a year. Reefs are not generally rich, but encompass considerable area.

Persistent exploitation over the past 2 millennia and recent increases in coastal development and pollution seem likely to have reduced the numbers of *Chelonia* and *Eretmochelys*. Nest predation on *Chelonia* is severe, and recruitment may be insignificant.

Marine parks are at Malindi, Watamu, and Shimoni, and a reserve is at Kiunga. These are excellent reef areas, but no important turtle beaches are protected. There is a total ban on hunting both *Chelonia* and *Eretmochelys* (Frazier 1979), although tortoiseshell is still exported (Mack, Duplaix, and Wells, this volume).

Somalia

This territory has the longest coastline in the region; it is arid and largely uninhabited. Offshore waters are rich from upwelling. All 5 turtles are known to the Bajun in the south, but only *Chelonia* is apparently common (Grotanelli 1955).

This turtle nests along much of the Indian Ocean coast (Ninni 1937), and there seems to be concentrated nesting (Travis 1967). The numbers involved are unknown, but several thousand a year are likely to nest. Somalia's rich marine pastures support dugongs and *Chelonia* (Travis 1967); there may be resident as well as migratory turtles. Animals that nested in South Yemen have been recaptured in Somalia (Hirth 1978).

Although exploitation for export may have reduced reproduction during the 1960s and early 1970s, these turtles seem to be less disturbed than are many other populations. There are evidently no marine parks or reserves, and no laws protecting turtles.

Summary and Conclusions

Chelonia is the most common turtle in the Central Western Indian Ocean, the total numbers nesting yearly may be about 6,000. *Eretmochelys* is much less numerous, under 2,000 per year. The main nesting season for *Chelonia* is during the southeast trade winds, and *Eretmochelys* nests most actively during the northeast monsoon (Table 1).

Given the number of *Chelonia* that have been exploited annually from just Seychelles, the numbers of

Table 1. Summary of estimates of annual numbers and main nesting seasons of *Chelonia* and *Eretmochelys* in the Central Western Indian Ocean

Territory	*Number nesting annually*		*Main nesting season*	
	Chelonia	*Eretmochelys*	*Chelonia*[a]	*Eretmochelys*[b]
BIOT	300	300	June–Sept	Nov–Jan
Seychelles	2,500	600	May–Sept	Oct–Jan
Mayotte	500	25	June, July?	Nov–Jan?
Comores	1,900	50	June, July?	Nov–Jan?
Tanzania	300	50	June–Oct	Feb–Mar
Kenya	200	50	Aug?	?
Somalia	2,000?	?	?	?
Total	7,700	1,075		

a. *Chelonia* nest during Southeast trades.
b. *Eretmochelys* nest during Northeast monsoon.

animals that nest today appear to be greatly reduced from earlier in the century. The situation with *Eretmochelys* is less clear, but is likely to be similar. It is unlikely that these turtles will be exterminated from the CWIO, but maintenance of breeding reserves, such as Cousin and Aldabra, are imperative for the existence of these animals as significant resources. Nesting reserves and protective legislation are needed in Moheli, Mayotte and Ras Biongwe, Kenya, and effective enforcement is urgently required in all territories.

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Subsistence Hunting in the Indian Ocean

ABSTRACT

Sea turtles are exploited by subsistence hunters throughout the Indian Ocean. All 5 species are involved, but *Chelonia* is commonly killed for meat, *Eretmochelys* for tortoiseshell, and *Dermochelys* for oil. Nests of all species are excavated for eggs. International trade in tortoiseshell was well established two millenia ago. Present day coastal populations often lack animal protein, and subsistence-level exploitation concentrates so heavily on reproducing animals and nests that reproduction in many turtle populations has been severely reduced.

Introduction

Subsistence hunting is a difficult topic to describe for various reasons. The term defies unambiguous definition but often connotes traditional forms of exploitation for no monetary reward. Today, the wholly traditional hunter, without concern for money, is a rarity. Noncommercial, subsistence-level hunting is of little importance to governments and so is rarely discussed and almost never documented in detail. Finally, an area as vast as the Indian Ocean (Figure 1) can hardly be treated in a few pages, and it is symptomatic of its isolation and neglect that the situation on over one-seventh of the planet is to be considered in the same space available to a single country. This report is thus a summary of a more thorough study (Frazier, 1980; in prep.).

Sea Turtles Available for Hunting

Five of the 7 species of sea turtle are recorded from the Indian Ocean. Within the region, each species has its areas of abundance, but the most common species in general are green turtles, *Chelonia mydas*, and hawksbills, *Eretmochelys imbricata*. They occur and are hunted in most territories. Loggerheads, *Caretta caretta*, are

Note: Revised April 1980.

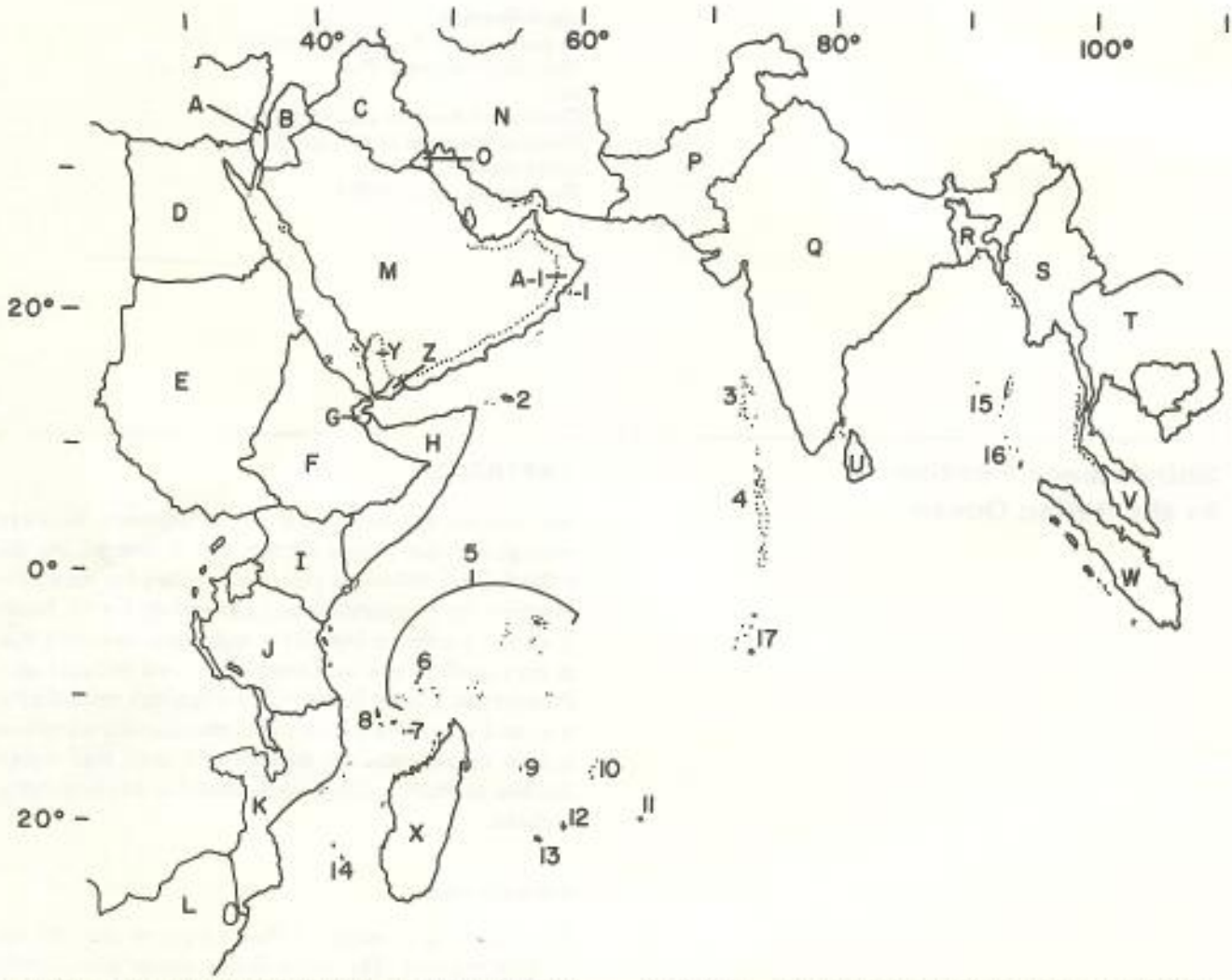

Figure 1. The Indian Ocean. Mainland countries: A) Israel; B) Jordan; C) Iraq; D) Egypt; E) Sudan; F) Ethiopia; G) Djbouti; H) Somalia; I) Kenya; J) Tanzania; K) Mozambique; L) South Africa; M) Saudi Arabia; N) Iran; O) Kuwait; P) Pakistan; Q) India; R) Bangladesh; S) Burma; T) Thailand; V) Malaya; W) Indonesia; X) Madagascar; Y) Yemen Arab Republic; Z) People's Democratic Republic of Yemen; A-1) Oman. Islands: 1) Masirah (Oman); 2) Socotra (PDRY); 3) Laccadives (India); 4) Maldives; 5) Seychelles; 6) Aldabra (Seychelles); 7) Mayotte (France); 8) Comores; 9) Tromelin (Reunion, France); 10) St. Brandon (Mauritius); 11) Rodriguez (Mauritius); 12) Mauritius; 13) Reunion (France); 14) Europa (Reunion, France); 15) Andamans; 16) Nicobars; 17) BIOT (Chagos).

generally uncommon but abound on Masirah Island, Oman, and are common in South Africa, Mozambique, and Madagascar. Olive ridleys, *Lepidochelys olivacea*, are abundant in the Bay of Bengal and evidently Pakistan. Leathery turtles, *Dermochelys coriacea*, are nowhere common, although one of the largest nesting areas in the world is on the eastern Malaysian peninsula. The only major nesting areas, where they occur regularly in the Indian Ocean, are South Africa, Mozambique, and Sri Lanka. Details of the status of sea turtles in the Indian Ocean region are in Kar and Bhaskar (this volume); Frazier (in press, this volume, in prep.); Hughes (this volume); Ross and Barwani (this volume); and Sella (this volume).

Coastal Peoples that Hunt Turtles

People have occupied the coastal areas of the Indian Ocean basin for hundreds of generations, and many depend on marine resources for food and trade materials. The tortoiseshell trade was well established by the first century A.D. (Freeman-Grenville 1962; Parsons 1972). However, coastal peoples differ tremendously in their expertise as sailors and fishermen. The most adept turtle hunters are the Seychellois, of Seychelles, St. Brandon, and Chagos Islands; Vezo of southwest Madagascar; Bajun of northern Kenya and southern Somalia; Tamils from southern India and northern Sri Lanka; and Selung from the islands of

Burma and Thailand. Exploitation by these peoples often fits the "subsistence hunter" paradigm, and sea turtles are important in their cultures. However these animals are exploited for nonmonetary reasons throughout the Indian Ocean, although to varying degrees.

General Patterns of Exploitation and Consumption

Meat and eggs are generally consumed, except in some Islamic areas where turtle meat is not allowed for religious reasons. Nutritive products of sea turtles are used by subsistence hunters and are also marketed within the country of origin. *Chelonia* is consumed widely, but other species may also be eaten depending on the area; eggs of all species are commonly eaten. Whole *Chelonia* have been exported for foreign consumption from many countries: Seychelles, Kenya, Somalia, People's Democratic Republic of Yeman (PDRY), and India. In all but PDRY, it has been traditional turtle hunters, using traditional hunting methods, that have provided the turtles for this export trade.

Likewise, *Eretmochelys* is killed by fishermen living at subsistence levels throughout the Indian Ocean region, and the tortoiseshell is exported to oriental and occidental capitals. Turtle oil is produced for medicinal or culinary purposes where *Chelonia* is killed in numbers, and it is popularly used in local communities. This product was also exported in the past.

Trade in turtle leather, or skins, has seen only 2 main centers of development in the region: Pakistan and eastern India. This is neither a traditional activity, nor is it carried out by traditional turtle fishermen. Begun in the last decade, it is one of the fastest growing fisheries of marine turtles and accounts for tremendous numbers, especially of *Lepidochelys*. In other parts of the world, enormous populations of this turtle are being threatened by this type of exploitation (Frazier, ms.) *Lepidochelys* meat, and eggs, have been eaten by local peoples: there is a long-standing trade in eggs from Orissa to Bangladesh (Singh, *in litt.*, 20 July 1976).

Caretta is occasionally killed for meat, but *Dermochelys* is rarely slaughtered, except in certain areas. The oil from the latter is used in boat preservation.

Even in those territories where large numbers of turtles occur and turtle hunters are expert, the main source of protein is fish. Details are not available, but the greatest per capita consumption of turtle was probably in the Aldabra Islands earlier in this century, during the heyday of the *Chelonia* fishery; turtle meat may have been eaten as often as 3 or 4 times a week. This contrasts with the situation in eastern Nicaragua where *Chelonia* traditionally provided 70 percent of the animal protein for Miskito Indians (Nietschmann 1972).

Specific Patterns of Exploitation for Each Territory

South African natives did not traditionally catch turtles (McAllister, Bass, and Van Schoor 1965). Strict laws and efficient enforcement inhibit killing, and no significant exploitation of sea turtles occurs in this territory (Hughes, this volume).

Coastal peoples in Mozambique eat eggs and meat of most sea turtles, even *Dermochelys*. Some turtle products have been marketed locally, but subsistence-level exploitation has been widespread. In the south, women patrol beaches for eggs and nesting turtles; though unorganized, this exploitation has reduced reproduction. Because of the impact of subsistence-level beach predation, the populations of *Dermochelys* and *Caretta* nesting in this territory are thought to be doomed (Hughes 1973). *Eretmochelys* has been exploited for tortoiseshell for at least a century, but this is a small fishery (Frazier, unpubl. data; Hughes 1973).

Madagascar has subsistence hunters all around the coast, but the Vezo and Sakalava in the west are the most experienced as marine exploiters. The latter capture turtles by a variety of techniques, but turning nesting females is not as important as in other territories. This is one of the most important countries for traditional, noncommercial turtle hunting, and turtles are an important part of the culture. However, stuffed turtles and tortoiseshell are prepared for sale to expatriats or for export, and this may account for more turtles than are consumed locally. Annual catches have been estimated to include thousands of each of the 4 species, excluding *Dermochelys* (Hughes 1971).

Reunion has few turtles, hence, little hunting, but its dependencies, Europa and Tromelin Islands in particular, are major nesting areas for *Chelonia*. Because of their remoteness, they have had little concerted exploitation. Passing sailors and temporary inhabitants have caught nesting turtles, but there is no significant hunting today, and the main rookeries are nature reserves (Hughes, this volume).

Turtles on Mauritius were exterminated along with the dodo, but the St. Brandon Islands still have nesting *Chelonia*. Most exploitation here is for export to Mauritius, but the islanders (mainly Seychellois) catch and eat turtle regularly. As the fishing population is transient and small, *Chelonia* exploitation for local consumption is minimal, about 30 per year (Hughes 1975).

The British Indian Ocean Territory (BIOT) now consists of only the Chagos Archipelago, and the Créole des Isles inhabitants, of Mauritian and Seychellois origin, have been evacuated. They hunted turtle, the catch was commonly bought by an island's lessee, and *Chelonia* meat was divided among the islanders. Minimal export occurred (Frazier 1977). Fish was the main source of protein.

The Republic of Seychelles, dispersed over a vast area of the western Indian ocean, is famous for turtles and turtlemen. Harpooning mating animals and turning nesting females are the main techniques of capture. Since its inception, the Seychelles turtle fishery has been geared for export, but turtle products are an important part of the culture. Eating *Chelonia* is presumed to be an inalienable right, and restraint in killing turtles is uncommon. Many gourmet dishes and specialty items have been prepared from turtle products. Some tortoiseshell is crafted locally, but most has been exported (Frazier, in press).

Mayotte, a dependency of France, but geographically one of the Comoro Islands, has no organized turtle fishery. Nesting *Chelonia* are exploited regularly at Pamanzi Island and, although the numbers taken are but several a week, the impact on the nesting population is great. Hunters often cook meat on the beach right after capture and take some choice cuts home in the morning. Waste of eggs and the less choice pieces is tremendous. There may be some local sale of meat, but this is uncommon (Frazier 1972).

Comores are over populated and few turtles occur at the 2 main islands of Ngazidia (Grand Comore) and Anjouan. Before the islands' independence from France, most turtles that were caught at these islands were netted and sold to expatriates and tourists. Moroni Island has thousands of *Chelonia* nesting annually, dispersed over a dozen important beaches. Small numbers are killed while nesting, and occasionally meat is taken to large villages for sale. Most exploitation is for local consumption (Frazier 1977). Although nowadays the people are inexperienced in turtle biology or lore, the fishermen from these islands were once reported to have complicated ceremonies and techniques for hunting turtles and dugongs (Petit 1930).

Tanzania's most able sailors and fishermen are on Zanzibar and Pemba Islands. They catch nesting *Chelonia* happened upon, but, except for sorties to Maziwi Island and other small cays around Mafia Island, turtles are encountered sporadically. Only a few persons are involved with the net fishery in the south. Total catches for local consumption are probably less than 100 per year. *Chelonia* was exported for a few years in the 1960s. Tortoiseshell is, as usual, collected when possible and sold to merchants for export.

Zanzibar was a major clearing house for tortoiseshell from the late 1800s until recently. Subsistence-level fishermen from countries all around the western Indian Ocean supplied the product which was exported to both Europe and the East (Frazier, unpubl. data).

Kenya has few nesting turtles, but the Bajun of the north coast are expert at netting and catching turtles with grapnels and sucker fish. Although *Chelonia* meat and oil are relished, turtle seems less important to their culture than it is to the Vezo. Most coastal people eat meat and eggs if available, but exploitation is sporadic, and now illegal. Bajun fishermen supplied an exporting company from 1952 to 1964. For thousands of years, tortoiseshell has been collected for sale to merchant exporters (Freeman-Grenville 1962).

Somalia's south coast is inhabited by Bajun who are culturally related to Bajun in Kenya, and their relationship with marine turtles is the same. Somalis, although also Moslems, will not eat turtle or other animals from the sea for religious reasons, so exploitation has been concentrated in the south. It has not all been for local consumption; an exporting company was active here about the same time as in Kenya (Travis 1967). The original turtle canning concern was taken over by Russians, but has evidently ceased production with their exodus.

Little is recorded from Djibouti.

Eritrea is Ethiopia's only coastal province. The Islamic people inhabiting the coastal strip occasionally sail to and among the Dahlak Islands where *Chelonia* may be butchered if encountered. What little exploitation occurs is for subsistence (Minot, n.d.).

In Sudan there is also little involvement with turtles. Yemeni fishermen may visit the Suakin Archipelago and catch any nesting animals that they find. There may once have been a large number of turtles slaughtered by passing sailors. *Eretmochelys* is thought to occur in large numbers in the Archipelago (Moore and Balzarotti 1977).

Egypt probably has some nesting turtles, which may be occasionally exploited, but little is known from this territory.

Bedouins traveling along the coast of Sinai may dig up nests and eat eggs. This, the epitome of subsistence hunting, occurs infrequently (Sella, this volume).

Israeli law does not allow exploitation of sea turtles; its tiny coastal strip makes much fishing activity unlikely (Sella, this volume).

Jordan's situation is not known, but the small coastal strip precludes much of a fishery.

Saudi Arabia's Red Sea coast may support sizable turtle populations particularly on the Farasan Islands, but little is known of the situation. Exploitation is likely to be mainly for subsistence, but predation by foreign-owned turtle exporting companies have been rumored.

Fishermen of the Yemen Arab Republic patrol beaches for nests. Male turtles are also eaten, but the numbers killed are small. Nesting beaches on the volcanic offshore islands are less likely to be disturbed than mainland beaches (Walczak 1979).

Yemenis from the People's Democratic Republic of Yemen (PDRY) eat turtle if food is scarce, and some islanders, as on Socotra, eat turtles regularly. Their catching techniques are varied, including the use of sucker fish. *Chelonia* is netted on pastures at Khor Umaira, and a major nesting area has been exploited

for export, but this is a nontraditional, commercial fishery (FAO 1973).

Omani Arabs catch *Chelonia* around Kuria Muria and Masirah Islands and dig up nests of any of the 4 nesting species on Masirah. There is some exploitation of nesting *Chelonia* at Ras al Hadd for export, but only a few hundred are caught annually at this major rookery (Ross and Barwani, this volume).

The Persian Gulf states have little documented about their turtle populations. *Chelonia* is imported into Abu Dhabi for consumption. In Qatar both *Eretmochelys* and *Chelonia* are eaten. Turtles are probably not consumed in other states for religious reasons (Ross and Barwani, this volume).

Iran has a large and poorly surveyed coast. Turtle meat is not eaten for religious reasons, but eggs are collected throughout the territory. On Larak Island, oil from *Dermochelys* is prepared for boat preservation (Kinunen and Walczak 1971).

Pakistan has no traditional turtle fishery of significance, but at a recently developed enterprise in the west large numbers are slaughtered and their skins exported (Salm 1976). These may be *Chelonia* or *Lepidochelys*. Eggs and meat may once have been eaten in Karachi (Murray 1884).

India has the largest coastline and the greatest population in the region and turtles are traditionally hunted in many areas. However, the net fishery in the Gulf of Mannar is most developed. Eggs and meat of most species are eaten and sold in local markets. *Chelonia* has been exported to Sri Lanka and elsewhere. Eggs of *Lepidochelys*, and recently whole animals, are taken in large numbers in Orissa and exported to Bangladesh. Possibly many of these turtles are also taken for leather. Oil from *Dermochelys*, and occasionally other species, is used in boat maintenance, and sometimes for medicinal purposes. India has both imported and exported large numbers of turtles and turtle products, but it also has the greatest amount of subsistence hunting in the region (Frazier, 1980).

The Republic of Maldives includes hundreds of islands. Tortoiseshell has been exported for centuries, but as the populace is Moslem, consumption of eggs and meat was banned until recently. In the last decade most exploitation provided stuffed animals for tourists, and subsistence hunters were able to realize the equivalent of a month's income with the sale of 1 turtle (Didi, *in litt.*, 15 June 1976; Colton 1977).

Sri Lanka is also a rich area for sea turtles and turtle culture. According to one estimate, 50,000 people depend on the turtle fishery (Salm 1975), many of them around Jaffna, where there is a net fishery. Formerly artisans of tortoiseshell worked in the south, but *Eretmochelys* there has been extirpated. In the past only *Chelonia* was eaten, and other species were released if caught accidentally. Now all species are eaten, and there is tremendous pressure on nesting turtles. Protective legislation has been ineffective because of pressures on food resources (Deraniyagala 1939; Hoffmann, in litt., 21 April 1975).

Bangladesh has not been studied, but may support large numbers of *Lepidochelys*. "Hundreds" of eggs are collected from an (?) island off the Sundarban (Choudhury 1968). *Lepidochelys* and eggs are imported from Orissa, India.

Burma is also poorly known, but millions of eggs are reported to have been collected in a year on Diamond Island (Maxwell 1911). Moslems do not eat turtle meat, but most turtles are eaten in the eastern part of the territory. *Lepidochelys* is evidently the main species involved, although *Chelonia* is also exploited (Theobald 1868). The Selung are expert sailors and fishermen, and they hunt turtles for their own consumption (Anderson 1889).

Summary and Conclusions

Marine turtles are hunted by subsistence fishermen throughout the Indian Ocean. Meat, eggs, and oil are valued foods in most territories. These, together with tortoiseshell, have been exploited for millennia.

One of the myths about subsistence hunting, along with the belief that it is completely divorced from monetary considerations, is that it is sustainable and does not damage a resource. However, there are numerous examples in the Indian Ocean where human populations are dense and lacking in protein sources, and their exploitation, concentrated on breeding turtles, has all but stopped the animals' reproduction. The most threatening forms of exploitation are those stemming from commercial enterprises and involve intense, organized exploitation for export. The leather and skin trade is a recent example (Frazier, ms.). In the past, tortoiseshell was collected in a desultory way, but with present-day prices (Mack, Duplaix, and Wells, this volume), *Eretmochelys* is now under tremendous pressure.

Ideally, subsistence exploitation should be uninhibited, but the present situation over much of the Indian Ocean indicates that this is untenable and that unless strict breeding and feeding reserves are established and management policies implemented, it is unlikely that marine turtles will continue to be a significant part of the subsistence hunter's diet.

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Conservation of Sea Turtles in the Southern Africa Region

ABSTRACT

The Southern Africa region has received uneven attention regarding stock assessment surveys. South Africa, Réunion and its dependencies, and South West Africa-Namibia have few problems. Mozambique, Madagascar, and Angola all have extensive sea turtle populations but require more encouragement and assistance. Mauritius and its dependencies need more dedicated management. None of the 5 species is in immediate danger of extinction, but all would benefit from enforced legislation, and formal protection of breeding grounds.

Introduction

The Southern African region (Figure 1) has always been an area rich in sea turtles. Just how rich is difficult to assess, but intense exploitation once reached substantial proportions (see Hughes 1973, 1974a, 1976a; Lougnon 1970). The extensive exploitation by the coastal peoples of the region has been of such importance that the sea turtle is woven throughout the cultural fabric of some societies, especially in Madagascar (Hughes 1973, 1975; Petit 1930).

In 1963 the Natal Parks Board started a study program in Tongaland, where interest in sea turtles has been increasing. Hughes's major survey (1974a and b) between 1969 and 1973 stimulated workers in other areas to pursue independent studies (Servan 1975; Vergonzanne, Servan, and Batori 1976; Lebeau, Gobert, and Durand 1978; Lebeau et al., in press).

Hughes concluded (1974a and b; 1976b) that 5 species were represented in the area: the leatherback turtle *Dermochelys coriacea*, the green turtle *Chelonia mydas*, the loggerhead turtle *Caretta caretta*, the hawksbill turtle *Eretmochelys imbricata* and the olive ridley turtle *Lepidochelys olivacea*, and that none was in immediate danger of extinction.

For the present review, an attempt was made to obtain first-hand information of the current situation;

varying success was achieved by writing to the countries in the region. Some excellent and most rewarding reports were received. Where no information was forthcoming the latest data available, which may be years old, was used. No apologies are made for using this material because its inclusion will at least present the situation as it was in the recent past.

On the whole the situation remains basically optimistic. Some local populations have increased and others are at least holding steady.

Present Status

It is perhaps unfortunate that this section should be dealt with by country rather than by turtle populations. Regrettably, however, conservation measures are not equally pursued by all countries, and turtles may be safe and threatened over a single kilometer of their feeding range. All the countries reviewed below have at least well motivated legislation in common. In theory the sea turtle is well protected throughout the area; in practice the situation is unsatisfactory.

Angola

During 1971 a series of photographs of nesting leatherback turtles was published in Angola (Anonymous 1971). Regrettably no details were provided but interest in sea turtles was stimulated. Hughes, Huntley, and Wearne (1973) reported that leatherback, olive ridley, green, loggerhead, and hawksbill turtles occurred in Angolan waters, and that the first 3 species were known to nest. The only figures available indicated that in certain areas nesting densities were quite high, for example, 30 tracks on a 500-m stretch of beach. Some turtle beaches were happily situated within the Quiçama National Park.

Huntley (1974) reported that on a flight south of Luanda, he saw 613 nests of green turtles and leatherbacks along 150 km of coastline. Huntley (personal communication) continued aerial surveys north of Luanda and found that sea turtles nest extensively. The distribution of nesting is very uneven: several dense concentrations with extensive, sparsely utilized areas in between. There are far more nesting turtles in the north of Angola, although recent information from South West Africa, indicating that loggerheads may nest in the Skeleton Coast (below), suggests that nesting occurs in the Iona National Park and therefore probably along the entire coastline where suitable beaches occur.

As recently as 1975, exploitation was for domestic use only. Eggs were taken before adult turtles and only occasionally was a turtle killed to sell its carapace to tourists.

There was no official protection until 1973 when a law was proclaimed enforcing vigorous protection and carrying a substantial fine for harming a sea turtle, US$300. But the law was not enforced. No details are available on the recently revised legislation or on the current situation. Despite hopes to the contrary, Angola could not be included in Southern Africa survey. Angola thus remains unsurveyed in detail; a thorough quantitative assessment of the country's large remaining sea turtle populations is highly desirable.

Southwest Africa-Namibia

In 1844 a Captain Morrell reported that turtles nested on Bird Island and at Sandwich Harbour (23° 35'S, 14° 28'E): ". . . green turtles also visit the sandy beaches for the usual purposes" (Morrell 1844).

Those beaches are now protected within the Namibia Desert Park, but there are no recent records of sea turtles nesting in this area. It is also unlikely that the nesters would be green turtles as it would be unheard of for green turtles to nest in such temperate waters. It seems more likely that the turtles were loggerheads. Recently it has been found that loggerheads are occasionally found in the Skeleton Coast Park. The number of nesting turtles has not yet been established, but they are in no danger as the area in which nesting occurs is uninhabited (B. de la Bat, personal communication).

Stranding records indicate that leatherbacks, loggerheads and the occasional green turtle do frequent the waters of Southwest Africa. Coastal surveys are currently being carried out by the Penrith State Museum, Windhoek.

Republic of South Africa

All 5 species are recorded from South Africa (Hughes 1974a), but only 2 species, leatherbacks and loggerheads, are known to nest in the Kwa-Zulu coast, an area known locally as Tongaland (the local black tribe is the aMa-Thonga).

The first laws to protect sea turtles in Natal were passed in 1916. These laws have been progressively updated until the present when sea turtles are protected from all forms of exploitation or interference by Section 101 of Ord. 15 of 1974.

Since 1963–64 a tag-study and protection team has patroled beaches of Tongaland nightly from October through March. Excellent cooperation has been obtained from the Tonga people, and for the past few years staff from the new Kwa-Zulu Conservation Department have joined the Natal Parks Board to share the protection effort.

Results in general have been promising. After a decade of little change both populations appear to be increasing (see Hughes, this volume, Figures 1 and 2).

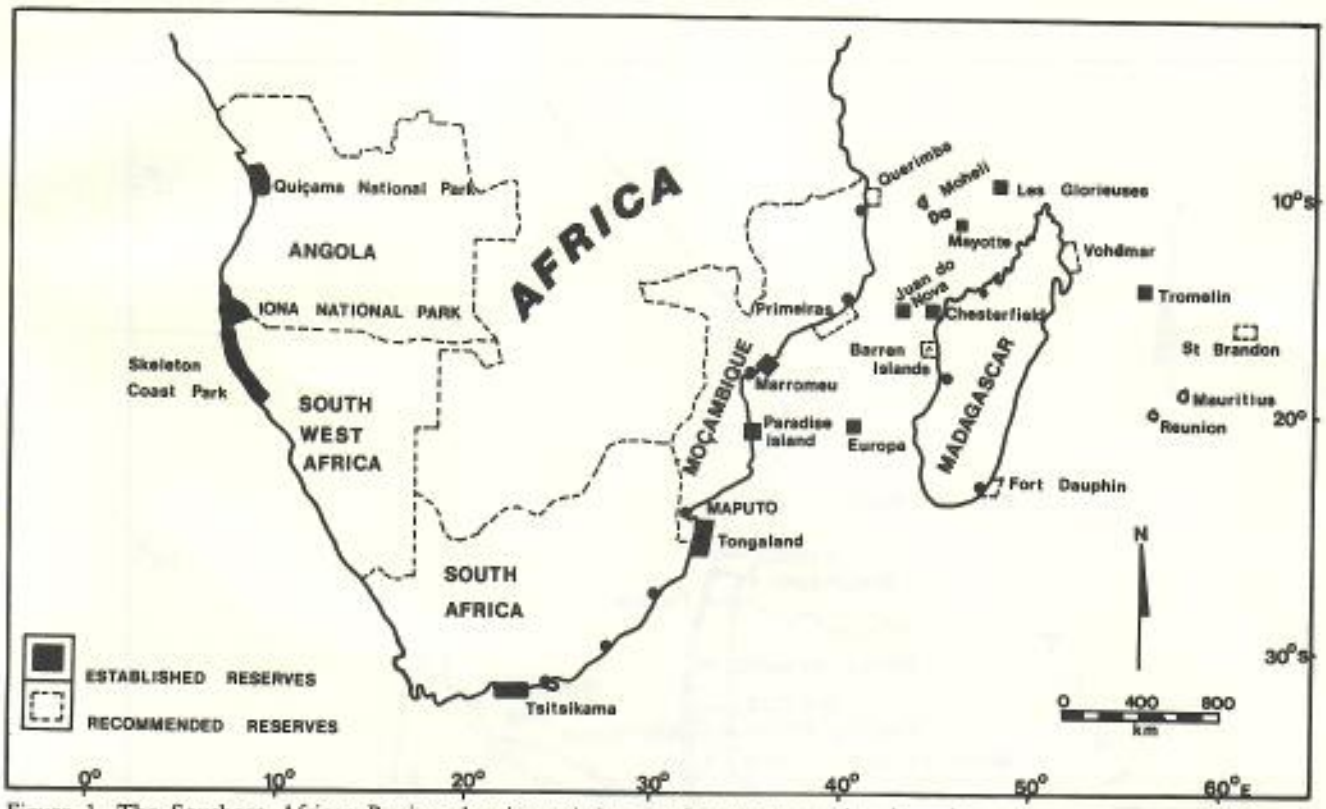

Figure 1. The Southern African Region showing existing marine reserves and parks and some areas recommended for protective status.

Loggerheads have gone from a low of 184 (discounting 1963–64 which was mainly exploratory) to 408 (1978–79) and leatherbacks from 5 (1966–67) to 70 (1977–78).

Considerable attention has been given to hatchling and adult distributions in the sea. Figure 2 illustrates the distributions of sea turtles tagged in Tongaland and recaptured elsewhere. It can be seen that the Tongaland protected beaches are "home" to turtles found along half of the East African coast and the west coast, at least, of Madagascar.

Since 1963 numerous pleas have been made for the total protection of the Tongaland Coast and an offshore zone. On 23 February 1979 the South African government declared an 80-km section of the coast from Cape Vidal to Sodwana Bay a marine reserve. The most important sea turtle breeding beaches were excluded because the area fell under the jurisdiction of the Kwa-Zulu Territorial Authority. On 5 June 1979 the Cabinet of Kwa-Zulu resolved (Resolution 187/79) that steps should be taken to declare a further strip of the Tongaland coast a marine reserve. This strip will stretch from the Mozambique border south for some 61 km, and embracing almost all of the as yet unprotected turtle beaches. Following the next session of Parliament the future of the Tongaland nesting populations should be safeguarded.

Sea turtles are not generally exploited in South Africa and the general attitude of the majority of the populace is conservative. It is the policy of local conservation bodies, however, to protect the interests of local people, when possible from a conservation point of view. Once turtle populations in Tongaland increase to a satisfactory level, it is intended to harvest a minor number. Because the populations have not yet reached satisfactory level, this program is of theoretical interest only.

Mozambique

With 1,300 km of tropical coastline Mozambique is rich in sea turtles with 5 species recorded in the area (Hughes 1971a). All are adequately protected by the Hunting Law (Designation No. 7/78 of 18 April 1978) and Decree No. 117/78 of 18 May 1978 (Anonymous, 1978).

Despite these laws, local authorities have difficulties in controlling the killing of sea turtles or egg collecting. The problem is simply that this new state does not have the personnel or resources to protect adequately or cover the lengthy coastline. There is no legal exploitation, and that exploitation about which something is known is strictly domestic and is believed to result in minor illegal export of tortoiseshell by tourists.

At the 4 marine reserves in Mozambique, sea turtles receive more intensive protection: Reserva Especial do Maputo, Maputo Province; Illia de Inhaca; Parque Na-

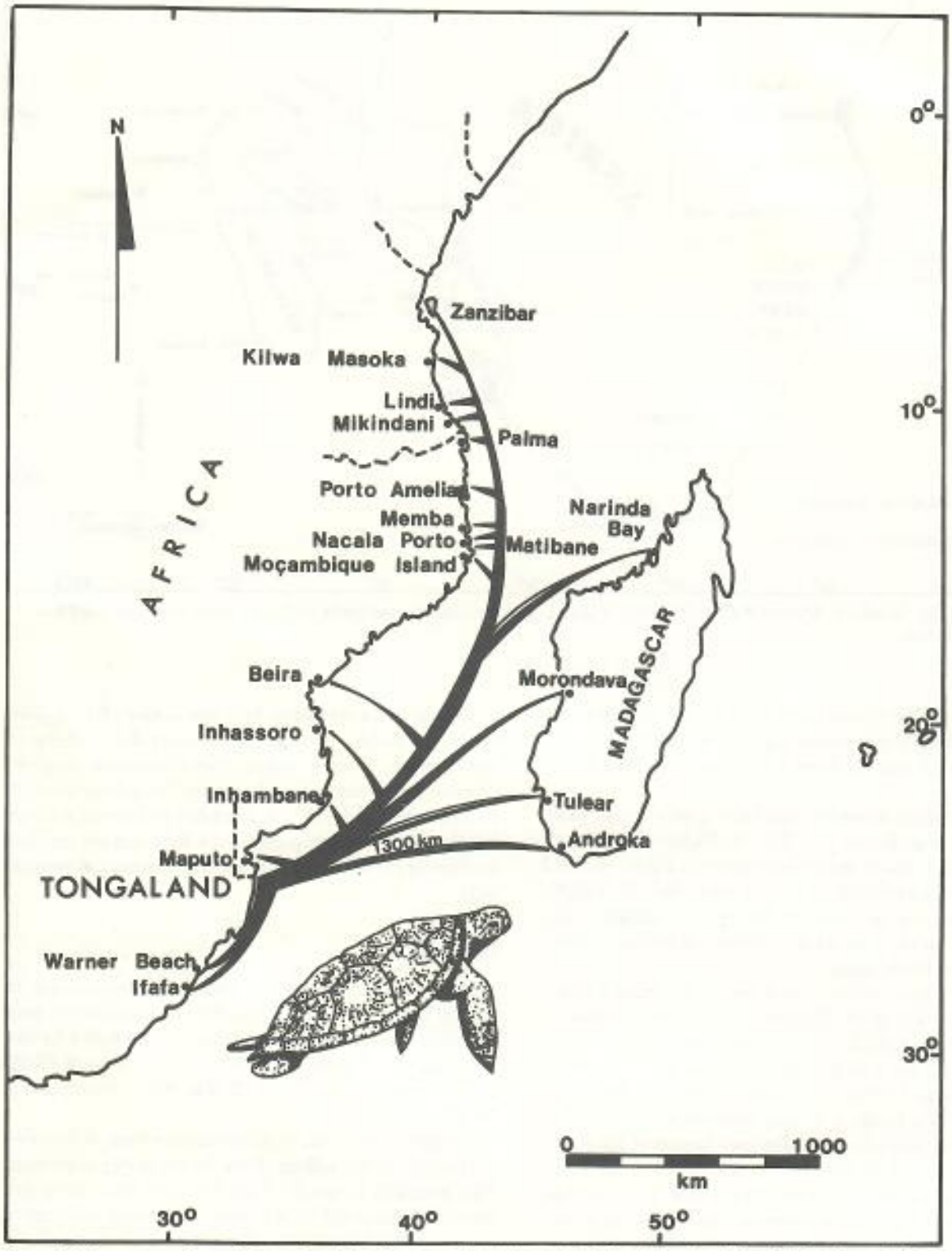

Figure 2. Recovery sites of loggerhead females tagged in Tongaland, Natal, South Africa, 1963–64 to 1979.

cional de Bazaruto, Inhambane Province; and Complexo de Marromeu, Sofala Province.

It is too early to see whether protective efforts, especially in the Maputo Reserve, are having any beneficial effects, but it is suspected that in most areas there is a decline in sea turtle populations.

Madagascar

The coastal waters of Madagascar are host to 5 species

of sea turtle: green, loggerhead, olive ridley, hawksbill, and leatherback turtles. Figures 2 and 3 indicate quite clearly that protected colonies of sea turtles such as Tongaland, Europa and Tromelin are of great benefit to Madagascar.

This is no minor contribution. Hughes (1971b) during a survey of Madagascar calculated that the sea turtle resource is considerable and extensively exploited. Over 13,000 individual turtles are killed along some 600 km of the southwest coast of Madagascar every year. The past exploitation of hawksbills for the tortoiseshell trade is legendary (Hughes 1973). Even recently, a single taxidermist shop in Diego Saurez had a licence to take 400 hawksbills annually. Throughout the country stuffed juvenile hawksbills are displayed for sale in almost every major market place and general store. All other species are exploited mainly for domestic consumption, but the juvenile hawksbill is an article of commerce (see also Mauritius, below) and is undoubtedly the most threatened species in the territory.

All this exploitation occurs despite the existence of perfectly adequate sea turtle protective legislation.

1) Resolution of 23 May 1923 (J.O. a/vi/23 p. 439) instituted areas reserved for turtles: Nosy Ovambo or Ilot Boise, Diego Province; Nosy Iranja, Nosy Bê Province; Chesterfield Island, Morondava Province; Nosy Trozona, Tulear Province; Nosy Ve, Tulear Province; and Europa, (now under French control, see below). "The protected species are the green turtle (*Chelonia mydas*) and the hawksbill (*Chelonia imbricata*)" [*sic*].

2) Resolution of the 24th October 1923 (J.O. 17/11/23 p. 856) states: "It is forbidden to capture sea turtles; when they are laying; and when the width of the carapace, measured across the plastron, does not exceed 0.50m."

Regrettably surveillance is minimal, and the legislation is ignored by most fishermen. The problems of any law-enforcer, trying to persuade the Sakalava or Vezo people to stop eating sea turtles, are almost insurmountable. Sea turtles are woven into the very cultural fabric of these coastal peoples who practically revere the animal.

There are no coastal marine reserves where the green, hawksbill, loggerhead and, possibly, olive ridley turtle can nest unmolested. A slow and steady disappearance of these species must be expected unless positive action is taken.

The problems facing Madagascar are similar to those of Mozambique. It, too, is a large and poor country that simply cannot afford adequate law enforcement.

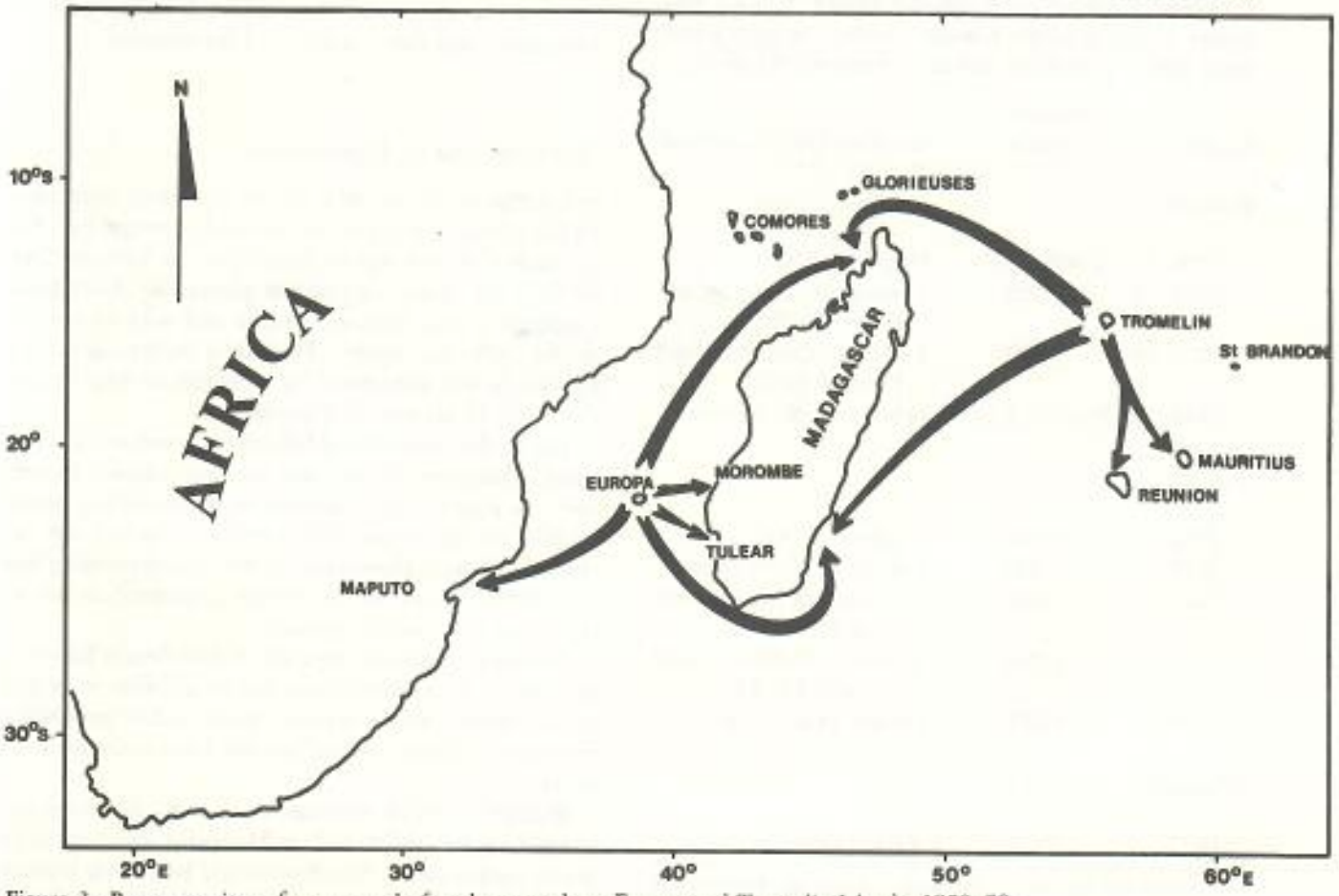

Figure 3. Recovery sites of green turtle females tagged on Europa and Tromelin Islands, 1970–78.

Réunion and Its Dependencies

One of the most rewarding areas for sea turtle study and conservation is Réunion Island with its dependant islands: Europa, Tromelin, Juan do Nova, Les Glorieuses, and Mayotte (Figure 1).

All sea turtles are protected from capture in Réunion itself, and the outer islands have full nature reserve status with complete protection of turtles, nests and hatchlings. The law is not broken on the islands, but a very few turtles are killed by fishermen on Réunion.

The most common species, virtually the only species so far found nesting on the islands, is the green turtle, *Chelonia mydas*. Some hawksbills, *Eretmochelys imbricata*, are seen occasionally on Europa and Tromelin, and loggerheads are infrequently seen in the waters around Réunion but are not resident (Hughes 1974a).

Since 1970 a number of research programs have been conducted on some of the islands. The first, was conducted by Hughes (1970), on Europa. He was followed by Servan (1975); Vergonzanne, Servan, and Batori (1976); and excellent work continues under Dr. Alain Lebeau (Lebeau, Gobert, and Durand 1978, in press). Vergonzanne, Servan, and Batori (1976) and Vergonzanne (in press) have produced reports on the Glorious Islands (Les Glorieuses), and Batori (1974) prepared a report on Tromelin Island. Annual estimates of green turtle females nesting on each island have varied somewhat and are summarized below:

Islands	*Number of females*	*Source and publication date*
Europa[a]		
1970–71	4,000–5,000	Hughes 1970
1973–74	3,000	Vergonzanne, Servan, and Batori 1976
1977–78	1,500	Lebeau, Gobert, and Durand 1978
1978–79	9,000–18,000	Lebeau, et al., in press
Tromelin		
1970–71	200–400	Hughes 1974a
1973–74	3,000	Lebeau et al., in press
1973	600	Vergonzanne, Servan, and Batori 1976
1977	1,000	Lebeau, Gobert, and Durand 1978
1978	4,400>	Lebeau et al., in press
Glorious		
1973	70–80	Vergonzanne in press

[a] As regards this past season the number of eggs laid exceeded 3.4 million.

There are no available figures for Juan do Nova, but populations appear to be very limited. Frazier (this volume) deals with Mayotte.

Many hundreds of green turtles have been tagged on Europa and Tromelin, lesser numbers on the Glorious Islands. Figure 3 illustrates the recoveries of turtles from these areas and shows that Madagascar depends heavily for its harvests on the island rookeries protected by the French.

No exploitation of adult green turtles occurs on any of the islands, but 20,000 hatchlings have recently been captured on Europa and transferred to the main island of Réunion for market rearing by a firm called Compagnie Réunionnaise d'Aquaculture et d'Industries Littorales. All collection of hatchlings is undertaken by the Scientific Institute. Every hatchling collected emerges in daylight, a time when it would almost certainly have been taken by frigate birds (*Fregata minor* or *F. ariel*).

It is stressed, therefore, that this "exploitation" program in no way interferes with the natural survival rate or recruitment of green turtles on Europa Island.

The rearing station, situated near the town of St. Leu on the southwest coast of Réunion, intends to sell its products abroad. These exports are expected eventually to reach 100 to 200 tonnes/yr.

Conservation in the areas under French control is admirable, and there is no need for concern.

Mauritius and Its Dependencies

Sea turtles no longer nest on the shores of Mauritius. Its law protecting sea turtles is widely disregarded. For example a recent report stated that "at present *Eretmochelys* are being captured in places like Rodriguez, Madagascar and Agalega, stuffed and sold to tourists for Rs. 500—per turtle." Further, a recent claim for a tag return was submitted by a fisherman who caught the turtle in his net on Mauritius.

The St. Brandon Island fishery for green turtles continues (Hughes 1976a), and the exploitation figures over the past 37 years indicate no sharp decline. Some 10,880 turtles (mean 295 turtles/yr) have been recorded as killed. However, the toll almost certainly has been higher counting the turtles consumed on the islands and thus not on record.

Attempts to obtain more up to date details have not succeeded. It is understood that in addition to North Island, which had always been protected (if not always sacrosanct), Frigate Island has also been declared a reserve.

Hughes (1976a) recommended that, if a local sea turtle farm be established on Mauritius, the harvest of green turtles on St. Brandon should be strictly limited to 150 for at least 5 years; that there should be a closed

season, and that hawksbill exploitation should cease forthwith. Maurition authorities do not seem to have implemented any protective measures.

Discussion

During the last 5 years, only limited changes have occurred in the conservation situation of sea turtles in the Southern African region. Hughes (1976b) listed 19 areas in the region that, if given Park status with full protection, would assist various species of sea turtle to survive. Some of the 19 have been raised or are about to attain to Park status: 1) South Africa, the Tongaland Coast; 2) Mozambique, Parque Nacional de Bazaruto and the Reserva Especial do Maputo; 3) Réunion, Europa's 4 islands, and Juan do Nova; and 4) Tromelin and Les Glorieuses.

There appears to be an additional protected island in the St. Brandon Archipelago, but this is the work of the private company working on the islands and not the action of the Mauritius government. In Angola it is fortuitous that many turtles nest in the Quiçama National Park.

Even these modest advances are not enough, and all 5 species would benefit from enforced legislation. This is not suggested merely from an esthetic point of view nor from any particular plea for sea turtles as creatures that have a right to exist as does any other creature. This is for the benefit of the peoples of coastal Southern Africa themselves.

There is no doubt that turtle populations respond readily to protection of the nesting grounds provided that the numbers of turtles has not reached too low a level. Two good examples of such responses are the Europa Island green turtles and the Tongaland sea turtles. Both populations have undergone varying degrees of persecution from which the Europa green turtles appear to have completely recovered and loggerheads and leatherbacks in Tongaland are gradually increasing in numbers.

In Southern Africa, where the hunting of sea turtles and the consumption of turtle products are traditionally regarded as a right and not a privilege, turtle conservation must be applied in recognition of the sea turtles' role as a natural resource. Preservation for esthetic value alone in a protein-poor region is hardly justifiable and can expect only limited, if any, support from government bodies incapable of providing substitute sources of protein. On the other hand, governments should not jeopardize the resource as a whole by using such reasoning as an excuse for inaction.

Adequate and convincing proof of the viability of sea turtle populations is available, and the responsibility for the conservation and management of this resource lies in the hands of individual governments. South Africa, Réunion Island and Namibia do not appear to need any further encouragement. With Mauritius and Réunion, we have 2 opposing situations. Réunion has only limited and well controlled "exploitation" for the benefit of its own people but expends a not inconsiderable amount of time and effort for the benefit of the coastal peoples of Madagascar. Mauritius makes virtually no effort to safeguard an ancillary source of protein for its own people, and seems oblivious to recommendations and appeals. Mozambique, by contrast, is only too well aware of its shortcomings and requests further assistance and guidance.

The economic potential of well managed marine reserves containing sea turtle populations can hardly be measured. Along thousands of kilometers of coastline, sea turtles could range freely and could be harvested by coastal fishermen in their traditional manner. Marine reserves would form the source of stock.

The tourist potential of marine reserves should also be considered and their concomitant revenue-earning potential. Well-targeted educational programs can greatly enhance the value of the reserves and the prestige of the country involved.

Except in cases of dire extremity, all conservation efforts should contribute education, appeal to esthetics, and generate some financial return. Sea turtle conservation need not be an exception. Indeed, few other animal groups can meet all 3 criteria in return for a modest financial expenditure.

The resilient sea turtle has survived, in some cases, centuries of exploitation. As a source of high protein food, they are an important factor in the lives of the developing peoples along the coasts of Southern Africa. Given peace during the nesting season, the sea turtle can continue to be an important food resource and can, with minimal management, increase its contribution to the well-being of the peoples of the Southern African region.

Recommendations

It is recommended that the following regions should be considered for state-established and protected marine parks in order to further improve the survival of sea turtle populations in the region: 1) Mozambique: Primeiras Islands, Querimba Islands; 2) Madagascar: All the areas mentioned above under Madagascar should be redeclared Marine Parks or Nature Reserves and the Barren Islands should be declared a sanctuary. In addition, sanctuaries should be declared for loggerheads at the St. Luce area north of Fort Dauphin and for hawksbills on the Vohemar-Sambara Coast; 3) Mauritius and its Dependencies: The entire St. Brandon Archipelago should be declared a marine reserve albeit with limited exploitation of its natural resources

(fish, turtles, rock lobsters) being allowed under state control with limits vigorously enforced.

Quantitative research involving sea turtle experts should be encouraged on the coasts of Angola, Mozambique and Madagascar in order to ascertain the size of those populations identified by the early general surveys.

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Atlantic Ocean

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Marine Turtles of the Eastern Atlantic Ocean

To facilitate the survey of the marine turtles found in the Eastern Atlantic Ocean, this region may be divided into 3 major areas: European Atlantic Waters; Macaronesian Waters; and African Atlantic Waters.

European Atlantic Waters

European Atlantic Waters (EAW) comprise the eastern part of the North Atlantic Ocean, bordering upon European coasts, together with the seas, bays, channels, and estuaries connected to it, and extending from Iceland in the northwest and North Russia in the northeast to Punta Marroqui, Spain, in the south. In this way EAW include the Barents Sea, North Sea, Baltic Sea, Irish Sea, British Channel, etc.; the Mediterranean is not included (Brongersma 1972:5).

Five species of turtle have been recorded from these waters. In order of frequency these are: the leathery turtle or leatherback, *Dermochelys coriacea* (L.); the loggerhead, *Caretta caretta* (L.); Kemp's ridley, *Lepidochelys kempi* (Garman); the green turtle, *Chelonia mydas* (L.); and the hawksbill, *Eretmochelys imbricata* (L.).

In the past it has been assumed that the turtles found in these waters were just poor waifs that had lost their bearings. Wandering around aimlessly in the ocean, willy-nilly they were borne along by the currents eventually to perish on European coasts. Indeed the climate of the area does not allow breeding there, and in winter it is definitely unfavorable even for the most hardy turtle to stay and survive. An exception may be the seas off the southern part of Portugal and along the south coast of Spain. In summer, turtles may move northwards to fairly high latitudes. The record is held by a young *C. caretta* captured alive at Murmansk (68° 55'N) (Konstantinov 1965:111; Brongersma 1972:110); to get there, the turtle must have rounded the North Cape (71° 10'N) and Nordkyn (71° 05'N). The second best is the *D. coriacea,* taken alive in September 1958 off the Norwegian coast at 69°18'N (Holgersen 1960:135; Brongersma 1972:32).

In years gone by much of our knowledge about the occurrence of turtles along the western coasts of Europe was based upon juvenile *C. caretta* and *L. kempi* being washed ashore in winter, dead or dying. Observations on turtles sighted at sea were scarce at the time, and this is not to be wondered at. Never being numerous, small loggerheads and Kemp's ridleys easily escape notice. In regions, such as Portugal, where loggerheads were stated to be common (Themido 1942:21; except in the North, Ferreira 1893:26), not much attention was paid to them, and the majority of the turtles observed were not recorded individually as to place and time. In fact we do not know how many young turtles actually come to EAW, nor do we know whether any of them succeed in turning back before the cold sets in. From stranded specimens we know that at least some (or perhaps most) die in northern waters; the chances of perishing are greater the farther north the turtles have traveled.

If we still have some doubts about whether *C. caretta* and *L. kempi* succeed in returning to warm waters, there is little doubt that *D. coriacea* does. Once considered extremely rare, the number of observations has grown considerably in the last 3 decennia, and today we know that *D. coriacea* is a regular visitor to the area. Before 1951 only 68 records (since 1729) were available; the years 1951 to 1971 gave 116 records (Brongersma 1972, Table 3a); and since that time many records have been added, for example, from Ireland, the Netherlands, and Portugal.

Duron-Defrenne (1978:68–77) added scores of reports from France. It has been stated (Moulton 1963; Brongersma 1972:101) that *D. coriacea* may travel in groups, and indeed today we have various records of 2, 3, 5, or 6 turtles being sighted together. Once 12 turtles were observed in a restricted area (Duron-Defrenne 1978:79, 83). Thus, *D. coriacea* is a fairly stable element in the fauna of EAW, and especially so in the Gulf of Gascony along the south coast of Britanny and from there southwards to Biarritz (Duron-Defrenne 1978:68–77). The fact that the majority of the records stem from the area of the islands of Ré and Oléron, west of La Rochelle, may be due to the research being organized from La Rochelle. Some of the leathery turtles die in summer from drowning when they become entangled in lines attached to lobster pots, or in nets, or when they are hit by ships' propellers. However, the fact that relatively few specimens that show no wounds wash ashore in winter indicates that the majority of *D. coriacea* visiting the area in summer, leave for warmer waters before winter sets in.

Chelonia mydas, the green turtle, is rarely encountered. The situation is complicated by the fact that before the second world war, green turtles used to be shipped alive to Western Europe to the manufacturers of turtle soup. Turtles that died during the voyage were jettisoned, and among these I count the green turtles washed ashore on the Dutch coast in 1934 (3) and 1937 (1) (Brongersma 1972:180, 181). I know of only 2 records from EAW after the shipping of live turtles had been abandoned: one is that of a young green turtle (carapace 360 mm) stranded alive at Petten, the Netherlands, the other (carapace 362 mm) captured alive in the Ría de Arosa, northwest Spain (Brongersma 1972:180, 186). These 2 I believe to have reached EAW on their own. It may well be that some of the French and Spanish records from the nineteenth century (Brongersma 1972:185–87) belong in the same class, but there is no proof. That *Ch. mydas* is found occasionally on the Portuguese south coast is substantiated by a half-grown specimen from Algarve (Museu do Mar, Cascais).

Eretmochelys imbricata has been mentioned various times as occurring in EAW. As yet I know of only 1 specimen from this area. It was found in the Channel (Brongersma 1972:195), but we do not know the exact locality, whether it was dead or alive, or who found it. In 8 instances specimens reported to be hawksbills proved to have been misidentified: 5 were *C. caretta*, and 3 were *L. kempi* (Brongersma 1972:194). Further proof is needed to show that the hawksbill really does come to EAW on its own.

Summarizing, we may state that *D. coriacea*, *C. caretta*, and *L. kempi* are visitors to EAW, and of these *D. coriacea* is a regular visitor at least to French waters. The question arises as to the origin of the turtles found in EAW. For *L. kempi* the answer seems to be simple as the only known nesting beaches are to be found in Tamaulipas on the Mexican Gulf coast. We must conclude that the juveniles, after passing from the Gulf into the Atlantic Ocean through the Florida Strait, crossed the Atlantic to Europe and, as will be mentioned below, also to the Azores and to Madeira. Most *C. caretta* found in EAW are young specimens, and it seems likely that they too came from the western Atlantic. However, the possibility cannot be excluded that some *C. caretta*, for example, the few adult specimens found in northern EAW, came from populations living farther to the South, or that they came from the Mediterranean (Brongersma 1972:238–39).

Only in Portugal is *C. caretta* exploited but, according to recent information, in a very limited way.

For individual records for each of the species mentioned see Brongersma (1972), where detailed lists are given.

Macaronesian Waters

Macaronesian Waters (MW) comprise the seas around and between the Azores, the Madeira Archipelago, the Selvagens Islands, and the Canary Islands. As in EAW,

the MW do not harbor breeding populations of turtles. The same five species are involved. *Caretta caretta* is by far the most common species; *Lepidochelys kempi*, *Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea* are known from relatively few records.

The Loggerhead Turtle, Caretta caretta *(L.)*

Caretta caretta occurs in large numbers around the Azores, and in the seas north of these islands (to about 42°N) (Brongersma 1971:106; 1972: Chart 5). It has been stated (U.S. Department of Commerce 1978:64) that I estimated 4,000 loggerheads were slaughtered annually in the Azores, but this is a misunderstanding. The estimate of 4,000 is that of Mr. Dalberto Teixeira Pombo (of Sta. Maria, Azores) for the number of loggerheads killed annually in Madeira (*in litt.*, 16.vi. 1969). However, in this letter Mr. Pombo indicates that in the Azores the demand for the loggerhead for human consumption was increasing. Large numbers of *C. caretta* are also found around Madeira. Following a visit to Madeira in 1967, I estimated the number of loggerheads slaughtered annually to be 1,000 (and probably more); Mr. Pombo arrived at a number of 4,000. Recently, when I again visited Madeira, I found the exploitation still going on, in a somewhat different manner. During my 1967 visit, I got the impression that loggerheads were slaughtered for human consumption and that as a side-line the cleaned-out turtles were stuffed to be sold to tourists. The slaughtering was more or less a home industry at the time. During my visit in July 1979, it appeared that the turtles were not slaughtered primarily for human consumption, but for the tourist trade. In 2 souvenir shops, 1 and 2 loggerheads, respectively, were on sale for 800 escudos each (about US$20). In another shop (annex workshop), 29 loggerheads were drying on the roof. As the number of cruise ships visiting Madeira had declined since 1967, local sales have decreased; this is compensated, however, by exporting stuffed turtles to the Canary Islands where they can be sold to tourists. The turtles vary in carapace length from about 25 to 50 cm. Larger loggerheads may occasionally be slaughtered locally for human consumption, but these are not stuffed, as tourists will not take home cumbersome adult loggerheads. The turtles are caught by fishermen at night from fairly small boats while fishing with hook and line for the *espada preta* or scabbard fish (*Aphanopus carbo* Lowe). Should they chance upon loggerheads during the night, they are captured whenever possible. Slaughtering and stuffing is not a home industry any more. Behind the Funchal fish market only 1 man was at work on turtles. On 9, 11, and 17 July, I saw 9, 3, and 8 loggerheads, respectively; I was told that none was obtained on 10 July. Within 2 months (May and June) the man had dealt with about 200 turtles (all loggerheads); in winter he gets fewer specimens. I do not know whether there are other slaughterers around Funchal. My informants believed that 4,000 loggerheads annually would be too high a current estimate, but it was believed that 2,000 a year might be correct.

Caretta caretta is also known from the Selvagens Islands (carapaces found on the island in the Rijksmuseum van Natuurlijke Historie [RMNH], Leiden, the Netherlands). The species is found in the Canary Islands. Steindachner (1890:305) recorded the presence of *C. caretta* off Gran Canaria and Tenerife, and he stated that it was somewhat more common along the coasts of Lanzarote. I saw 2 small specimens taken in the waters off Gran Canaria in 1966. On a visit to Tenerife in 1975, I learned from a fisherman that *C. caretta* was more or less regularly taken in summer, all small specimens. He showed me a juvenile (carapace about 23 cm) which he had at home in a bathtub. On 26 March 1975, while on a ferry from Los Christianos, Tenerife, to San Sebastian, Gomera, I saw a small *C. caretta* off the Tenerife coast. The Naturmuseum Senckenberg, Frankfurt a. Main, Federal Republic of Germany, has a loggerhead shell from Punta Retinga, Island of Hierro (Brongersma 1968:129). In an advertisement in the periodical "Delphin, Revue der Unterwasserwelt" (August 1975:26) to recruit scuba divers to come to Hierro, it is stated "dort wo noch Seeschildkröten zu sehen sind" [where one still can see marine turtles]. In a swimming pool near Jaméo del Agua, Lanzarote, there were 6 turtles, all loggerheads as far as I could see.

Whether there is any exploitation of loggerheads in the Canary Islands, I do not know. Considering the small size of the specimens found in the area, exploitation for human consumption does not seem likely. The fact that small specimens are captured fairly regularly in summer may have led to some exploitation for the tourist trade. However, since stuffed turtles are imported from Madeira for the souvenir trade, it is unlikely that large numbers are captured in the Canary Islands.

The Kemp's Ridley Turtle, Lepidochelys kempi *(Garman)*

A very young specimen (carapace 99.7 mm) of *Lepidochelys kempi* was found on Corvo, Azores, in 1913 by Col. F. A. Chaves (Mus. Monaco, no. 2660; Deraniyagala 1938:540; 1939:1–4, 2 figures; Brongersma 1972:265, Figure 30; Pritchard and Marquez 1973:26); 3 specimens have been recorded from Madeira (summer 1949, Museu Municipal, Funchal, Madeira, no. 3978; May 1950, Naturmus. Senckenberg, no. 41057; summer 1950, Mus. Mun., no. 3194; Brongersma 1968:133; 1972:266, Figure 31). The species has not been recorded from the Selvagens and Canary Islands.

The Green Turtle, Chelonia mydas *(L.)*

The green turtle has been found in the Azores and in Madeira, but there are very few records. They are represented in the Museu Machado, Ponte Delgado, São Miguel, Azores, and in the Museu Municipal, Funchal, Madeira. Old records, like the one by Drouët (1861:129) who states that *Chelonia mydas* [sic] is not rare in the Azores where it provides the inhabitants and the seafarers with a healthy and rather agreeable food, may have been based on a misidentification of *C. caretta*, probably because most people considered the green turtle the only edible one. The green turtle has been recorded from Madeira, by Mertens (1935:89), Sarmento (1948:262), Maul (1948:295), and Brongersma (1968:134, Museu Municipal, Funchal, no. 22242).

There is as yet no record of *Ch. mydas* from the Selvagens Islands, and but a single record from the Canary Islands (Tenerife; Duméril, and Bibron 1835:544).

The Hawksbill Turtle, Eretmochelys imbricata *(L.)*

This species has been found in the Azores and in Madeira, and it is represented in the collections of the Museu Machado, Ponte Delgado, and of the Museu Municipal, Funchal, but it must be considered very rare in the area. From Madeira it has been mentioned by Mertens (1935:89), Maul (1948:295), and Brongersma (1968:135). It has been found in the Selvagens Islands (specimen in RMNH, Leiden); I do not know of any record from the Canary Islands.

The Leatherback Turtle, Dermochelys coriacea *(L.)*

Dermochelys coriacea has been observed in the Azores and in Madeira, but there are few records, for example, 1 female captured off Vila Franco do Campo, São Miguel, Azores, 31.v.1966 (Brongersma 1970:333), and 1 taken off Mosteiros, west coast of São Miguel, 9.ix.1977, Museu Machado, Ponte Delgado, São Miguel. From Madeira, the leatherback or leathery turtle was recorded by Sarmento (1948:264), Maul (1948:295), and by Brongersma (1968:135, female, south coast of Madeira, 19.vii.1955, Museu Municipal, Funchal, 5952; Pritchard 1971:32). Sarmento (1948:262) refers to 6 leathery turtles having been seen near the coasts of Madeira in the preceding 10 years. As yet there are no records from either the Selvagens or the Canary Islands, but it is very likely that occasionally or rarely the species appears in these islands.

West African Waters

West African Waters (WAW) comprise the waters along the west coast of Africa, from the Straits of Gibraltar to Cape Agulhas (South Africa), including the Cape Verde Islands, the Bissagos Islands, and other islands close to the African coast, as well as the islands in the Gulf of Guinea, such as Fernando Póo, São Thomé, Principe and Rolas, and St. Helena. But little reference will be made to the turtles of Angola, Southwest Africa, and South Africa, as these countries will be dealt with at more length in the contribution of the Southwest Indian and Southeast Atlantic Oceans by Hughes (this volume).

Recently, Ross et al. (1978) reviewed the present status of sea turtles. The maps indicating the principal nesting beaches indicate 2 nesting sites on the west coast of Africa: those of *Lepidochelys olivacea* in Senegal and Angola. No nesting is indicated on the west coast of the African continent, or on the islands for *Caretta caretta, Chelonia mydas, Eretmochelys imbricata*, and *Dermochelys coriacea*. Indeed recent information about the presence and nesting of the various species along the west coast of Africa is very scarce. Where such information is lacking, it may be of use to point to information obtained in the past. It is hoped that this may stimulate people to obtain information about the presence of turtles, their nesting, and also about the exploitation and other dangers that threaten various populations of turtles in their countries. Of course, records do exist (for example, those of Loveridge and Williams 1957:484, 489, 494, 497, 502), but sometimes the author and date of the records are hard to trace from lists. Therefore, I give fairly detailed lists of records for the 5 species found in WAW with references to literature (if possible to the original reference; sometimes later references are given).

There was a time when *Lepidochelys olivacea* was not recognized as a distinct species; the specimens were placed with *Caretta caretta*. One of the best known examples is Gadow's paper (1899) in which he developed a theory about the reduction of the number of scutes in the carapace, during an individual's growth based upon a comparison of hatchlings, which in fact were *L. olivacea*, and halfgrown and adult specimens, which were *C. caretta*. Accepting *C. caretta* and *L. olivacea* as distinct species, the following records must be transferred from *C. caretta* to *L. olivacea*: San Pedro, Ivory Coast, by Loveridge and Williams (1957:494), and that from Cameroon by Nieden (1910:3, 5). Boettger (1888:18) recorded a specimen from Banana, Zaïre as *Thalassochelys olivacea*, and Bocage (1895:6–7) transferred it to *Thalassochelys caretta* (*i.e., C. caretta*), but it should be returned to *L. olivacea*. A hatchling figured by me as *C. caretta* (Brongersma 1941: Figure 5c) is in fact a hatchling of *L. olivacea* (from Liberia). It may well be that the record of *C. caretta* from Cameroon (Tornier 1902:665) was also based upon *L. olivacea*.

Observations of turtles in WAW at some distance from the coast were made by the Guinean Trawling Survey (GTS); I have indicated as best I could, the

positions of the various stations.

Lepidochelys kempi has not been recorded from WAW. Pasteur and Bons (1960:101) consider it possible that the species might accidentally reach the Moroccan coast. As the species is known to enter the Mediterranean (Brongersma and Carr, in prep.) it might strand on the Moroccan coasts bordering the approaches to the Straits of Gibraltar. Bons (1972:120) lists *Lepidochelys olivacea kempii* under the species that probably are to be found in Morocco, or which should be looked for.

The Loggerhead Turtle, Caretta caretta *(L.)*

The following localities have been recorded. Morocco (Bons 1972:10); Menasra (north of Kenitra, about 34.36°N, Pasteur and Bons 1960:27); Mogador (Pellegrin 1912:256); plage Blanche (the coast between the former Spanish possession of Ifni and Rio de Oro, Pasteur and Bons 1960:100). Rio de Oro (Carr 1952:382). Mauritania: western part of the Baie du Lévrier (about 20.40 to 21.10°N); Banc d'Arguin (Maigret 1975:118–119 not seen), Maigret 1977:11–12; Trotignon and Maigret 1977:27–28, (not seen). Cape Verde Islands (Bertin 1946:91, 105; Bannerman and Bannerman 1968:54); São Vicente (Bocage 1896:66, a very young specimen); São Vicente and Sal (Angel 1937:1696); Boa Vista (Schleich 1979:12). Senegal: Hann, Joal, Fadiouth (Cadenat 1949:19); Dakar, plage des Almadies, Gorée, Kayar (Cadenat 1957: 1371, 1373); Cap Vert (Dakar, Gorée, Kayar) (Maigret, 1977:11, 12); îles de la Madeleine, off Dakar (Dupuy and Maigret 1979:4). Guiné-Bissao; GTS II, LR, Sta. 2/2, 11.37°N, 17.01.5°W (Williams 1968:98). Sierra Leone: GTS I, LR,Sta. 9/2, 07.54°N, .11.37°W (Williams 1968:98). Ghana: GTS I, LR, Sta. 30/2a, and 32/1b (Williams 1968:98). Gabon (Loveridge and Williams 1957:494, perhaps *L. olivacea* ?). Congo: Pointe Noire (A. Crosnier, *in litt.*, 16.iii.1968). Its presence in Angolan waters has been reported by Hughes, Huntley, and Wearne (1973:58).

J. Blache (*in litt.*, 22.ii.1968) states that turtles are rare around the island of Gorée, and A. Blanc (*in litt.*, 9.iii.1968) also is of the opinion that *C. caretta* is rare, in Senegal.

The species has been reported by Pasteur and Bons (1960:27) to breed on the Moroccan coast as far north as Menasra, and these authors (1960:101) infer that it also breeds on the plage Blanche. Bocage (1896) accepts the very young specimen from São Vicente, in the Cape Verde Islands, as proof of the species breeding there. In Senegal, *C. caretta* nests or used to nest on Gorée Island, on the beach of Almadies (near Dakar), and it was found to nest on 1 of the very small beaches of the îles de la Madeleine (off Dakar). This is the only nesting recently observed (Dupuy and Maigret 1979:4).

The Olive Ridley Turtle, Lepidochelys olivacea *(Eschscholtz)*

As mentioned above various old records of *Caretta caretta* in reality were based upon *Lepidochelys olivacea.*

The species has been recorded from the following localities: Mauritania: Port Etienne (21°N) (Carr 1957: 48, 49: Villiers 1958:186; Pasteur and Bons 1960:101). Senegal: Dakar, Hann, Gorée, Guet N'Dar, N'gaparo, Joal (Cadenat 1949:17, 19, 33, 35; 1957:1370, 1374; Carr 1957:48, 49, Figure 1, hatchling from Dakar; Loveridge and Williams 1957:497; Maigret 1977:12). Liberia: 2 hatchlings (Brongersma 1961:27); Grand Cape Mt. (Brongersma 1961:27); north of Point Marshall (Carr 1957:49, 50). Ivory Coast: San Pedro, hatchlings (Deraniyagala 1943:82, 92; Carr 1957:49; Loveridge and Williams 1957:497). Ghana: Tema (leg. Irvine, Brit. Mus. (N.H.) 1940.2.23.3; Carr 1957:49; Loveridge and Williams 1957:497: Tenia). Cameroon: Victoria (Nieden 1910:5, *C. caretta*; Carr 1957: 48, 49, 50). Gabon (Duméril, 1860:170; Carr 1957:49). Congo: Pointe Noire (A. Crosnier, *in litt.*, 16.iii.1968). Zaïre: Banana (Boettger 1888:18; Bocage 1895: 6, *Thalassochelys caretta*); Banana and Moanda (Carr 1957: 48, 49); "Congo" (Brongersma 1961:27). Angola: Ambriz (Brongersma, 1961:27), Luanda (Hughes, Huntley, and Wearne 1973:58).

Maigret (1977:12) writes that probably the species breeds on the Senegal coast, but that there is no confirmation of this. The photograph of a hatchling from Dakar (Carr 1957, Figure 1) definitely points to nesting in the area. Likewise the hatchlings from Liberia, Ivory Coast, Ghana, Cameroon, Zaïre, and Angola point to nesting taking place along the coastline from Senegal to Angola; Hughes, Huntley, and Wearne (1973) suggest that nesting takes place near Luanda, Angola. Deraniyagala (1943:92) writes "Probéguin Côte d'Ivoire," thus suggesting that Probéguin is the locality; a list received from the Paris Museum, gives San Pedro as the locality and Probéguin as the collector.

The Green Turtle, Chelonia mydas *(L.)*

The species has been recorded from the following localities: Morocco: Pasteur and Bons (1960:99) are convinced that incidentally the green turtle will be found along the Moroccan coast. They add that it may nest from the "plage Blanche" (the coast between the former Spanish possessions of Ifni and Rio de Oro) southwards; Bons (1972:120) considers it very probable that the species occurs on the coast of Tarfaya (the area of Cape Juby) and even farther to the north. Mauritania: Gulf of Arguin (Pasteur and Bons 1960:99; Parsons 1962:45); eastern part of the Baie du Lévrier, Banc d'Arguin, breeding on Pointe d'Arguin (Maigret 1975, not seen; Trotignon and Maigret 1977, not seen; Mai-

gret 1977:10, 11, and 1978). Cape Verde Islands: São Vicente (Loveridge and Williams 1957:484); for records by Parsons (1962:43–45), see discussion below. Senegal: Langue de Barbarie (nesting), Saint Louis, Gandiole, Cap Vert, Kayar, plage des Almadies (nesting), Dakar, Hann, Somone (nesting), M'Bour, Joal (nesting), Tare (Cadenat 1949:17, 22, and 1957:1369, 1371, 1374; Maigret 1977:10; 1978), Guiné-Bissao (Bocage 1866:5; 1896:74; Monard 1940:147); GTS II, LR, Sta. 4/5, 10.15°N, 16.34°W (Williams 1968:98). Sierra Leone: Turtle Island off Sierra Leone (J. Tomlinson, in: Parsons 1962:45); Sussex (Phaff 1964:15; 1967:49, "soepschildpad", figures). Liberia (Büttikofer 1884:31; 1890, vol. 2:147, 438, 439; Johnston 1906:819, 833); near Robertsport (nesting) (Büttikofer 1890, vol. 1:266, 267, 302); Monrovia, Robertsport (Loveridge and Williams 1957:484). Ghana (Irvine 1947:309; Parsons 1962:45); GTS I, LR, Sta. 32/1a, 05.38°N, 00.07°W (Williams 1968:98); a hatchling from Tema, Ghana, leg. Irvine, Brit. Mus. (N.H.). Togo (Villiers 1958:331, lists a vernacular name from Togo). Fernando Póo: south coast (Eisentraut, 1964:472–74, nesting). São Thomé (Greef 1885:49, nesting). Ilha do Principe (Bocage 1903:52, specimen collected in 1881); Ilheo das Rolas (Greef 1885:49, nesting). Congo: Loango (Pechuël-Loesche 1882:277, nesting). Cabinda (Angola): Chinchoxo (Loveridge and Williams 1957:484). Zaïre: Banana (Boettger 1888:17). Angola: Luanda (Bocage 1866:5, 1895:6); Bahia dos Tigres (Monard 1937:146, formerly frequently nesting, but became rare, A. J. Vilela 1923); Hughes, Huntley, and Wearne (1973:58, nesting south of Luanda). Southwest Africa: a specimen caught locally is in the Museum at Swakopmund. South Africa, St. Helena (A. Loveridge, *in litt.*, 1.xi.1968, sometimes nesting).

In Senegal, *Ch. mydas* is the commonest of the sea turtle species (Cadenat 1949:17, 22). The turtles are captured more or less accidentally when they become entangled in nets used to catch sharks. The remark by Parsons (1962:45) that "A small turtle industry is said to have existed in recent years at Requins in Senegal" is erroneous in so far as "Requins" does not refer to a locality, but to the "filets à requins" (nets to catch sharks). However, the figure of about 70 turtle shells in the yard of a sharks-fishery at Joal (Cadenat 1949, Figure 1; Villiers 1958, Figure 57) shows that there was some exploitation. Maigret (1978) remarks that according to fishermen of Glandiole (St. Louis region) 20 years ago there were about 300 nests each year on the beaches at the Langue de Barbarie; in 1975 only 3 nestings were observed.

Parsons (1962:43–45) mentions the islands of Sal, Boavista, Maio, Fogo, and São Tiago as localities, and he adds that the green turtle nests (nested) on Sal, Boavista, and Maio. However, Angel (1937:1696), Bertin (1946:91, 105); Bannerman and Bannerman (1968:54), and Schleich (1979) mention only *Caretta caretta* and *Eretmochelys imbricata* from the Cape Verde Islands. Cadenat (in Parsons, 1962:45) states that on several trips to the islands he had never seen a green turtle. Parsons based his statement on the evidence of early voyagers visiting the Cape Verde Islands, for example, Dampier (1697, ed. of 1968:60; Bannerman and Bannerman 1968:14), but Dampier stated only that in the months of May to August "a sort of small Sea-Tortoise came hither to lay their Eggs." The small size of the nesting turtles makes it unlikely that Dampier saw green turtles nesting in the Cape Verde Islands. The scope of the present survey does not allow a complete discussion of this matter. However, it seems more probable that Dampier saw hawksbills (known to occur in the Cape Verdes) or olive ridleys (not yet recorded from the islands). The fact that the turtles were collected as a source of meat may have led to misidentifying them as green turtles. A careful study of the original sources is necessary before a definite conclusion can be reached about *Ch. mydas* once nesting in great numbers in the Cape Verde Islands.

From the list of records it is clear that *Ch. mydas* breeds in many places: perhaps in southernmost Morocco, but definitely in Mauritania, Senegal, Sierra Leone, Liberia, Ghana, Fernando Póo, São Thomé, Principe, Rolas, Congo, Zaïre, Angola, and on rare occasions on St. Helena.

The Hawksbill Turtle, Eretmochelys imbricata *(L.)*

The following localities have been recorded: Morocco? (Pasteur and Bons 1960:100, very probably as an accidental visitor; Bons 1972:120). Mauritania: Banc d'Arguin (Loveridge and Williams 1957:489); between Cape Timiris (19.23°N) and St. Louis in Senegal (16.16°N) (Maigret 1977:11). Cape Verde Islands (Schleich 1979:12); Togo (Boulenger 1905:197; Loveridge and Williams 1957:489); Senegal: Hann, Joal (Cadenat 1949:22; Loveridge and Williams 1957:489); St. Louis, Hann, Casamance (Cap Skirring), Betenti (Parc national du delta du Saloum) (Maigret 1977:11); iles de la Madeleine (Maigret 1978:4). Gambia, Brit. Mus. (N.H.), leg. Tucker, no. 45.12.29.12. Sierra Leone: Bonthé (Loveridge and Williams 1957:489); Sussex (Phaff 1964:15, 16, figure; 1967:49, figure, "haviksnavel"). Liberia (Büttikofer 1884:31; 1890, vol. 2:438; Johnston 1906:833); Angel River (Loveridge and Williams 1957:488, 489); Liberia, 1884, leg. Büttikofer and Sala, RMNH 8104, 3 hatchlings. Ghana: Anamabu (Irvine 1947:311); Tenia (= Tema) (Loveridge and Williams 1957:489); Gold Coast, leg. Irvine, Brit. Mus. (N.H.), 1930.6.9.38 (head); G.T.S. I, TH, Sta. 32/a, 5.40°N 0.13°E (Williams 1968:98). Togo (Villiers 1958:329, vernacular name). Cameroon: Longji (Longuy) (Nieden 1910:5). Gabon (Loveridge and Williams

1957:489). Fernando Póo (south coast, Eisentraut 1964:471). São Thomé (Greef 1885:49; Mus. nat. Hist. nat., Paris, leg. Almada Negreiros; Loveridge and Williams 1957: 489). Rolas (Greef 1885:49; Loveridge and Williams 1957:489). Angola (Hughes, Huntley, and Wearne 1973:58). South Africa (Loveridge and Williams 1957:489). St. Helena (A. Loveridge, *in litt.*, 1.xi.1968).

Maigret (1977:11) believes that *E. imbricata* nests in Mauritania and Senegal, but there are as yet no exact observations. Büttikofer (1884:31; 1890, vol. 1:267) mentions its breeding in Liberia, and the 3 hatchlings in the Leiden Museum support this statement. Similarly we may accept the breeding records for Fernando Póo (Eisentraut 1964:471), São Thomé and Rolas (Greef 1885:49).

Maigret (1977:14) and Schleich (1979:12) mention the exploitation of *E. imbricata* in the Cape Verde Islands. F. Reiner, Museu do Mar, Cascais, recently told me that it is heavily exploited in São Thomé (in a way similar to *C. caretta*'s exploitation in Madeira) for the souvenir trade.

The Leatherback Turtle, Dermochelys coriacea *(L.)*

The following localities have been recorded: Morocco (Bons 1972:110): off Casablanca, Cap Cantin (= Meddouza) (Pasteur and Bons 1960:29). Senegal: Hann (Cadenat 1949:17, 35 Figure 1); Hann, Rufisque (Loveridge and Williams 1957:513); Hann, Joal (Villiers 1958:191, Figure 164); Rufisque, Bargny, Joal, Langue de Barbarie, Pointe de Sangomar (nesting), south of Palmarin (nesting) (Maigret 1977:12); coast and peninsula of Sangomar (Dupuy and Maigret 1979:5, nesting); A. Blanc (*in litt.*, 9.iii.1968). Liberia: (Büttikofer 1884:31; 1890, vol. 1:267; Johnston 1906:819, 833; Brongersma 1970:332, pl. xi, hatchling, 13.iv.1893); Mahfa River (Büttikofer, 1890, vol. 2:438, nesting; Loveridge and Williams 1957:501, 503). Ivory Coast (Villiers 1958:192, Figures 169, 170, hatchling). Ghana: (Irvine 1947:312); Tenia (= Tema) (Loveridge and Williams 1957:502, 503); [St. George d'] Elmina, Tema, "Gold Coast" (Brongersma 1970:332, pl. xii, hatchlings); Salt Pond (Pritchard 1972:148; 1976:752, Figure 3, specimen tagged at Bigisanti, Surinam). Togo: (Matschie 1893:208); Sebbe (Sebe or Zebe) (Tornier 1901:66, 3 specimens still within the egg membranes; Loveridge and Williams 1957:503). Gabon (Loveridge and Williams 1957:503). Zaïre: "Congo" (leg. Kamerman, viii, 1883, RMNH, 5477, taken from the egg or just hatched, remnants of yolk sac present). Angola: Rio Dende (hatchling, leg. F. Reiner, 1970, Museu do Mar, Cascais, Portugal); some 200 km of coast S. of Luanda (Hughes, Huntley, and Wearne 1973:58, nesting; Huntley 1978:1374).

By direct observations or by the presence in collections of hatchlings (or specimens taken from the egg) nesting has been demonstrated to take place in Senegal, Liberia, Ivory Coast, Ghana, Togo, Zaïre, and Angola.

Species Unknown

J. A. Sayer of FAO reported nesting activity in the area of Ouidah, Benin; the species was not identified (Anne Meylan, *in litt.*, 12.x.1979).

Conclusions

European Atlantic Waters have a population of turtles that move in when the water temperature has risen in summer, to leave again (or perish) when the cold sets in. A female *Dermochelys coriacea* came ashore near the Pointe d'Arçay, Vendée, France, on 17 August 1978, at 18 hrs; it was disturbed by the crowd that had assembled around it, and it returned to the water. Also, in the summer of 1938, at twilight, with rising tide, a *D. coriacea* came ashore at the beach of Vert-Bois, Island of Oléron, Charente-Maritime, France (Duron-Defrenne 1978:75, 83). Interesting as these observations are, there is no reason to assume that successful nesting can take place on the French Atlantic coast.

The population in Macaronesian Waters consists of turtles that stay in the area for a part of their life; turtles do not breed in the area, but they do get there when they are young, moving away again when they become adult. For both areas (EAW, MW) the question arises: whence do these turtles come, and where do they go? The occasional presence of *Lepidochelys kempi* in EAW and MW (as well as the Mediterranean) can only be explained by assuming a migration from the Gulf of Mexico through the Florida Strait into the Atlantic, where they may travel with the currents to Europe, to the Azores, and to Madeira. Likewise, young *Caretta caretta* might come from American beaches. A chart showing the positions of turtle sightings on the high seas (Brongersma 1972, Chart 5) shows a large concentration of records in the Azores area, around Madeira and between these islands and the approaches to the Straits of Gibraltar. The fact that sightings are much less common between 30° and 50° W and are lacking between 50° and 60°W may seem to plead against the assumption that young turtles move in a more or less steady flow from the Western to the Eastern Atlantic. However, one must take into account that the majority of records stem from merchantmen, who follow more or less fixed shipping lanes; the waters of the Azores and Madeira carry heavy shipping traffic, and correspondingly more records are received from that area.

That turtles can and do cross the Atlantic from west to east is shown by a *C. caretta* tagged and released (head-started) by Ross Witham on Hutchinson Island

(Florida, United States) and recently recaptured off Porto Moniz, Madeira; also by a head-started *Ch. mydas* (from the same source) having been washed ashore on the island of Flores in the Azores (Maul, Witham, and Brongersma, in prep.). Still, one cannot ignore that *C. caretta* breeds (or used to breed) on the Moroccan west coast northwards to Menasra (about 34°36'N), and that turtles are known to move through the Straits of Gibraltar in both directions (east to west and west to east). In September they are abundant on the Atlantic coast of Southern Spain; in July, August, and September many are captured on the Mediterranean coast near the Straits of Gibraltar (Dr. Julio Rodríguez-Roda, Instituto do Investigaciones Pesqueras, Cadiz, Spain, *in litt.* 23.ii.1968). Some of these turtles might succeed in reaching the Azores, Madeira, and the Canary Islands.

To solve these problems, it is necessary to start tagging programs. The difficulty is that in this case one should try to obtain turtles from fishermen, and then tag and release the turtles. I understand that some tagging is done by Mr. Dalberto Teixeira Pombo on Santa Maria Island, Azores. It would be of great value if tagging could be extended to other islands in the Azores and to Madeira. One would also like to know to what extent, in winter, the turtles of MW may move to warmer parts of the ocean.

Although there is a heavy exploitation of *C. caretta* in Madeira, it seems that the numbers occurring in the area have not diminished, and apparently the breeding stock from which they stem has not yet been affected.

West African waters harbor breeding populations of turtles. Our knowledge of nesting in this area is limited mostly to observations on individual nestings, or on hatchlings having been preserved in collections. Very little is known about the numbers of females that come to nest; the exceptions are the observations by J. Maigret in Senegal, and those by G. R. Hughes in Angola. Large stretches of coastline remain unexplored. On his search for the possible occurrence of ridleys in northwest Africa, Carr (1957:54) wrote: "But a flight along the coast from Mauritania to Morocco showed the whole shore there to be practically uninhabited for hundreds of miles and a place where ridleys might abound, with nobody the wiser"; substituting "turtles" for "ridleys" the statement still holds. Not only would one like to know much more about nesting sites, the species nesting there, and the number of females that come ashore but also whether migrations take place and, if so, over what distances. A remarkable record is that of a female *D. coriacea* which had been tagged in Surinam, and which was recaptured in Ghana (Pritchard 1972:148; 1976:752).

A decline in the number of turtles may be due in part to over-exploitation in past centuries. Today intensive exploitation for human consumption does not seem to take place in the Eastern Atlantic. Of course, people living on the coast will use some turtles and their eggs but the turtles can withstand this sort of exploitation. Exploitation increases when people move into coastal areas after continuous drought makes food scarce in the hinterland; this has been observed around St. Louis in Senegal (Maigret 1977:13). The exploitation of *E. imbricata* for tortoiseshell and for turtles stuffed as souvenirs for tourists takes place in the Cape Verde Islands (Maigret 1977:14), and very heavily in São Thomé (F. Reiner, personal communication). Maigret (1977:14) considers the exploitation of shells of the various species of turtles for the souvenir trade as a danger, which may have already been realized in the Dakar area and at Cap Skirring. A very serious danger is the urbanization of coastal areas and the use of the beaches by tourists: the nesting sites are destroyed, the eggs are collected for consumption, and the souvenir trade is stimulated (Maigret 1977:13; Dupuy and Maigret 1979:2).

To obtain a better insight into the turtle populations along the west coast of Africa, still existing nesting beaches will have to be located and a record made of the species nesting there, the numbers of females that come to lay, and the results of the nesting. Threats to the survival of these populations must also be identified. A tagging program may help to get some idea of possible migrations.

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Sea Turtles in the Eastern Mediterranean and Northern Red Sea

ABSTRACT

The ecology of the sea turtle in the Mediterranean Sea was a subject unfamiliar to science until the 1950s, even though in the first half of the century they were hunted indiscriminately and on a very large scale in Israel and Turkey.

This hunting did not bring the population to the brink of extermination. However, in Israel, a serious additional hazard developed in the 1950s, due to sand excavations. Since then the annual number of specimens in the sea, as well as the number of nests, has decreased. In 1979 only 2 nestings were recorded in Israel along 250 km of shore, as compared with 15 per km per year at the beginning of the 1950s.

There seems to be no chance of a natural revival even after the total prohibition of fishing, declaration of nesting preserves, and a slight improvement in the condition of sandy beaches. This year the Nature Reserves Authority in Israel began to collect eggs for the purpose of raising and freeing 1-year-old turtles into the sea. Activities of this type should be undertaken in cooperation with the other countries concerned, namely Turkey and Egypt.

Introduction

The sea turtle has been known as an economic factor in the eastern Mediterranean since before the beginning of the century. Gruvel (1931) reports on turtles off the shores of Syria and Turkey, and on trade in turtles with England and Egypt. A report on the fisheries of Palestine (Hornell 1934) describes the export of 2,000 turtles a year from Palestine to Egypt.

Lortet (1883) mentions sea turtles on the shores of Syria, Lebanon, and Israel (Haifa). In Haifa he saw "several hundreds which were washed up onto the shores." It is of course possible that these were females that had gone ashore to nest. In the 1920s Haifa children were accustomed to such sights; it is likely that these were turtles concentrated on shore for the purpose of being sent abroad.

At this point, all interest and recorded information ceased until our time. Nor did anyone foresee the almost total destruction of the turtle population in Israel and in Turkey until 1963.

Recent interest in sea turtles began in Israel in 1954, but not to the extent of developing serious research on the subject. Most of the observations until 1958 were made by amateurs. In the same year, organized recording began, though not on the level required by the subject. The destruction of the shores, which increased towards the end of the 1950s, convinced the Society for the Protection of Nature that serious action was required. This approach led to the first nesting research in Israel (1964) and to preliminary research in Turkey (1965) and Sinai (1968).

The basic purpose of the study was to define the problem of the survival of sea turtles in the Mediterranean. Thus, a partial study was undertaken of such aspects as incubation conditions on various shores, species composition of the population, and the size of nesting specimens. However, the information collected was insufficient, because only very small remnants of the population could still be found.

A most important source of information was an aged fisherman from Acre, the late Abu Hanafi, who had organized turtle hunting in the 1920s and the beginning of the 1930s. The data he gave us were accurate and should be treated accordingly. This conclusion is important in order to estimate correctly the extent of destruction of the turtle population in such a short time.

Relying on this and other sources, it is possible to estimate that between the end of the first world war and the end of the 1930s, at least 30,000 sea turtles were caught in systematic fishing off the shores of northern Israel by Abu Hanafi's crews. At the same time, other fishermen were also active in this field, but we have no definite information on them.

Similar numbers were caught in Turkey, off the coast of Mersin and Adana, mainly in the 1960s. Fishing in these areas continues today. Additional damage through occasional fishing, egg collecting, accidental destruction of clutches, pollution of the shores by crude oil, underwater explosions, and other disturbances also continues. As a cumulative result, the turtle population in the eastern Mediterranean has been thinned out alarmingly, especially in Israel.

Distribution of the Species

The following species have been found in the eastern Mediterranean: *Dermochelys coriacea*, *Chelonia mydas*, *Caretta caretta*, and *Trionyx triunguis* (see Appendix). *Eretmochelys imbricata* is mentioned by Gruvel (1931) and by Wermuth and Mertens (1961), but its occurrence has not been substantiated by our study in the eastern Mediterranean.

Dermochelys coriacea is rather rare, but we have some proof of possible nestings. On 30 June 1963 trails were found on the beach at Palmachim (south of Tel-Aviv, Figure 1), but the trails did not end in any nests. The width of the tracks, 1.10 m, and the incomplete excavation, about 2 m in diameter, indicate that these were tracks of *Dermochelys*.

Chelonia mydas, as related by fishermen, now appears at least singly in the eastern Mediterranean between Turkey and the Nile Delta.

Nesting shores in the past (as told by Abu Hanafi) were found on all sandy beaches in north Israel without any distinct relation to the size of the grains of sand. Grain size varies from a minimum of 0.065 mm on Acre beach to 1.7 mm on Nahariya beach. Abu Hanafi did not know of nesting on the shores of Syria and Lebanon, but he did know about the spring migration of the species to the shores of Turkey, and he assumed that nesting also occurred there.

In the course of our research, scattered nests were found in Israel in the following localities: the beaches of Netanya, Caesarea, Atlit, Nahariya, and Rosh Haniqra. As related by fishermen in Turkey, in 1965–67, there were nesting beaches at Viransehil, Kazanli, Tuzla, Karatas, and Yumurtalik. In these places, according to the same sources, large numbers of turtles were caught, and there was also much nesting activity.

Smaller concentrations which were not hunted, and for which we have no estimates of quantities, are known at Tasucu, Silifke, Chahenem, and Side. According to information we received at Yumurtalik, nesting also occurs at Samandagy, but we found no on-site evidence.

Caretta caretta is known all along the shores of the eastern Mediterranean from Turkey to Egypt. Gruvel (1931) indicated that this was the most common species in the Bay of Iskenderun, whereas today *Chelonia* clearly is the most prevalent.

During the 1950s, I found some 15 nests per km a year on the stretch of coast between Nahariya and Rosh Haniqra (5 km). A similar number of nests were found in 1958 on the beach of Atlit (8 km). On the rest of the shores of Israel and northern Sinai, a length of about 400 km, we may find occasional nests. No accurate counts were undertaken, but a rough survey by aircraft counted 100–150 nests in 1968.

Since the beginning of our study, not a single emergence has been recorded on the shores of Haifa Bay (22 km), indicating a clear preference for the coarse-grained beaches. However, we have to note that the number of specimens caught before and during the 1960s off this coast, was large (Table 1).

Table 1. Quantity of turtles caught in Haifa Bay and north of Acre, and brought to the Acre market

Year	Chelonia	Caretta
1963	1	15
1964	2	16
1965	8	5
1966	7	4
1967	11	15
1968	0	0
1969	24	54
1970	0	0
1971	0	0
(All were tagged and released)		
Average weight of male (kg)	61.5	37.5
Average weight of female (kg)	45.2	27.7
Maximum weight (kg)	100	65

Fishing

Both common species of sea turtles, and sometimes their eggs, are eaten by Moslems and Christians in Israel and Egypt. In Turkey this is not customary.

Today in Israel there is no systematic fishing, and even collecting of eggs along the shores of northern Sinai is only incidental. We know about systematic fishing from various sources, but full and accurate data were furnished to us by Abu Hanafi.

Massive fishing in Israel started immediately after the first world war, and reached a peak in the middle of the 1930s off the shores of Nahariya, Haifa Bay, and Atlit. Abu Hanafi alone employed up to 12 crews of 2 boats each during the above period, April to July, the nesting and mating season. The size of the mesh in the nets was about 40 cm, and every specimen caught in these nets was taken.

At the height of the season, some 600 specimens were caught a day, 90 percent of them *Chelonia*. Hanafi estimated that during these years some 30,000 turtles of both species had been caught. The normal weight of *Chelonia* in those days was 100 to 150 kg, and *Caretta* weighed no more than 60 to 80 kg.

Systematic fishing was carried on into the 1960s but on a much reduced scale. In the second world war it stopped altogether due to the thinning out of the population and decreasing profit. From then until the 1960s, fishing continued based on occasional catches, but not for export. The quantities that reached Acre market, which has always been the center of turtle fishing and commerce, are shown in Table 1. Turtle fishing is prohibited by Israeli law. For the purpose of our research we encouraged fishermen to bring and sell us their entire catch, but sometimes turtles were slaughtered, and we were informed only afterwards or not at all. Therefore our data are not entirely complete.

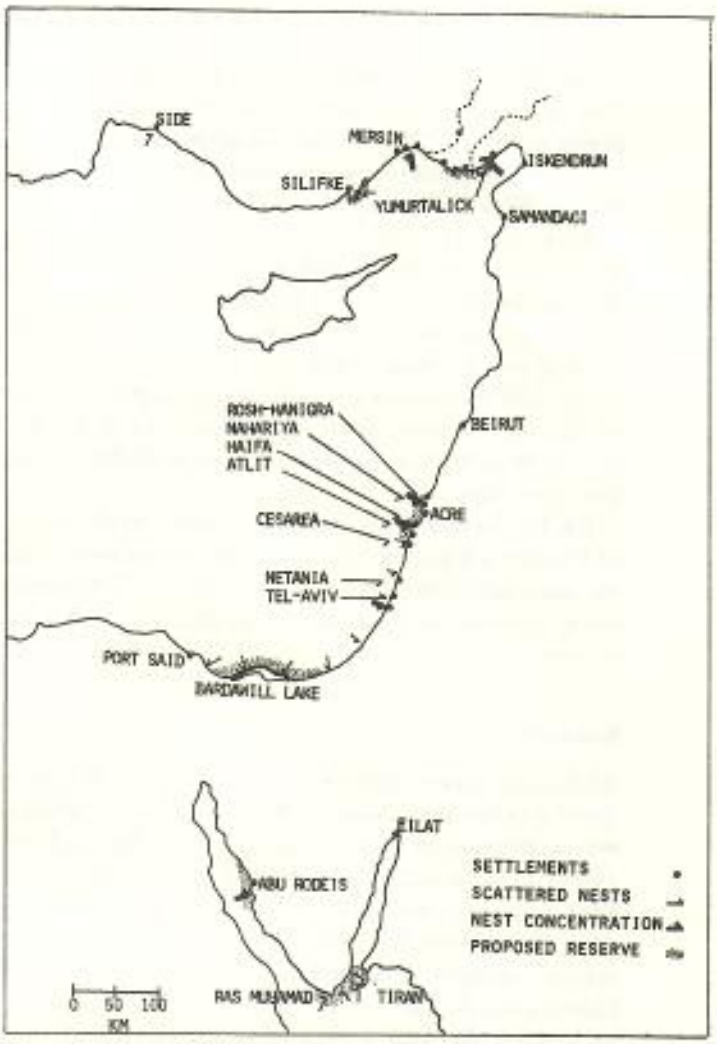

Figure 1. Eastern Mediterranean nesting sites and proposed turtle nature reserves.

Since 1970 trade in turtles in Acre has stopped altogether. Even turtles caught by chance are returned to the sea, owing more to lack of profit than prohibition by law.

Events in Turkey have followed a similar path since the 1950s. In May 1965, we made a trip to that country to locate the fishing and nesting shores. In 1967 we were given an additional chance to visit these shores and to meet the people who are actually involved in fishing and commerce.

Official records of turtle commerce before 1967 do not exist, and local people refrained from speaking for fear that the information would reach undesirable addresses. Nevertheless, in our opinion, the following information is reliable.

A fishing company from Iskenderun began to buy turtles from fishermen on the shores of Mersin and its surroundings. The slaughter house at Iskenderun could absorb a good number of turtles, and at the end of the 1960s a number of groups specialized in this field. This slaughter house's entire production was destined for Europe.

During the main hunting season, from April to June, 200 turtles and more were brought to the slaughter house each day. Usually they weighed 120 to 150 kg, but 15-kg juveniles were not returned to the sea (M. Swartz, personal communication).

Between 1952 and 1965, up to 15,000 specimens were taken from the shores of Mersin alone. Toward the mid-1960s, the turtle population thinned out considerably, and the center moved to the estuary of the Seyhan and Ceyhan rivers, south of Adana. In May 1965, 100 specimens or more were caught each day in this new hunting area, all *Chelonia*. In this single area by May 1965, apparently more than 10,000 turtles had been captured.

Dr. U. Hiersch observed turtle fishing off the shores of Yumurtalik in April 1972, and he was informed that the seasonal catch reached approximately 1,200 turtles (from a letter to Prof. Mendelssohn, Tel-Aviv University).

Excavations

Additional severe damage to the turtle population in Israel was brought about by the excavation of sand for the production of concrete in 1954–63 (Niv and Nir 1969). In these years the nesting beaches of Nahariya, Rosh Haniqra, and Atlit, which were previously the main and almost the only nesting beaches, were severely damaged. The strip of beach between Rosh Haniqra and Nahariya was destroyed down to the beachrock layer. At Atlit a strip of beach 80 m wide was removed from the original 120 m (Figure 2). Other beaches were also badly damaged.

At the same time, increasing numbers of tracks ended without any nesting, clutches rotted, and embryos developed abnormally (Table 2).

The prerequisites for normal nesting and incubation are a stable temperature of ± 28°C at a depth of more than 30 cm, and no flooding by waves. These 2 conditions became disrupted as soon as the excavations passed the natural line of the wave flow.

As compared with about 15 successful nestings per km per year until the 1960s, in 1964 the number of nests had decreased, as shown in Table 2.

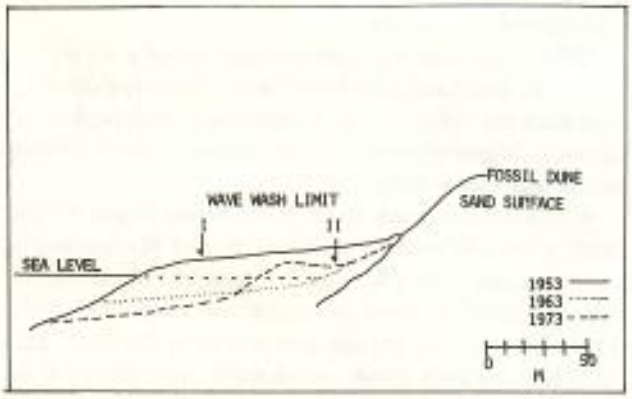

Figure 2. Beach destruction, Atlit, 1963.

Table 2. Nesting success, 1964

Category	*No. on Nahariya – Rosh Haniqra 5 km*	*No. on Atlit 8 km*
Nests	16	10
Barren emergences	10	18
Spoiled clutches	3	3
Abnormal hatchings	11	3
Normal hatchings	2	4

All the defective or partially defective nestings were found within the wash line and were flooded at least once or as many as four times during the season. Some were found to be very near to the surface, and as a result underwent extreme temperature fluctuations of 18–35°C per day, resulting in spoilage. One nest was found in a concentration of gravel, and the young were not able to emerge to the surface.

At the urging of the Society for the Protection of Nature in Israel, a state committee was set up to examine the problems caused by the excavations. It recommended a halt to all the excavations on all the shores.

The recommendation was adopted, and within 5 years an improvement was apparent. However, this improvement has not yet brought the shores back to their original state. The destruction of the beaches, together with the extreme thinning out of the turtle population, seem to have reduced the number of turtles below the minimum necessary for natural survival of the species in Israel.

Results of the 1979 nesting survey by the Nature Reserves Authority show the steady decline in nest numbers. This year only 2 nests and 7 non-nesting emergences were encountered along the Israeli coast (250 km).

In Turkey in 1965, at least in the vicinity of Mersin, there were excavations on the nesting shores. We have no information as to what is happening there today.

Unnatural and Premature Mortality

An estimated 20 to 30 dead turtles are cast onto the shore every year between Nahariya and Ashqelon (200 km). Information nearly always reaches us too late to establish the cause of death or the date, or sometimes due to the disintegration of the corpse, the exact species. Each year, our count of dead turtles adds up to a similar figure. This is not logical because the number should decrease every year, in relation to the decrease in the number of nests and living turtles in the sea.

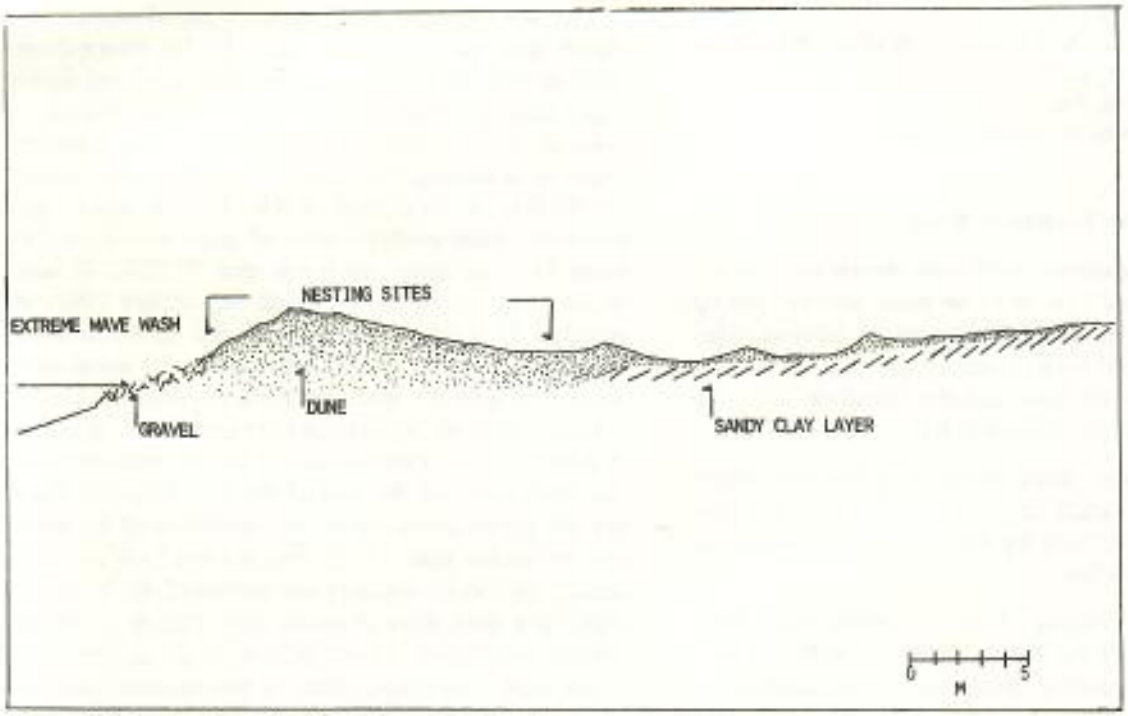

Figure 3. Cross section, Ras Shartibe nesting beach.

Summary and Conclusions

At the beginning of the century, 30,000 to 40,000 turtles lived off the northern shore of Israel (a length of 35 km). Some of the turtles hunted in Israel may have belonged to the Turkish population and may have been caught during their spring migration northwards. In Turkey, over about 100 km of shoreline, the numbers were similar. In both areas, the turtle populations have come close to extinction due to a similar process and over a similar length of time.

We have no knowledge of any other nesting grounds in the Eastern Mediterranean. Because of this and the very low potential rate of natural increase, we cannot foresee the rehabilitation of the species in the near future, if at all, without man's active intervention. Aid could come through preservation and rehabilitation.

In the framework of preservation, all sea turtles should be declared protected species (Israel has such a law) and hunting should be prohibited, at least for a limited period, pending the development of a method of artificial propagation. At the same time, international control of trade in turtles should be initiated. Nature reserves should be established with the main purpose of protecting the nesting beaches and mating area, irrespective of whether or not these two overlap (Figure 1).

Rehabilitation by artificial methods should be tested locally and in minimum quantities to ensure the survival of the 2 species. However, it is worthwhile to consider rehabilitation also for commercial purposes. A common plan for the countries of the Eastern Mediterranean would be more economical than separate local plans, due to the migratory character of the turtles in this area.

In Israel the following plans are being implemented: besides 2 nature reserves in Atlit and Rosh Haniqra, an artificial raising system is being undertaken to raise 1-year-old turtles in the maximum number available.

The current state of research on turtles in the area is far from satisfactory. Therefore, before, and parallel with, any action for preservation and rehabilitation, research on a suitable level must be completed in the 3 main countries concerned: Turkey, Israel, and Egypt.

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Appendix 1. Sea Turtles in Sinai

Up to 1967 we gathered very little information on sea turtles in the Red Sea, or to be more precise, the tip of the Bay of Eilat. The information we possess today was gathered from Israeli sources.

On the shores of Sinai and the Island of Tiran the following species are known today:

1. *Caretta caretta*. Some bones (of a few specimens) were found in a small cave on the beach of Ras Muhammed (identification by Prof. A. Carr). None has yet been caught alive.

2. *Lepidochelys olivacea*. Two specimens have been identified south of the Peninsula (Prof. A. Ben-Tuvia, University of Jerusalem, personal communication).

3. *Dermochelys coriacea*. This species is very rarely seen and caught in Eilat Bay. A few were observed by a helicopter pilot from the air throughout the month of July 1969 off the nesting shore of *Chelonia* (see below) south of Abu Rodeis. No nests have been found (D. Ron, personal communication).

4. *Eretmochelys imbricata*. This species is occasionally seen and caught in various places along the shores of Sinai. No nests have been found to date.

5. *Chelonia mydas*. The green turtle is seen and caught more than any other species along the shores of Sinai. Nesting activity is known around the southern point of Sinai and Tiran.

Chance collecting of eggs and fishing are known in Sinai, but the Bedouin population on the Sinai shores is so sparse that they have no effect on the existence of the species there. Nevertheless, we can point to a few facts which jeopardize the existence of the only colony known to date.

The nesting areas of *Chelonia* were identified in a survey undertaken in 1968 (Figure 1). The entire shores of Sinai and the island of Tiran were examined during flight from a height of 100 m and driving by jeep.

In all cases except 1, nests were found scattered singly or in small groups. Only in 1 locality, Ras Shartib on the Bay of Suez south of Abu Rodeis, was a comparatively high concentration of nests found. In October 1967 we found no fewer than 40 nests, or what appeared to be nests. In July to September 1969, we counted 37 nests in a stretch of 200 m. In an aerial observation at the end of September, 30 more nests were observed (D. Ron, personal communication).

Congestion of the nests is very great here. Most are dug one on top of the other in a limited strip between the wash line and the end of the beach dunes, which are about 2 m above the regular boundary of the waves and no wider than 15 m. Beyond the belt of beach dunes, tiny sand mounds are scattered 30 to 50 cm high on a hard layer of sandy clay (Figure 3). In this section we found dozens of trial diggings but not a single nest. South and north of this section there are no beach dunes, and the waves wash up to the area of the small mounds. We found no additional nests 40 km north and 30 km south.

The coastal belt seems to have declined and destruction of the beach dunes to have advanced, leading to a constant reduction of the stretches suitable for nesting.

Due to lack of time and the great difficulties in finding nests dug one into the other, incubation conditions were not properly examined. However, from the small number we did find, the percentage of successful nesting is clearly very small. The general failure is increased by 2 new factors. An oil tank farm has been put up on the border of the nesting strip, and the shore is polluted by crude oil. Development of the oil industry naturally draws people and their dogs, which rove all over the area and dig up some of the nests.

From all of the above, it appears likely that the only proper colony known in Sinai is being destroyed.

Appendix 2. *Trionyx triunguis* in the Mediterranean Sea

This tropical fresh water species was once common in Israel in every stream and small river flowing into the Mediterranean. Today, because of pumping and pollution, they have become rare. They are also known in Lebanon, Syria and Turkey (related by fishermen).

In our study we found that this species appears regularly in the Mediterranean Sea. Gruvel (1931) gives evidence of finding this species as an unusual phenomenon in the Bay of Iskenderun at 30-m depths. We found soft-shelled turtles along the shores of the Eastern Mediterranean as shown below:

There is, therefore, no reason to think that their appearance in the sea is accidental, or that their penetration into the sea is caused by floods. In experiments carried out in the physiological laboratory of the Tel-Aviv University, Prof. A. Shkolnik and his student tried to "acclimatize" these turtles to sea water, but without success. This interesting phenomenon should be included in the framework of research and preservation plans for the turtles of the Mediterranean Sea.

Place (from south to north)	*Date*	*Dead or alive*	*Depth of sea (m)*	*Distance from shore (km)*	*Distance from fresh water (km)*
Bardawil Lake	Sept 1979	Disintegrated skeleton	On shore	—	150.0[a]
Tel-Aviv	June 1978	Alive in net	?	?	6.0
Haifa Bay	Oct 1963	Alive on rod	6	2.5	3.0
Haifa Bay	June 1972	Alive in net	6	2.0	2.0
Haifa Bay	Sept 1972	Alive on rod	4	0.5	0.5
Iskenderun Bay	May 1965	Alive in net	10	12.0	25.0
Karatas Lagoon	June 1967	Disintegrated skeleton	On shore	—	20.0
Side Lagoon	May 1965	Disintegrated skeleton	On shore	—	12.0
Side Lagoon	May 1965	Alive in net	5	0.5	12.0

— No data.

a. This specimen undoubtedly died within historic times (according to the state of the skeleton) 150 km away from the nearest fresh water. Even the old eastern arm of the Nile Delta (Sne and Wisebrod, 1969), which dried up in the first century is 60 km away.

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Status of Sea Turtle Populations (*Caretta c. caretta* and *Chelonia m. mydas*) in the Northern Mediterranean Sea, Turkey

ABSTRACT

Observations on the species, distribution, mating behavior, nest making, the relationship between marginal shield distributions and the size of subadult individuals and young were made on the sea turtles nesting on the Mediterranean coastal beaches of Turkey. Nearly 2,000 km of the Mediterranean coastline is composed of sandy beaches. For investigation of the mean clutch size and the annual mean egg production, 5 stations were chosen, covering a total of almost 100 km.

Caretta caretta nested at all 5 stations without differentiation. *Chelonia mydas* made its nests only at Belek, Side, and Alanya. Also, *Trionyx triunguis*, which lives in freshwater, at times in lagoons, and sometimes even in the sea (Atatür 1978) was found in large numbers in our study regions. These carnivorous animals are disliked by fishermen.

The mating of loggerheads began in mid-April and lasted until the last week of May. Mating occurred just opposite the shore where the nests were made. The first report of a loggerhead nest came on 8 May and the nest making season lasted until the end of August. But almost 50 percent of the nests had been made by 20 June.

The total number of eggs laid at the research station areas during the egg laying season was 140,000. On the average, 47.0 percent of the eggs were destroyed by predators or the tide.

In the distribution of marginal shields in sub-adult and young *Caretta caretta* the 11 to 11 and 12 to 12 distribution was frequently observed; important correlations were found in some of the relationships in size.

Introduction

Some species of sea turtle that are widespread in the Pacific and Atlantic Oceans reach as far as the eastern Mediterranean and compose large populations in specific areas along this region, but scientific knowledge

about them remains scarce.

The purpose of this study is to investigate the sea turtles visiting Turkey's Aegean and Mediterranean coasts (36°N, 26°E and 42°N, 36°E) and to help preserve these populations. To do this, representative species must be examined, their inter-relationships investigated, their population size recorded, and their ecology understood.

The good flavor and the high protein content of their meat has increased the turtle's commercial importance in many regions. Also, these animals are important in areas where their carapaces are sold as decorative articles to tourists, or where superstitions state that their meat, fat, and blood cure several illnesses (such as breathlessness and hemorrhoids). Many factors, including pollution and tourist traffic force the turtles to leave their eggs haphazardly or to look for a new territory in order to lay eggs. In this way, they might lose continuity between generations and they, like other species before them, would become extinct. Many dangers await young hatching, including the numerous predators. As long as predation does not become overwhelming, it can be tolerated as a requirement of the food chain needed to maintain the natural balance.

Methods

The Aegean and Mediterranean coasts of Turkey include long, sandy beaches totaling more than 2,000 km. For this reason investigations were carried out at 5 stations chosen during the first, inventory-taking survey, trip. The stations chosen are shown in Figure 1:

- Köycegiz Dalyanköy Bogaz Beach, 7-km long, 36°47'N, 28°38'E;
- Kumluca, 10-km long, 36°22'N, 30°19'E;
- Belek, 40-km long, 36°50'N, 30°58'E;
- Side-Nigit, 30-km long, 36°46'N, 31°28'E; and
- Alanya, 12-km long, 36°36'N, 32°05'E.

The research groups (composed usually of 3 persons) were sent to these regions at 1- or 2-week intervals (leaving 1 observer in the area during the intervals) and spent the same length of time at each station. These groups made observations either on foot or by jeep from 2100 hr to 0400 or 0600 hr. Track countings and nest evaluations were done in daytime. Investigation of false emergences was also emphasized.

The behavior of individual females during the sequence of emergence on land, nest digging, and egg laying were observed. They were captured during their return to the sea and measured for the length and width of the curved and straight carapace, length and width of the plastron, width of the nose shield and lengths of the head with a steel yardstick and a compass suited for morphometry. Also, the major shields of the carapace and plastron were counted, and the weights were determined with a portable scale.

By day, the number of emergences onto land and the number of nests were counted. The distance to the shoreline, depth, inner temperature, relative humidity, and the number of eggs were determined for each of the 50 nests opened. The amount of destruction caused by people (tractors, etc.), predators (crabs, dogs, foxes, pigs, jackals, and some birds), and tides was calculated for the marked nests.

The biometric measurements taken on the 15 captured subadult *C. caretta* were statistically examined.

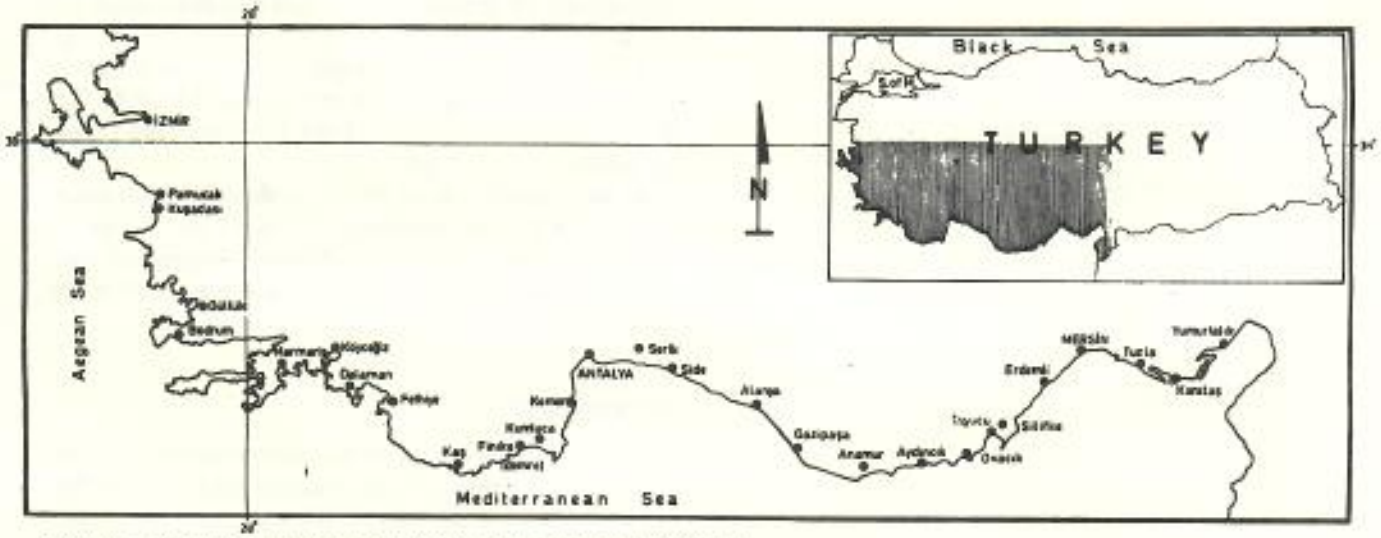

Figure 1. Map of the Aegean and Mediterranean coasts of Turkey.

Sea Turtles Visiting and Making Nests on the Northeastern Mediterranean

The first report directed seriously towards the subject of sea turtles in Turkey outside of routine observations was Hathaway (1972). Hathaway (1972) stated that there are more turtles in the Mediterranean than in any other sea. However, in the absence of any definitive report on the species and number of these animals, some facts are known about their feeding habits, but almost nothing about their migrations, mating behavior, and the role of instinct during migration, emergence, and nest making. So far, our only knowledge about turtles visiting Turkey and their numbers comes from the statistics: the year and weight (in kg) of the fish and turtle catch in Turkish waters. These statistics are difficult to read for turtles. The number of turtles cannot be calculated from total catch weights because individual weights vary enormously from juvenile to adult. These statistics, for example, report a drop in the turtle catch from 286,505 kg in 1968 to 52,355 kg in 1969. Why did the catch decline in 1969? Did fewer turtles visit Turkish waters, or did a drop in price discourage turtle hunters, or were fishermen careless about reporting their turtle catches (Hathaway 1972)? The explanation for the sudden decrease of 1969 is not known. Additionally, no differentiation is made between species, another possible source of miscalculation of numbers.

For these reasons, work on population numbers (with population dynamics research), along with differentiation of species, presents a difficulty in the investigation of the large groups on Turkish coasts. For now this work has been done by following the emergences onto the beaches or by examining the tracks.

The turtles' destination after leaving the Turkish coast is unknown. Although this research is a part of our program, we had to leave this inquiry for future seasons due to circumstances not under our control. The tags (monel metal tags) that we had ordered were not sent to us on time.

Where do these animals go after they have laid their eggs? Do they, as many people state, roam the Mediterranean (Brongersma 1972) or do they pass to the western Indian Ocean (Indowest Pacific Ocean) through the Suez Canal, or do they come from the Atlantic and return to this ocean? There is no doubt that these questions will be answered easily and with certainty after the marking operations are completed. The other remaining questions (age, maturation, underlying reason for false crawls, etc.) can be answered with some careful scientific observations.

In general, sea turtles are found mostly in tropical seas, but they are also found in considerable numbers in subtropical and temperate regions. In the Mediterranean there are 5 species: *Caretta caretta, Chelonia mydas, Dermochelys coriacea, Eretmochelys imbricata, Lepidochelys olivacea* (Basoglu 1973). But all of these species lay eggs on the Mediterranean coast.

The species of sea turtles known to nest along the coasts of the Turkish seas [Mediterranean, Aegean, Marmara (inner sea), and Black seas] can be summarized as follows.

Family: Dermochelydae

SUBSPECIES: *Dermochelys c. coriacea*

Found in small numbers in Turkey only on the Mediterranean coast, this species also occurs in the Greek Mediterranean (Ondrias 1968), and even though specific regions are not given, in the Mediterranean and Aqaba Gulf around Israel (Hoofien 1972). Also, the subspecies *Dermochelys c. schlegelii* should not have been published (Mertens and Wermuth 1960).

Family: Cheloniidae

SUBSPECIES: *Caretta c. caretta*

Though found in large numbers along the Black, Marmara, Aegean, and Mediterranean seas of Turkey, this turtle is known to nest only on the Aegean and Mediterranean shores. It also occurs along the Greek Aegean and Mediterranean coasts (Ondrias 1968), the Mediterranean shores of Israel (Hoofien 1972), and the western portion of the Bulgarian Black Sea (Beskov and Beron 1964). There is no evidence that they nest in these areas. Russian literature reports that they are also present on the Black Sea (Terentjev and Chernov 1975).

SUBSPECIES: *Chelonia m. mydas*

In Turkey the green turtle is distributed along the Black, Marmara, and Aegean Seas but particularly large populations form on the Mediterranean. It is not known whether green turtles nest on the Aegean and Mediterranean coasts of Greece where their presence has been reported (Ondrias 1968). They have also been reported from the Mediterranean and Aqaba Gulf of Israel (Hoofien 1972). Found on the western Black Sea region of Bulgaria (Beskov and Beron 1964), they are not known to nest there.

SPECIES: *Eretmochelys imbricata*

Hawksbills are probably found along the southern shores of Turkey and Greece (Mertens and Wermuth 1969). They have been reported from the Mediterranean and Aqaba Gulf of Israel (Hoofien 1972).

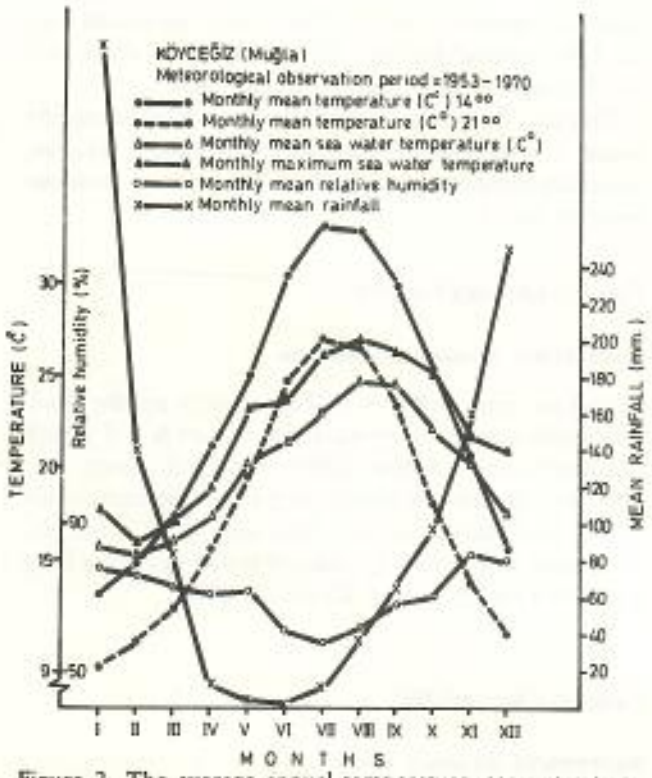

Figure 2. The average annual temperature, sea water temperature, relative humidity and rainfall for Köycegiz over a 17-year period.

SPECIES: *Lepidochelys olivacea*

Olive ridleys are rare along the Mediterranean coasts but resemble *Caretta caretta*.

Work at Köycegiz

Köycegiz-Dalyanköy Beach is in the region between the Aegean and the Mediterranean and east of Marmaris Bay (36°47′N, 28°38′E). It has a typical Mediterranean climate.

Figure 2 summarizes meteorological observations at Köycegiz for 17 years. According to these data, the highest average temperatures are recorded for July (27.8°C) and August (27.3°C). The lowest average temperature of the year is in January (9.5°C). August (25°C) and September (24.5°C) have the highest average sea water temperatures; February (15.3°C) the lowest. The most rain falls in December (245.5 mm), the least in August (1.8 mm).

The Dalyanköy Beach stretches around the entire mouth of the canal joining the sea with the lake of Köycegiz. Mollusc shells are always strewn on this beach. The littoral region is rocky without forming a set.

The pale yellow sand, when wet, turns a yellowish-tan. *Euphorbia paralias* is frequent at a distance of 10 m from the shoreline. Almost 20 m from the shoreline *Nerium* sp. and from place to place *Scirpus* sp. can be seen.

Many *Ocypode cursor* (Order Decapoda) are found on the Dalyanköy Beach. The forests of plane trees at the junction between lake and sea are hideways for foxes (*Vulpes vulpes anatolica*). Only from May to September, when people visit the beaches, are dogs seen and many of them have learned to open sea turtle nests.

In this region observations made during the summer months of May to August show that only *Caretta caretta* nests here. Two males were caught by fishermen in the sea with a net. During work in the egg laying season, 330 nests were observed. But, almost 43.6 percent of these were destroyed by predators and tides (Figure 3). Only *Chelonibia* sp. was noted as the characteristic epizoic organism. *Trionyx triunguis* is found in large groups in Köycegiz lake, canal and lagoons. It is understood from the complaints of the fishermen that they pass into the sea from time to time.

Although one of the aims was to determine the population of *Caretta caretta*, the re-nesting interval could not be calculated because the monel metal tags arrived too late. Thus, Hughes's equations to estimate population size (1974) could not be used. The total number of nests was not used to reach an estimate because of the probability of large error.

The mating season begins in the middle of April and lasts until the last week of May according to Dalyanköyü coastal fishermen and our own observations. A mating pair was observed at a distance of 300 m from the shore on 14 May. As far as we know, supported by outside reports, mating occurs on sunny days and lasts 3 hours. Research in 1978–79 showed that the nesting season began in mid-May and lasted until the end of August along the Turkish Mediterranean coast (Figure 4).

Our first report of a nest in Dalyanköy was 8 May. In April and September, the observed tracks did not lead to nests.

The frequency of the "false crawl" (Carr, Carr, and Meylan 1978) attracts attention in this region. Of the 11 emergences onto land discovered the night of 12 June, only 2 ended with the production of a successful nest.

For the duration of the nesting season, the emergences onto land occurred between 2200 hr and 0400 hr. Emergences were not observed during the day or towards evening. Once a *Caretta caretta* at 0600 hr was observed. Two individuals were seen making nests on the Dalyanköy Beach at 2200 hr but emergences become more frequent between 0100 hr and 0300 hr. This agrees with the suggestions of Schulz (1975) that *Chelonia mydas* emergences are more frequent in a rising sea.

An animal reaching the shoreline remains there a little while, though completely out of the water. After this rest, the emergence begins with continuous movements. Figure 5 summarizes the distance of nests from

shoreline at the research stations. On the average, 50 percent of the nests were made 15 to 20 m from the shoreline.

The Dalyanköy nest-making females and males caught in the sea had a minimum straight carapace length of 55 cm and a maximum of 74.6 cm. They probably reached sexual maturity in this area. The minimum weight of the females was 40.0 kg, and the maximum was 75 kg with an average of 57.5 kg. As the number of times these animals laid eggs was not determined, these values include an error relative to the egg weight in the ovaries.

Evaluation of the 50 nests we opened indicated a likely clutch size of 70 to 120 eggs. The average egg number was 93, the minimum 23 and the maximum number 134. Diameter measurements of the top 10 eggs of each nest gave the minimum value as 3.7 cm and the maximum as 4.2 cm with an average diameter of 3.9 cm. The average weight of an egg was 20.3 g, lower than reports by other workers (Caldwell 1959; Hughes 1974) and probably due to the small size of the animals.

Incubation period is defined as the time from egg laying to hatchling emergence (Caldwell 1959). Data from marked nests and from the laboratory incubator indicate a minimum 50-day and a maximum 64-day duration with an average of 57 days.

The temperature inside the nest and the relative humidity may affect incubation period (Yntema and Mrosovsky 1979). Inner nest temperatures at Dalyanköy ranged from 24°C to 28°C with the average at 26°C.

Measurements of straight carapace length of 50 hatchlings captured upon leaving the nest were a minimum of 37 mm and a maximum of 42 mm with the average at 39.9 mm. Straight carapace width varied between 30 mm and 35 mm with an average of 32.3 mm. Weights of the same animals ranged from 12.7 g to 18.3 g with 16.1 g as the average.

Relationships between lengths of subadult individuals captured at the 5 stations were investigated within the 95 percent confidence limit (Figures 6, 7, and 8). Important correlations were found in measurements of weight and carapace length, and carapace length and carapace width for 50 *C. caretta* young (Figures 9 and 10).

The majority of subadult males and females examined on the Dalyanköy Beach showed marginal shield distributions of 11 R, 11 L; 11 R, 12 L; 12 R, 11 L; and 12 R, 12 L. Only 1 individual showed the 12 R, 13 L distribution.

The 50 *C. caretta* hatchlings mentioned above had mostly the 11 R, 11 L, and 12 R, 12 L marginal shield distributions. Some showed the 12 R, 11 L and 11 R, 12 L distributions.

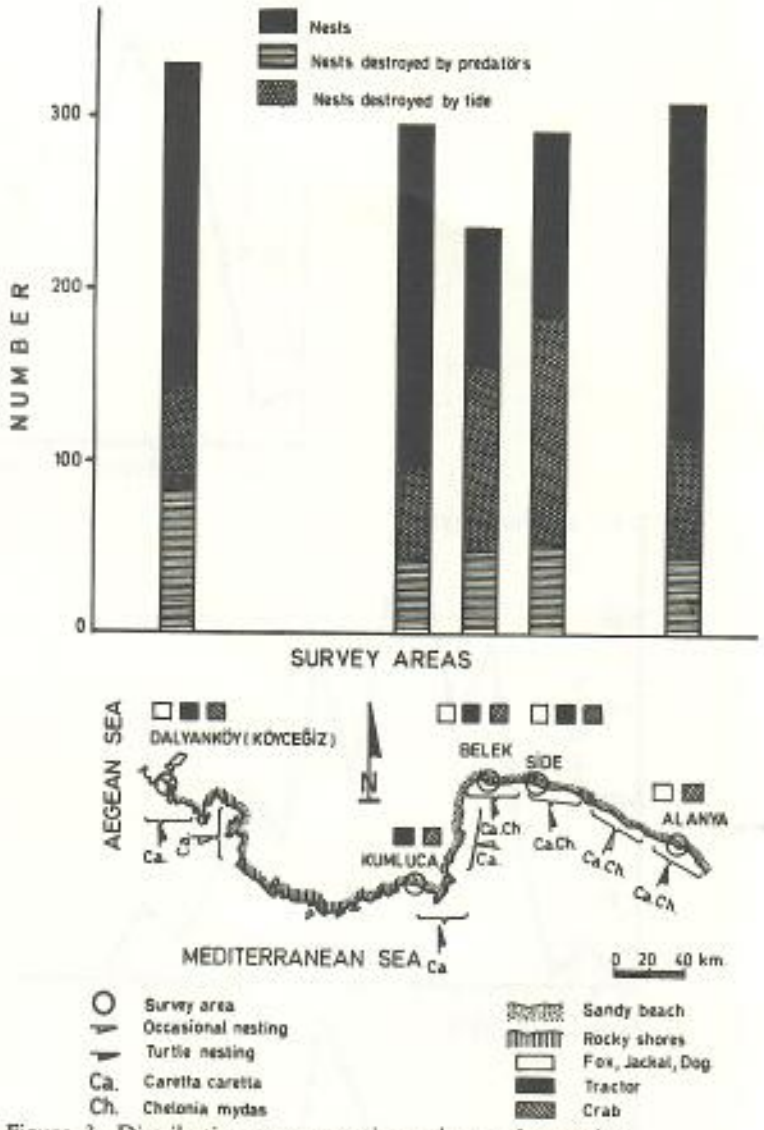

Figure 3. Distribution, nest capacity and nest threatening factors for *Caretta caretta* and *Chelonia mydas* at the research stations.

Other Beaches

Kumluca Beach

Kumluca Beach is located on the inner curve of the Bay of Finike (36°47'N, 28°38'E). It has the characteristic Mediterranean climate and plant cover.

Belek and Side Nigit Beaches

Belek and Side Nigit Beaches extend the length of Antalya Bay (Belek 36°50'N, 30°58'E; Side 36°51'N, 31°28'E) with a Mediterranean climate.

Alanya Beach

Alanya Beach is located in Antalya Bay (36°36'N, 32°05'E) with a Mediterranean climate.

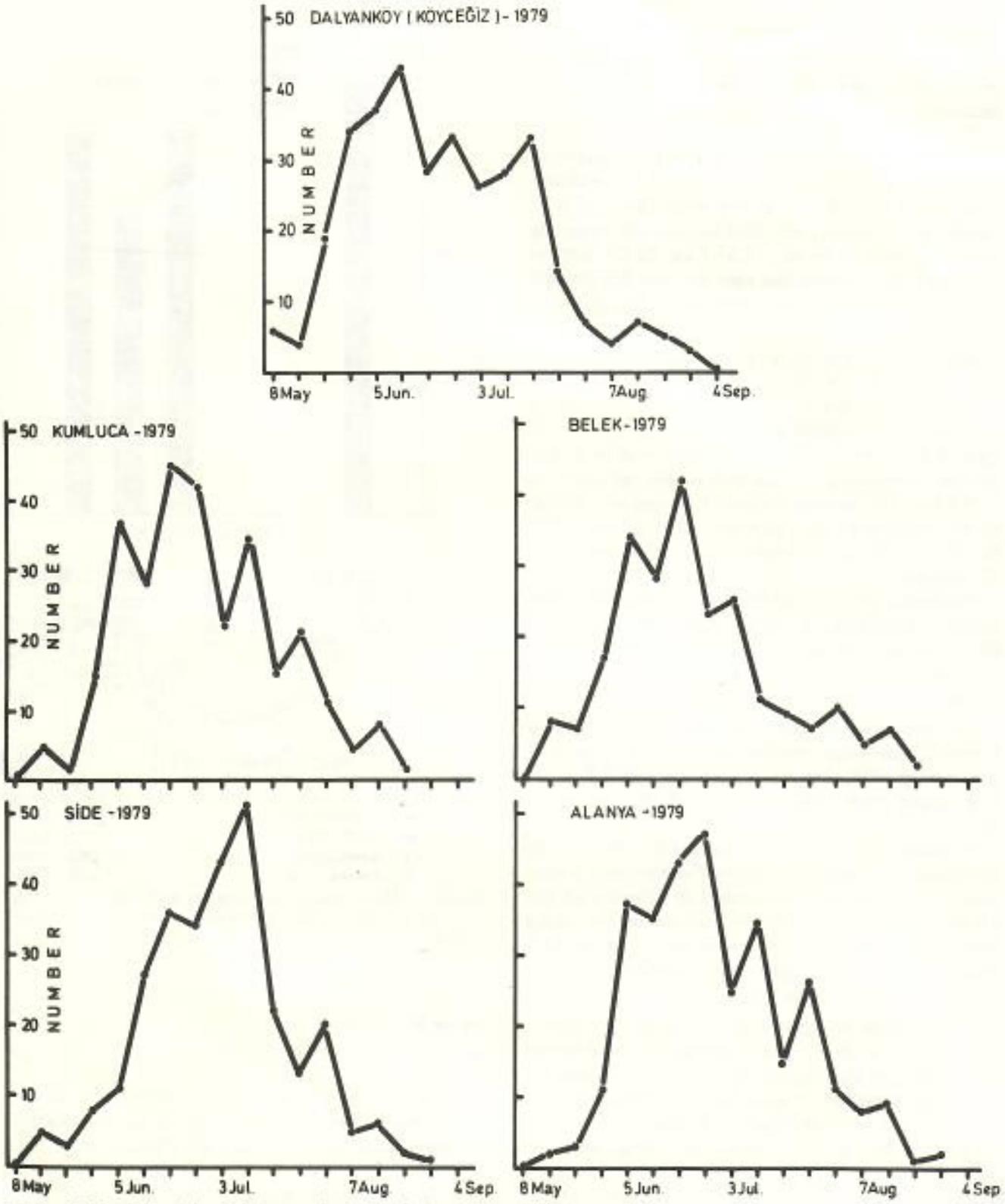

Figure 4. Nesting activity at the research stations during the 1979 egg laying season.

Discussion

Distribution of Caretta caretta and Chelonia mydas

Hildebrant and Hatsel (1937:35) described *C. caretta* as a cold sensitive species, but it reaches more northerly than other Atlantic species (Brongersma 1972). It nests up to 35°N on the eastern North American coast (Coles 1914, ibid.), reaches higher latitudes in Virginia (Carr 1952, ibid.), goes up to 35°N on the Atlantic shores of Morocco (Pasteur and Bons 1960, ibid.) and up to 43°N on the western Mediterranean shores of

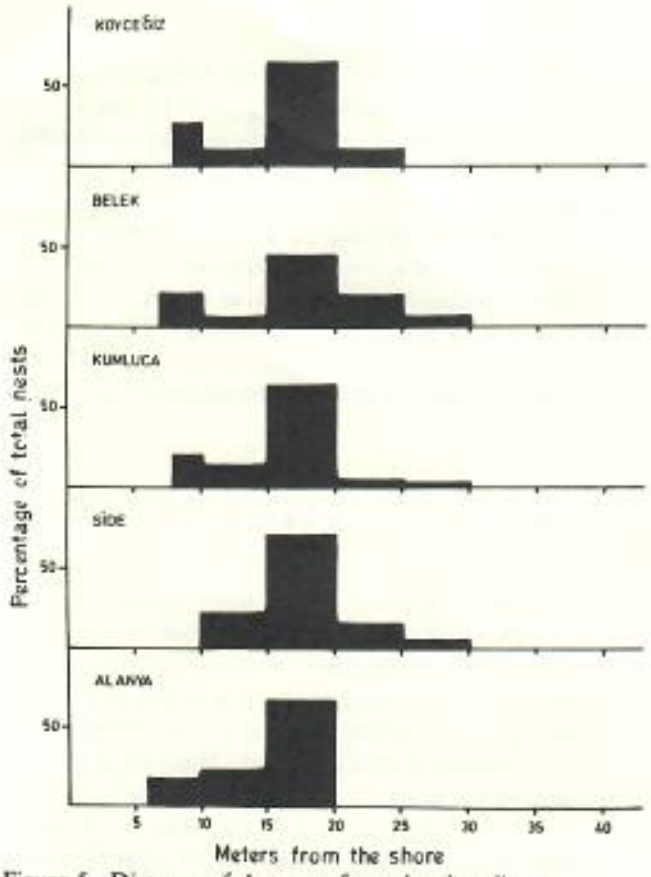

Figure 5. Distance of the nests from the shoreline.

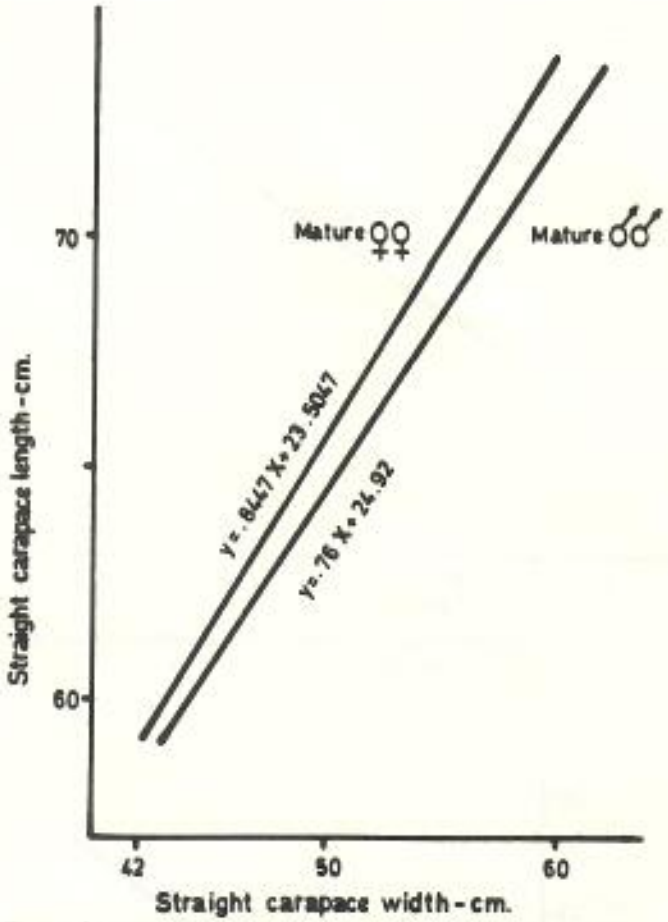

Figure 6. Relationship between straight carapace length and width of *Caretta caretta* subadult males and females.

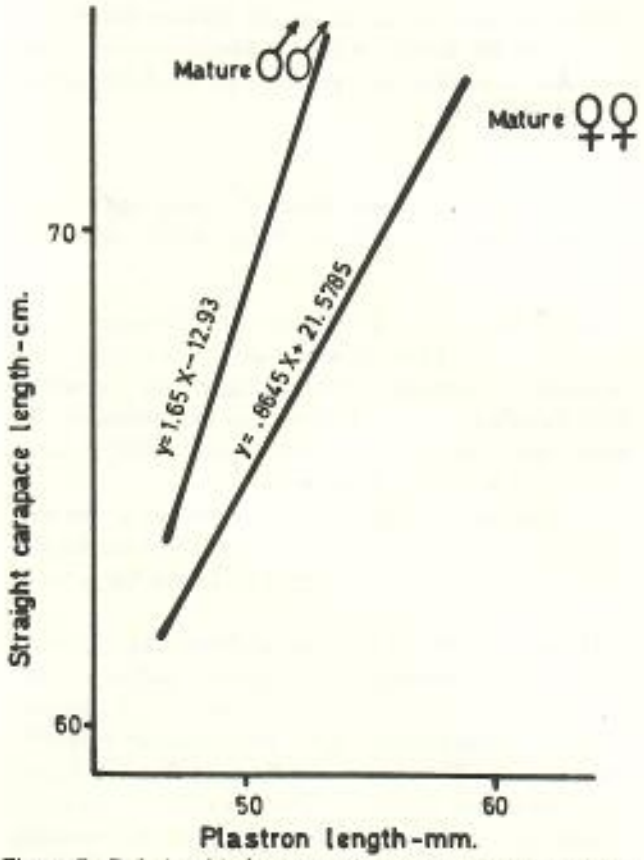

Figure 7. Relationship between plastron length and straight carapace length in *Caretta caretta* subadult males and females.

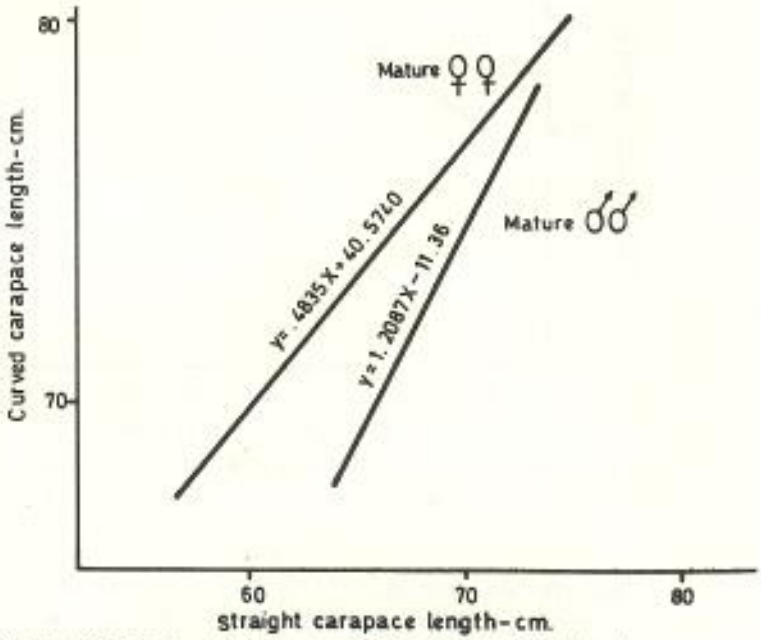

Figure 8. Relationship between straight carapace length and curved carapace length of subadult male and female *Caretta caretta*.

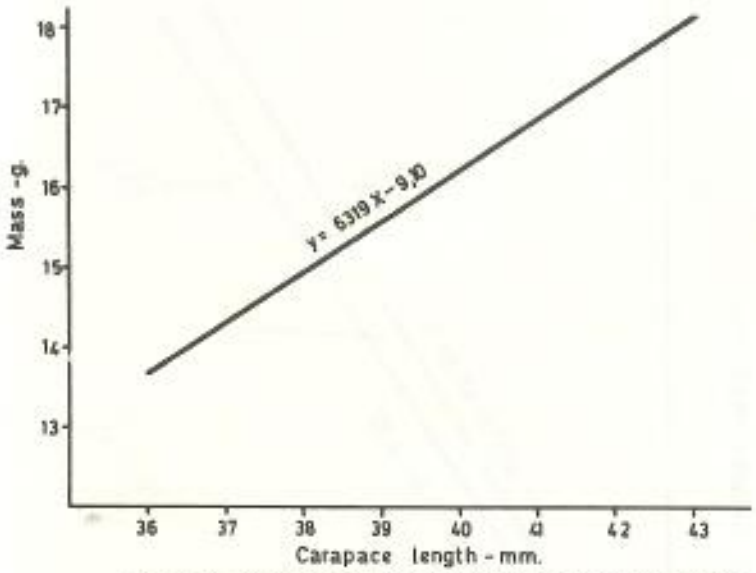

Figure 9. Relationship between carapace length and weight of *Caretta caretta* hatchlings.

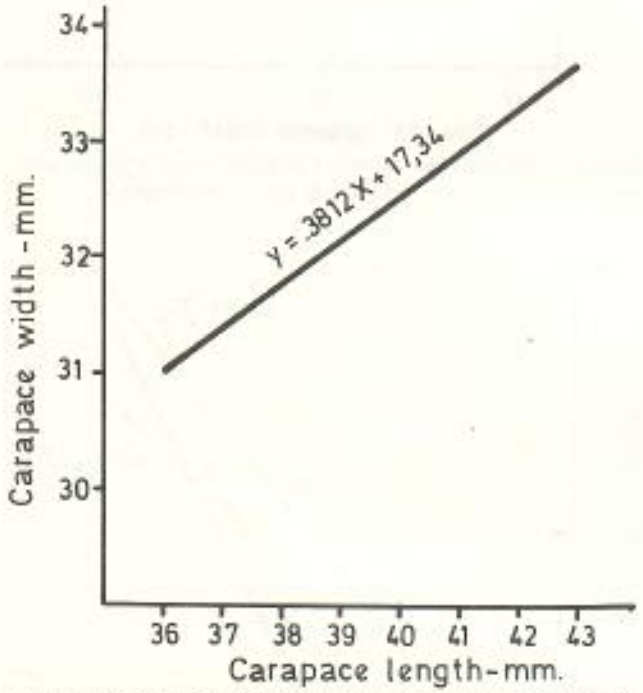

Figure 10. Relationship between carapace length and width of *Caretta caretta* hatchlings.

Italy (Bruno 1969, ibid.). It is also known to nest at 35°N on the Japanese coast (Nishimura 1967, in Hughes 1974).

The Mediterranean coast of Turkey (36°N) presents a major nesting region for *C. caretta*. Loggerheads are observed in the Aegean Sea and even reach the Black Sea (41°N) through the Sea of Marmara. We do not have any information about the animals' passage into the Black Sea.

Brongersma (1972) stated that *C. caretta* in northern and central latitudes were small or half-grown specimens. This interpretation is supported by our observations that all of the animals captured were subadults.

Hughes (1974) reported that distribution of *C. caretta* was bounded by the 25°C summer isotherm. This is verified by nest making on Turkish Mediterranean shores which show a 24–26°C summer isotherm.

Chelonia mydas is found only at Belek, Side, and Alanya. It does not move farther west. This may be due to the warmer temperatures in the east (Alanya, 28°C) as compared to the western waters (Dalyanköy, 25°C).

Hatchling Numbers on the Turkish Mediterranean Coast

The number of *Caretta caretta* nests around the research stations were counted as number of nests per kilometer for the nesting season. The beaches with the highest numbers of nests to the lowest are as follows: Dalyanköy, 47 nests/km; Alanya, 30 nests/km; Kumluca, 29.4 nests/km, and Belek and Side, 10 nests/km. *Chelonia mydas* nests may have been included in the calculations for the beaches of Belek, Side, and Alanya. A mathematical estimate, based on 93 eggs for each nest, puts the total number of eggs at 135,000; 47.0 percent damage leaves 71,550 healthy eggs. We should emphasize that our investigative regions cover only 100 km of the almost 2,000-km Mediterranean coastline. Actual production rate must be much more than our calculations.

Variations in Marginal Shields of Young and Mature Animals, and Linear Relationships in Length

Deraniyagala (1953, in Hughes 1974) separated Atlantic and Indo-Pacific *Caretta caretta* stocks by marginal shield numbers, vertebrae, and their curvation. This classification was believed to be incomplete in later years (Caldwell, Carr, and Ogren 1959; Hughes 1974), but it still remains useful.

Marginal shield counts of 50 hatchlings at the end of the incubation period showed 58.0 percent had an 11-11 distribution, 20 percent 12-12, and the remainder mixed.

Measurements of 15 subadults showed 46.1 percent had an 11-11 distribution, 15.3 percent had 12-12, and the remainder mixed. The 11-11 and 12-12 distribution percentages in hatchlings and subadults resemble one another. The 11-11 distribution shows a higher percentage than the 12-12. These results are markedly different from those of other workers, but the sampling size was too small to permit any definite conclusions.

There were no important correlations found be-

tween lengths of Atlantic loggerheads by Caldwell, Carr, and Ogren (1959) and Gallagher *et al.* (1972). Hughes (1974) showed linear relationships between lengths in the southeast African *C. caretta*.

Statistical analyses on basic measurements taken from subadult *C. caretta* captured on eastern Mediterranean shores suggested the existence of important correlations between some of them.

This situation falls into opposition with the views of Caldwell, Carr, and Ogren (1959) and Gallagher *et al.* (1972). As far as we know from publications, their smallest turtles were longer than our biggest specimens. In other words, they investigated adult animals. Hughes (1974) worked both with mature animals and subadults.

The relationship between curved carapace length and straight carapace length of subadult females and males is shown in Figure 8. As we can see females are more curved than males. Figure 6 shows the relationship between straight carapace length and straight carapace width of subadult males and females. Males are somewhat wider than females and this fact is true in larger size classes also. The relationship between plastron length and straight carapace length is summarized in Figure 8. Males from the same length group have shorter plastron measurements than the females.

There was no correlation found between curved carapace length and width of head and between straight carapace length and head width in subadult males and females.

Summaries of relationships among weights and carapace lengths and widths of 50 *C. caretta* hatchlings are shown in Figure 9 and Figure 10.

The first developmental steps of the young occur with increase in carapace length versus increase in weight. Increase in width of the carapace is slower when compared to the increase in length.

Acknowledgments

We wish to express our deepest gratitude to all the officials on the IUCN/WWF Joint Project Office and all the interested parties for their support of this research in the northern Mediterranean (Turkey). We express our great appreciation to Dr. Archie Carr, Dr. L. D. Brongersma and Dr. N. Mrosovsky for their kind assistance in sending the literature that we had difficulty in securing. Also, we wish to thank our department members, Zehra Ünver, Yilmaz Karacalioglu, Ethem Atalik and Osman Şimşek, for their unending energy and efforts during the preparation of this work.

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Status of Sea Turtle Populations Nesting in Surinam with Notes on Sea Turtles Nesting in Guyana and French Guiana

Four species of sea turtles nest frequently on the Suriname beaches: *Chelonia mydas, Lepidochelys olivacea, Eretmochelys imbricata,* and *Dermochelys coriacea.* The loggerhead, *Caretta caretta*, has been reported nesting only once.

There are 2 main nesting areas. Galibi (Galibi-Baboensanti-Eilanti) is located at the mouth of the Marowijne River. It is a nature reserve. At Matapica and Krofajapasi (formerly called Wia-Wia or Bigisanti when it was situated in the Wia-Wia Nature Reserve), nests are protected by special decree. A few small beaches are situated between Matapica and the mouth of the Surinam River.

For a detailed description of the beaches, see Schulz (1975). The most characteristic feature of the nesting beaches is the continuous alteration of the shoreline and the westward movement (± 1.5 km/yr) of the Wia-Wia beach.

Surinam Populations

The Green Turtle, Chelonia mydas

There is no explanation for the considerable fluctuations recorded in the yearly number of green turtle nests.

Population size is based on an estimated average of 3 nests laid per female during a nesting season (Schulz 1975, pp. 71–73) and an average interbreeding period of 2.3 years (Schulz 1975, pp. 62–68). It is estimated that in the period 1976–79 roughly 5,000 females made up the female population of green turtles nesting in Surinam. The population feeds off the coast of the states of Maranhão (?), Piauí, Ceará, Rio Grande do Norte, Paraiba, Pernambuco and Alagoãs in Brazil (Schulz 1975, pp. 104–10; unpublished data, Schulz and Reichart).

Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Number of nests	±5,000	2,495	3,115	5,755	6,885	6,600	7,465	3,610	8,080	4,955	8,465	4,330

The Olive Ridley, Lepidochelys olivacea

The startling decline in numbers of nesting olive ridleys is probably caused by the numbers of turtles that are caught in the nets of the shrimp trawlers that operate off the coasts of Surinam, French Guiana and Venezuela.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Number of nests	2,875	3,290	1,665	1,750	1,595	1,270	890	1,080	1,070	1,160	1,030	870	795

For a discussion of the dispersion of the population between breeding periods, see Schulz (1975, pp. 111–14).

The ridley population nesting in Surinam, estimated at 2,100 to 3,000 females in 1967–68, has dropped to an estimated 550 to 800 in the last 2 years. Estimates are based on the assumption of an average of between 1.4 and 2 nests/female/season and an interbreeding period of 1.4 years (Schulz 1975, p. 87).

The Leatherback Turtle, Dermochelys coriacea

The rise in the number of leatherbacks nesting in Surinam is probably largely caused by the turtles shifting from the deteriorating French Guiana beach at the mouth of the Marowijne River to the Surinam beaches.

Year	1964	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Number of nests	95	90	200	305	255	285	380	900	785	1,625	670	5,565	2,160	3,900

As little data are available on the number of nests a female lays during one season and on the length of the interbreeding period, an estimate of the population size seems very risky.

Protection in Surinam

Laws give total protection to all marine turtles plus nests in Galibi Sanctuary and on the Matapica-Krofajapasi beaches. The latter have been protected by special decree since the beaches moved outside the borders of Wia-Wia Nature Reserve.

The collecting of eggs is allowed on the small beach west of Matapica. An annual quota of approximately 300,000 to 400,000 green turtle eggs is allowed to be taken from Galibi beaches. These eggs are sold on the local market thorugh STINASU.

From 1968 to 1978, some 300,000 eggs have been sold to the Cayman Turtle Farm. Since 1978, approximately 12,000 eggs/yr have gone to the Surinam Turtle Farm run by STINASU.

Guyana

The only published information is in Pritchard (1969). Based on his observations in 1964–65, he concluded that "Shell Beach seems to be a site of considerable ridley nesting activity." He found hawksbill turtles and green turtles nesting in fair numbers on Shell Beach. Nesting of green turtles also occurred on some less important beaches east of Shell Beach.

In 1976, I was informed in Georgetown, Guyana, that turtle slaughtering continued unabated on Shell Beach and other sites, which corroborates Pritchard's comment that "parties . . . on the beach were slaughtering virtually every turtle that nested."

In June 1976 I flew over all the nesting beaches (except Punta Plaia on the border with Venezuela) without seeing a single turtle track. I fear that decades of unrestricted slaughtering of turtles has resulted in the extirpation of the Guyanese nesting populations. This predicates the desirability to do a survey of the Guyana beaches.

French Guiana

The nesting beach in western French Guiana, called Organabo Beach when it was situated near the mouth of Organabo Creek in the 1960s, is by far the world's most important nesting ground of the leatherback, and the population nesting in French Guiana the world's largest. In the 1970s the beach had moved so far westward that the western boundary reached the confluence of the Marowijne and the Mana rivers. By 1979 this beach had virtually disappeared, leaving only a sandspit, washed over by high tides.

The only suitable nesting ground remaining is the approximately 1.5-km-long stretch of sand at the junction of the mouths of the Marowijne and Mana rivers (Les Hattes-Aouarra). Nests are so crowded that a considerable number are destroyed by later arriving females. Moreover, every night spectators drive their cars onto the beach and create massive disturbances among the nesting turtles.

Based on 3 counts during the 1978 and 1979 seasons

(May to July), I estimated, very roughly, that between 10,000 and 15,000 nests are laid between Aouarra and les Hattes during a season. Fretey, who did extensive tagging in 1978–79, certainly has more precise data. Pritchard (1969) estimated that during a "good mid-season night" 300 leatherbacks nested on the beach that still existed at that time. During any night in July he ". . . would tag well over 100 leatherbacks on a single walk to the end of the beach and back."

Where did all these turtles go? The increase of leatherbacks nesting on the Surinam beaches does not account for the decrease in the number of nests in French Guiana.

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The Cultural Context of Sea Turtle Subsistence Hunting in the Caribbean and Problems Caused by Commercial Exploitation

Changing Patterns

In the Caribbean, the diverse cultural patterns that once linked many indigenous coastal and island societies to sea turtles are mostly gone now, having declined with the demise of the turtles and with the catastrophic loss of human population that occurred after the coming of the Europeans. The varied indigenous patterns of local subsistence use of sea turtles were replaced largely with intensive methods introduced and organized principally by the English and other north Europeans to feed their mariners, colonists, and slaves, and later to supply an export commodity for markets abroad. Yet in spite of almost five centuries of intensive pressure on sea turtles and indigenous peoples, vestiges and amalgams of former patterns persist. Here and there, in isolated backwaters, in corners of the Caribbean too far or too poor or too formidable to attract large-scale foreign colonization, indigenous societies survived as did reduced populations of the formerly abundant green turtles. These patterns, among the last of their kind, are now changing due to internal and external pressures and constraints.

In the big and small islands of the Caribbean, where so much was lost long ago but where also some of the old and introduced cultural traits and lifeways have been maintained in peasant fishing-communities, highly specialized livelihoods are threatened by marine resource depletion and demographic and economic change.

And on the horizon, pressures build for another pattern of change; this one guided by the desire to protect and conserve vanishing species. But what will happen to the indigenous peoples whose cultures are adapted in part to those animals? And what of the peasant peoples whose fishing skills have long provided a measure of economic and social independence and an important means of subsistence? What do these peoples stand to lose if sea turtles are lost through intensive exploitation or if they are protected by prohibitive legislation?

Ecological and Cultural Transformations

The intrusion and spread of European colonization in the Caribbean area meant rapid and widespread changes in biota and environments, the displacement and loss of native peoples and cultures, and the introduction of new peoples, lifeways and approaches to resource use. The decline of native societies in the West Indies was quick and final. Disease, slavery, loss of food supply, and cultural dislocation reduced populations estimated to have numbered several million to a few hundred surviving Amerindians on Dominica and St. Vincent by the end of the 1600s. Along with much of the native island fauna, green turtle populations were severely reduced.

The Island Arawaks and Caribs were skilled in obtaining resources from their marine environment, including sea turtles (Breton 1665; Dutertre 1667, II; Labat 1742, I; Price 1962). Unlike the Island Arawak, the Island Carib were never enslaved on a large scale and resisted European intrusions. They survived for a longer period than did the Island Arawak and "the prolonged and intimate interaction between these Island Carib fishermen and the French settlers played a major role in shaping future local fishing habits" (Price 1962:1370). In the Lesser Antilles French traders introduced large-meshed turtle nets and metal harpoon points to the Island Carib—as did the English in other parts of the Caribbean—and later these materials were sold and traded to African fishing slaves and to communities of freed and runaway slaves (Moreau de Saint-Méry 1797:873; Price 1962:1374, 1376). On the edge of the plantation system, a distinct and continuing fishing subculture evolved based first on African slaves, who provided food for the plantation staff and guests. Although some slaves from the Gold and Ivory Coasts may already have been experienced fishermen, "most slaves clearly learned to fish in their new home, and the techniques they practiced indicate that both the French and the Island Caribs served as teachers" (Price 1962:1371). These people and freed and runaway slaves served as the nucleus around which developed the unique and self-perpetuating fishing subculture in many parts of the Caribbean. "It should be clear that an early synthesis of Island Carib, French and Negro techniques, completed by the mid-eighteenth century, appears almost totally unchanged in fishing villages throughout the islands today" (Price 1962: 1376–77).

Thus, even though populations of Caribbean Amerindians were lost, much of their fishing technology and knowledge was maintained within the economic and later emerging cultural amalgam of African and European influences. The independent and distinctive means of livelihood in West Indian fishing communities are based in large measure on the persistence of Amerindian fishing knowledge and technology and continuing access to marine resources. Although I know of no West Indian society or community that is heavily dependent on sea turtles for subsistence or livelihood—other than the Cayman Islanders, on many islands these animals do contribute a significant source of food and small but important amounts of money.

Uninhabited at the time of European discovery, the Cayman Islands later became an important turtling ground. As the early settlers' dependency on turtles and the sea grew, socioeconomic patterns developed which relied heavily on the commercial and subsistence exploitation of green and hawksbill turtles. After 200 years of intensive turtling in local and foreign waters, large-scale exploitation came to an end when the Nicaraguan government closed the turtle grounds to the Cayman Islanders in the 1960s and markets were lost in the United States and Europe as the result of national and international legislation (Hirst 1910; Lewis 1940; Carr 1956; Parsons 1962; Nietschmann 1979b).

On the mainland margins of the Caribbean, several indigenous societies are culturally and nutritionally dependent upon green turtles whose survival has been threatened by commercial overexploitation.

Types and Scale of Exploitation

As a result of antecedent and introduced cultural and

Table 1. Types of sea turtle exploitation

Subsistence	
1.	exploitation, exchange and consumption are socially and nutritionally important and part of an indigenous culture complex
2.	exploitation and consumption primarily by individual households in peasant fishing communities
3.	opportunistic catches by subsistence fishermen
4.	exchange and socially-based sale of meat within communities provide meat and small sums of money
Market	
5.	sale of live turtles, meat and eggs to regional markets
6.	sale of live turtles to packing companies for export
7.	sale of turtle products (calipee, shell, skins, oil) for export
8.	opportunistic catches (primarily of hawksbill) by lobster divers and fishermen for market sale
Incidental	
9.	incidental catches by shrimp trawlers

economic systems, there exists in the Caribbean region a variety of contexts within which sea turtles have been and are being exploited.

In general, exploitation of sea turtles for subsistence is less of a threat to sea turtle survival than is market exploitation. Subsistence-related activities are dependent on the size of local human populations, their degree of reliance on the animals, and the society's cultural needs and exploitation controls. Exploitation for market, both regional and export, is much more open-ended, dependent on large, external populations with the power to purchase more than can be obtained; hence, the drain on sea turtles that provide meat and luxury by-products would rapidly escalate without legislative controls.

The Cultural Context of Turtling and Turtles

Among the traditional indigenous peoples who still make their own living rather than earning it and who still rely on turtling and turtles for part of their subsistence, the procurement, distribution and consumption of green turtles remain important to their culture. More than any other Amerindian society, the coastal Miskito Indians of Nicaragua and Honduras are culturally dependent on green turtles, as will be seen in the following material. Although other coastal Amerindians are less reliant upon sea turtles, the cultural and social context of resource acquisition and distribution are generally similar in structure and content.

Subsistence provisioning involves production for immediate use, distribution within a discrete social unit and area, and consumption by the producers and their dependents. In subsistence, resource exploitation is organized and internally regulated within kin-based networks to satisfy biological and cultural needs.

Turtling is more than a means to get meat, turtles are more than simply a source of meat, and turtle meat is more than just another meat. For several surviving coastal Caribbean Amerindian societies, turtling and turtles are part of a way of life, not merely a means of livelihood. The activity and the product are not elements that can be simply lost or substituted without consequent deep change in cultural patterns.

Turtling is part of a cultural complex that links people, society, environment, and biota. Rooted in cultural history and followed for generations, it is one of the principal means through which knowledge of the sea and marine life is passed on, technological patterns are maintained, and sea and resource procurement skills are socially rewarded. For many males it is an important if not a major activity and it supplies significant often substantial amounts of protein.

Chelonia mydas is the most important sea turtle exploited for meat by Amerindian peoples. Green turtle meat constitutes a significant source of protein and item for social exchange. In coastal Miskito villages subsistence turtling supplied up to 70 percent of animal protein in the diet prior to intensive commercial exploitation (Nietschmann 1973). Among these people turtle meat transcends all other food in esteem and social significance.

Miskito society is structured by kinship relationships and all subsistence activities have a social context. Individuals are obliged to freely share subsistence resources, especially if it is turtle meat. Socially based exchanges of resources between kin honor consanguineal and affinal relationships, spread meat distribution through the community, and insure that differential procurement is evened out so that many households share the results of an individual's skills. The giving of meat is as important as its receipt. Without these exchanges, social relationships and the quality of diet in the communities would decline.

But turtle meat also has a symbolic as well as social and nutritional value. Between the sea and the table turtle meat moves along a chain of cultural levels where each transformation increases its symbolic value. Males obtain and butcher the turtles, whose meat is distributed by women to kin and friends. As the meat moves from animals to hunter, from males to females, from individuals to kin and to the larger society, it is increasingly imbued with symbolic significance. In the end, the item is no longer simply meat but a cumulative symbolic record of relationships between nature and people, men and women, and the individual and society.

Thus, turtling and turtle meat are for the Miskito a means by which part of the structure and organization of society is maintained and their place in their world is defined.

Surviving Traditional Societies and Turtles

Because of the worldwide demise of green turtles[1] and traditional turtling societies, few situations remain where native peoples depend on *Chelonia*. In recent and contemporary times, the most important traditional turtling people have been the Seri in Mexico, the Marshall Islanders in Micronesia, the Torres Strait Islanders in Australia, the Andaman, Nicobar and Maldive Islanders of the Indian Ocean, the Vezo and Sakalava of Madagascar, the Bajuni of Kenya and Somalia, and the Miskito of Nicaragua and Honduras.

In the Caribbean, the Miskito are the foremost Amerindian turtling society. Other native groups that still exploit turtles are the Rama of Nicaragua (Nietschmann and Nietschmann 1974); Guaymí (Gordon 1969)

1. A survey of subsistence hunting of sea turtles is beyond the range of this short paper and my personal field experience. I thank Bill Rainey for sharing this information on sea turtle distributions and exploitation in the Caribbean.

Table 2. International recoveries of tags placed on nesting green turtles at Tortuguero and Aves Island

From turtles tagged at Tortuguero, 1956–76			*From turtles tagged at Aves Island, 1971–76*		
Place	*Number*	*Percentage*	*Place*	*Number*	*Percentage*
Nicaragua	957	86.2	Lesser Antilles	5	50
Colombia	45	4.1	Dominican Republic	2	20
Panama	28	2.5	Mexico	1	10
Mexico	28	2.5	Nicaragua	1	10
Venezuela	24	2.1	Venezuela	1	10
Cuba	13	1.2		10	
All others	15	1.4			
	1,110				

Source: Carr, Carr, and Meylan 1978:9

and San Blas Cuna (Stier 1976:45–46) of Panama; some Guajiro in Colombia (Kaufmann 1971:76; Rebel 1974:136); Maya along the northeastern coast of Yucatán; and Black Carib (Garifuna) in the Honduras coast-Bay Island area.

Many other peoples elsewhere in the Caribbean also exploit turtles for subsistence and small-scale market sales: for example, the Cayman Islanders; Creoles in Bluefields, San Juan del Norte (Greytown), Limón, Bocas del Toro area and Colón; Colombians in the Golfo de Urabá and waters off Cartagena, Barranquilla and Ríohacha; Venezuelans in the Golfo de Venezuela and off the Los Roques Islands and on Aves Island;[2] various groups throughout the Lesser Antilles; American and British Virgin Islanders; Dominicans in the Cabo Samaná and Puerto Plata areas; Cubans along the southern coast; Jamaicans, especially off the Morant and Pedro Cays; and people from San Andrés and Providence Islands who journey to Serrana Bank, Roncador Cay, and the Albuquerque Cays.

Hawksbills have scattered distributions yet are heavily exploited for their valuable shell. Hawksbill meat is also eaten by some peoples. Areas where hawksbill exploitation is heavy include the Gulf of Honduras (Cabo de Tres Puntas); Bay Islands; Miskito and Set Net Cays, Corn Islands and Cocal Beach in Nicaragua; Almirante Bay, Chiriquí Beach, and San Blas Islands in Panama; Roncador Cay and Serrana Bank in Colombian waters; Los Roques Islands in Venezuela; Huevos Island off Trinidad; the British Virgin Islands; Isla Mona off Puerto Rico; the Pedro Cays; and Cayman Brac, BWI.

The areas where green turtles are most heavily exploited in the Caribbean can be located by using the tag return data compiled by Archie Carr and Bill Rainey (Table 2).

2. Aves Island is the major nesting beach for green turtles in the eastern Caribbean. In 1978 the Venezuelan government established a military outpost there.

The overwhelming number of tags returned from Nicaraguan waters reflects the localized concentration of green turtles and highly focused exploitation for subsistence and market by the Miskito Indians. All other relationships between a native society and sea turtles in the Caribbean fade when compared with the Miskito's dependence on green turtles and the scale of subsistence and recent commercial exploitation.

The Cultural Impact of Commercialized Turtling on the Miskito and Nicaraguan Green Turtle Population

In 1969, on the heels of Nicaragua's failure to accept the Conferencia Tripartita agreement with Costa Rica and Panama for a three-year moratorium on green turtle exploitation, the first of three turtle processing companies began purchasing and exporting turtle meat and calipee. The Miskito had long been involved in a series of export market resource exploitation cycles (rubber, lumber, gold, bananas), each one of which made them increasingly dependent upon purchased goods and wage labor. Economic conditions were depressed in Miskito communities when the turtle companies started up.

The Miskito were the world's best turtle hunters, and the last large green turtle population in the western Caribbean inhabited the nearby shallow waters off eastern Nicaragua. The new companies provided a year-round connective link between local supply and distant demand. The Miskito started to sell large numbers of green turtles to the companies that exported the meat, oil, and calipee to foreign countries. Whereas they were once the central focus of the Miskito's subsistence system, green turtles now became the primary means to secure money to purchase, and the only surviving green turtle refuge came under severe exploitation pressure. From 1969 through 1976, up to 10,000 green turtles were exported every year. Already depleted by Cayman Island turtlers on the feeding ground at Miskito Bank and by Costa Ricans on the nesting beach at Tortuguero, the most

significant West Caribbean green turtle population was subjected to a sudden and intensive rise in human predation. The resulting reduction of the population soon became evident. The average amount of time it took to capture one turtle went up from two man-days in 1971 to six man-days in 1975. Even though hunting was less efficient, more turtles were taken from the depleted herds because more Miskito were hunting and were doing so almost year-round. Furthermore, tags placed on nesting turtles at Tortuguero to study migration and life cycle patterns began to be returned from Nicaraguan waters in unprecedented numbers, indicating a massive upward change in the scale of exploitation (Nietschmann 1979a:8–9).

For the Miskito the commercialization of turtling was different from previous economic booms in that it threatened the internal core of their subsistence and associated social relationships. Economic entanglement led to social quicksand as they became overly dependent on intensive exploitation for sale, rather than their former moderate exploitation for provisioning and social exchanges. Miskito society became as threatened as the species they hunted and netted for market sales. Decline of the turtle populations created the need to further intensify and both resource decline and intensification of turtling led to shortages of meat and agricultural foods and to social conflicts in Miskito communities.

The turtle companies extended credit and advanced foodstuffs to the Miskito so that they could stay on the turtle grounds for long periods, year-round rather than their normal pattern of short, seasonal trips. Simply to pay off the credit extended by the companies and to purchase food for families to live on while the turtlemen were away from the villages meant intensive exploitation. Labor had to be further diverted from subsistence activities to commercial turtling as the resource declined. The quality and variety of the diet fell as money obtained from the export of protein was used to purchase imported white flour, rice, beans and sugar that replaced traditional foods. As the resource further dwindled, and as labor was further overextended, sufficient yields could be maintained only by diverting turtles from subsistence consumption and social distribution to market sale. By 1972, the downward spiraling pattern of market exploitation had already passed the economic threshold where money earned from turtling could not buy the equivalent amount of food formerly produced in subsistence. During a year period between 1972–73, 913 turtles were obtained by Little Sandy Bay Miskito. Of these, 743 (81 percent) were sold to the companies and only 170 consumed in the village (Weiss 1977). By 1975, the resource and subsistence drain hit social rockbottom. Rather than incur the wrath of disgruntled kin by returning to the villages with only a turtle or two, many turtlemen preferred to sell all to the companies as there were no social pressures to distribute money. Social relationships became strained, turtlemen and their families were accused of selfish interests and denial of Miskito traditions, and members of the many households which were without turtlemen became nutritionally impoverished and felt socially abandoned.

In traditional subsistence, the risk of failure was ameliorated by access to a wide range of plants and animals and by generalized sharing of the yields between kin. Differential procurement was common but differential receipt was rare. As the Miskito became further involved in market activities by channeling more and more labor to acquire the culturally most important item to sell, economic risk was added to subsistence risk and magnified through the individualization of production efforts. Where all households once operated within a social network that saved them from a possible economic mistake or plain bad luck, some individual households began to have to secure resources, income, and food and run the risk of possible economic shortfall.

As the economy became increasingly monetized, a few households in every village became financially better off than the majority. Alterations in the focus of production and the individualization of production created economic differences between individuals and households. In order to secure a surplus to sell rather than to share, labor and materials that once helped support the less able, the elderly, widows, widowers, the sick, and the injured were diverted to market.

Until the Miskito began to sell a subsistence resource, they were able to keep distinct the two economic systems: one based on generosity and sharing between kin without expectation of return, and the other based on individual receipt of goods and materials with no expectation to share. But when labor and materials that were once exchanged between kin were channeled into market sales, social devaluation resulted. To sell a subsistence resource is a social contradiction. If a household produces food, it is obliged to share; if it purchases food, its members are under no such social obligation; if they sell what should be shared, they bring into conflict the opposing rules in the two economic systems (Nietschmann 1979a:12–13).

Between 1969 and 1977 intensive commercial turtle exploitation for export markets began to erode the ecological and social heart of Miskito subsistence and culture. Many other factors also contributed: increasing inflation in the price of purchased goods, depletion of other resources, wage labor migration from villages, and the younger Miskito's increasing dissatisfaction with the nonmaterial rewards of a subsistence-based way of life. In many other areas of the Caribbean migration, inflation, and changing lifestyles are reducing the at-

tractiveness of turtling whether for subsistence or for small-scale market sales.

National and international conservation led to the closing of many foreign markets that trafficked in endangered and threatened species. The 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and U.S. endangered species legislation (1973) were the two most important of many conservation measures enacted that included the protection of sea turtles. In addition, the West Caribbean population of green turtles received a reprieve from impending disaster when the Tortuguero nesting beach was declared a National Park by the Costa Rican government in 1975, and when the Nicaraguan government closed the turtle companies in early 1977 (the Miskito were permitted to continue subsistence turtling).

The loss of the market for green turtles created economic stress in Miskito communities but the decline of the resource would have led to the same result. Their response was to expand once again subsistence agriculture and hunting and fishing which had an immediate benefit in 1978 when the shipment and distribution of food supplies and goods to the east coast were interrupted by the Nicaraguan Revolution. The Miskito still have sufficient land and a relatively rich resource base and stock of green turtles which will provide for both subsistence and social well-being. Yet because of long exposure to outside goods and markets they will continue to feel economically deprived.

The new Nicaraguan government has major problems of economic and social reconstruction in ravaged western Nicaragua. When the government turns its attention to eastern Nicaragua, they may find that some of the social and ecological wounds caused from bleeding resources away from local societies have already begun to heal. May they be sensitive and wise.

If the Tortuguero nesting beach continues to be protected as a National Park and if the Nicaraguan green turtle population and those of other countries can be protected from commercial exploitation, I see no reason why subsistence turtling by local peoples should not continue, especially by Amerindian peoples such as the Miskito, Rama, Guaymí, and San Blas Cuna.

Elsewhere in the Caribbean, curtailment of market exploitation of sea turtles might cause economic hardship but I know of no island or mainland society whose culture is dependent on tortoiseshell; turtle calipee, meat, eggs, oil, skin; or stuffed turtle curios and shellacked carapaces.

Effective management and restocking of Caribbean sea turtle populations can be achieved by national and international programs to protect nesting beaches and marine habitats, and to prohibit commercial exploitation, export and import of sea turtle products (meat, eggs, oil, calipee, leather, shell, and curios). Just as Miskito society was not saved by selling a subsistence resource, endangered and threatened species cannot be saved by selling them.

There is a possibility that the Nicaraguan government will establish a marine reserve or park in the Miskito Cays area. This zone contains some of the best seagrass and reef habitat and largest number of green turtles to be found anywhere in the Caribbean. Hawksbills may still be fairly abundant. If within a large enough area both sea turtles and the marine habitat were to be protected from disturbance by turtlers, fishermen, lobster divers, and shrimp trawlers then these species would have an optimum chance for increasing their populations. The Miskito Cays-Miskito Bank region is large enough so that subsistence turtling could still be done in areas well outside a designated reserve.

The exploitation of sea turtles for subsistence by Caribbean mainland and island peoples often provides an important source of meat in local diets subject to nutritional decline caused by high-priced purchased foods. Furthermore, the cultural context of turtling and turtle meat in Amerindian societies must not be threatened by market exploitation or by overly prohibitive legislation. If Caribbean peoples once more have use of sea turtle populations, then management and conservation efforts will be well rewarded.

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A Historical Review of the Status of Sea Turtle Populations in the Western Gulf of Mexico

ABSTRACT

All species of sea turtles in the western Gulf of Mexico have declined in abundance in every state from Louisiana to Yucatan with the possible exception of the leatherback, *Dermochelys coriacea*, because of an intense exploitation by man of the eggs, subadults and adult turtles.

The major feeding grounds of the Kemp's ridley, *Lepidochelys olivacea*, are identified as the crustacean-rich grounds of Louisiana and the Tabasco-Campeche area of the southern Gulf. Thus, both the feeding grounds and the nesting grounds are in the western Gulf of Mexico.

The historical decline of the green turtle (*Chelonia mydas*) fishery in Texas is partially charted. At its peak it was in excess of 230,000 kg/yr, but it was virtually nothing when the catch of turtles was outlawed in 1963. Evidence was presented that climatic conditions as well as overfishing played a role in this decline.

The small population of loggerhead turtles, *Caretta caretta*, in the waters of Texas is being further depleted by incidental catch in shrimp trawls.

The state of Tamaulipas is not an important feeding grounds for turtles, but it has extremely important nesting grounds for the Kemp's ridley and, in the past, for other species as well.

The state of Campeche has the greatest landings of any state in the western Gulf, but the catch of all 5 species has been declining for more than a decade.

Introduction

The data base for this survey leaves much to be desired. In Texas, the turtle fishery began about the middle of the last century, and by 1900 the catch had declined to insignificance. In other words, one is left with the chore of writing the obituary of a fishery which disappeared before any scientific gathering of data was attempted. In Louisiana, on the other hand, an organized fishery never existed. However, an unknown but

sizeable number of turtles became a delectable part of the shrimpers' diet while at sea. Again this type of exploitation by excellent Cajun cooks leaves few records. On the Mexican Gulf Coast until the middle of this century, turtles were regularly taken in a subsistence fishery and very few were sold outside the local village. Turtle statistics gathered from tax records are available from 1948 to the present; however, there is no breakdown by species. Since 1966 data have accumulated from a good scientific program developed by the Mexican fisheries department. René Márquez has contributed greatly to these investigations.

Laud or Leatherback Turtle, *Dermochelys coriacea*

Information on the leatherback is very sparse in the western Gulf of Mexico. It is occasionally taken by shrimp boats in offshore waters, but the numbers are so small that this mortality is not significant. Furthermore there seem to be no data that can be used to assess changes in abundance of the leatherback over the years.

Leary (1957) observed on 17 December 1956 an estimated 100 leatherbacks, ranging in length from 1 to 2 m, along a 50 km line extending north from Port Aransas, Texas. The turtles were apparently feeding on the dense aggregations of cabbage head jellyfish, *Stomolophus meleagris*. This jellyfish is carried out of the bays by the strong currents produced by the northers. This concentration of feeding leatherbacks so near the beach is unusual, but undoubtedly they were attracted by these jellyfish concentrations which occur each year with the onset of winter. After the cold wave of 31 January to 2 February 1951 I observed 2 dead leatherbacks 1.2 to 1.5 m in length, adrift in the channel at Port Aransas. The potential for heavy mortality in winter schools of leatherbacks is certainly present, but no records of such a catastrophe have been unearthed in interviews or in the literature.

The leatherback is certainly widely distributed in Mexican waters, but only in Tabasco (Márquez 1976) have small concentrations been reported. These aggregations are found particularly off Barra de San Pedro from August to November.

Nesting records are rare. Hildebrand (1963) reported the leatherback nesting at Little Shell on Padre Island. One report was based on the record of a taxidermist who had mounted one in 1928. It was turned on the beach, and he still had an egg preserved in a mason jar in his shop from this turtle. The other authority for nesting leatherbacks was Lewis Rawalt, an Audubon warden and a recognized authority on Padre Island. He had observed the species nesting in the mid-1930s, and he had taken a picture of 1 occurrence. I have no records of leatherbacks nesting on Padre Island during the last 40 years.

The nesting of the leatherback along the east coast of Mexico is based on informed individuals. The species has nested in the past at Rancho Nuevo, Tamaulipas according to residents of this rancherria. A few times in the past, they had rendered a leatherback for oil. A leatherback will yeild up to 30 liters of oil according to my informant, and it is reputed to have medicinal value particularly for skin and lung disorders. Fishermen at Anton Lizardo, Veracruz have told me that the species occasionally nests on a nearby island. The turtle is not common there, but when it is encountered it is killed for its meat and oil. I observed the head and entrails of a leatherback that had been butchered near Veracruz on 24 February 1980. Carranza (1959) states that the leatherback is used for shark bait in Yucatan and that it also nests on Alacranes Reef.

Carey or Hawksbill Turtle, *Eretmochelys imbricata*

According to the available information the hawksbill is the rarest marine turtle in the Gulf. However, despite the gathering of eggs and the capturing of turtles at all sizes for the curio trade, a small population has persisted at Veracruz during the 25 years that I have known the area. According to Veracruz fishermen, the species nests from Isla Lobos to Anton Lizardo. They also state that the species prefers to nest on stormy nights. Perhaps this explains its persistence at Veracruz. Although the species is not readily taken with ordinary commercial gear, it is easily captured by skin divers. According to Carranza (1959) and Fuentes (1967) the species is taken in small numbers in both Campeche and Yucatan, but its greatest abundance is in Quintana Roo on the Caribbean coast of the peninsula, a region outside my purview.

There are few records of the hawksbill from Texas. Most specimens I have seen are small individuals (in their first year of life) that wash up on the beach in a moribund condition. Some of these have survived when cared for in aquaria. In 25 years of observations on the Texas coast I have seen only 2 hawksbill which were captured in a healthy condition. One was caught along the jetty at Port Mansfield and the other at an offshore oil rig. Both of these specimens were small, possibly in their second year of life. There are no records for adult hawksbills from the coast of Texas or Louisiana.

Cahuama or Loggerhead Turtle, *Caretta caretta*

In the western Atlantic the greatest concentration of loggerheads is found along the Atlantic coast from North Carolina to southern Florida. Smaller concentrations

are found along the entire Gulf coast from the Florida Keys to Quintana Roo. Lund (1974) estimates the eastern United States population at 25,000 to 50,000 adult loggerheads. There is no reliable count for loggerheads in the Gulf. It is certainly an ubiquitous species, but its total number is small. The species is regularly fished in the waters of the Yucatan peninsula where its center of abundance is on the Caribbean side. There is a secondary but much smaller concentration in the state of Campeche. Fuentes (1967) gives a catch of approximately 365 cahuama for Campeche during a year. Since the fishermen will capture every one they can, this catch is indicative of a small population.

In Texas information gathered by me indicates that loggerheads occur throughout the summer as isolated individuals around oil field platforms, rock reefs and obstructions. Sports fishermen may, at times, see large adults feeding on Portuguese man-of-war at considerable distance from the coast. There may be a southward migration in the fall and a northward one in the spring, but this has not been confirmed by tagging data.

There is no fishery for the loggerhead in Texas. It was utilized before the first world war by the inhabitants of the coastal villages, and a few were marketed. Rabalais and Rabalais (in press) have studied the strandings of marine turtles on the coast of south Texas from Cedar Bayou to Brazos Santiago. They logged 202 dead loggerheads during the period from September 1976 to 1 October 1979. Most of these turtles were subadult (98 percent were smaller than 76 cm). Strandings were greatest during the fall and spring, and in this sense they were correlated with peak inshore shrimping for white shrimp. A few loggerheads are also snagged by sports fishermen, but most of them are released unharmed because it is illegal to harm turtles in Texas. There has been no organized tagging effort on the Texas coast because of the small and scattered population. However, in the early 1960s my students tagged 8 loggerheads. Four of these tags—half—were recovered within a year. These results support a high mortality rate due to the activities of man. Dead turtles on the beaches of South Texas are not a new phenomenon, but no counts were made during the early 1950s when I frequently traveled the beach.

Nearly all substantiated records for nesting loggerheads are in the eastern Gulf of Mexico. There is a record of a loggerhead nesting on Chandeleur Island (Ogren 1977) and many reports of turtle tracks on the same islands. B. Melancon (personal communication) gathered loggerhead eggs on Grand Isle in the 1930s. Texas is usually placed in the nesting range of the loggerhead mainly on the basis of informed observers. Reports of the nesting of large, unidentified turtles must surely be this species. Indeed, the now nearly 300-year-old account of gathering of sea turtle eggs by members of La Salle's ill-fated expedition may refer to the loggerhead. However, I have been able to document fully only 2 nests—one in 1977 and the other in 1979 on south Padre Island. Hatchlings from these nests were identified by me.

In Mexico I have gathered numerous reports of the tracks of large turtles on the beaches of Tamaulipas north of La Pesca and in Veracruz from Tampachichi to Barra de Corazones. These may prove to be loggerhead nests. Almost all of them are soon despoiled by man. Isolated individuals do nest in some years at Rancho Nuevo, Tamaulipas. Loggerheads also nest around the peninsula of Yucatan, but most of the known sites are on the Caribbean side.

Lora or Kemp's Ridley, *Lepidochelys kempi*

Although the Kemp's ridley was described a century ago by Garman, most of the information on this species has been gathered during the past 25 years. There was no organized fishery for the species anywhere except as a by-catch of a green turtle fishery near Cedar Key, Florida. It is probable that the gray loggerhead eaten occasionally by Port Aransans prior to the first world war was a ridley.

Hildebrand (1963) estimated the nesting population at Rancho Nuevo in 1947 at 42,000 ridleys based on a statement of Andres Herrera and an analysis of the concentration of the turtles in the film. Exploitation of the population has been high for an undetermined number of years. In fact, the colony was located by following up a chance remark of a friend that an Arab trader packed out jute sacks full of eggs on a pack train of 40 or 50 burros. At the start of the investigations in the late 1960s, 5,000 to 6,000 nested there, but by 1975 the population has declined to a few hundred. However, since that time there has been a very slight increase in the number of nesters.

Exploitation of this rookery prior to its official protection in 1966 was confined almost entirely to the collection of eggs. This activity was so widespread in the 1950s and the early 1960s that the demise of the species was predicted (Hildebrand 1963) if it was not stopped. I am not personally aware of any large scale butchering of turtles for their meat or skin, although I have heard and seen such reports. A permit to slaughter ridleys was granted in 1970, but fortunately the arribada did not arrive on schedule and only 5 turtles were killed according to official accounts.

One can ask whether the present rookery at Rancho Nuevo is the sole survivor of many former nesting colonies or whether it is unique. There is no clear evidence of the species nesting in arribadas elsewhere along the Gulf Coast. There are records of scattered nesting from Port Aransas to Alvarado, Veracruz. Fishermen from Rancho Cruz told me that the lora nested by the thousands at Rancho Nuevo and by the hundreds

in the area from Punta Jerez to Barra del Tordo. E. Liner (personal communication) informs me that this species probably nested on Ile Derniere in Louisiana prior to the destructive hurricane of 1856. Ogren (1977) saw a small turtle which may have been this species crawling up a beach in the same general area more than a century later. Positive identification could not be made from the air, but daytime emergence and small size indicate a ridley. Percy Vioscai (1961) stated that the ridley nested on the Chandeleur Islands. This record apparently was based solely on tracks seen from the air.

Many inferences concerning the life history of this species have been made on scanty data. The following hypothesis best explains the existing data on the ridley, in my opinion. The Kemp's ridley nests in arribadas at Rancho Nuevo, Tamaulipas and the feeding grounds for the subadults and adults are the highly productive white shrimp-portunid crab beds of Louisiana (Marsh Island to the Mississippi Delta) and Tabasco-Campeche (Chupilco, Tabasco to Champoton, Campeche). As in the case of the nesting grounds, there is some leakage of individuals and small groups to other areas away from the primary sites.

This hypothesis is supported by the following information. First, the ridley feeds primarily on decapod crustaceans, particularly 2 genera (*Ovalipes* and *Callinectes*) of the swimming or portunid crabs. Portunid crabs occur in the greatest concentration in Louisiana and the Tabasco-Campeche area of Mexico.

Secondly, current patterns—either the loop current for northward transport or an eddy for southward transport—favor the distribution of the ridley to the 2 areas. Because of the variability of these currents, large numbers of young turtles in some years could be transported through the Florida Straits via the Gulf Stream. The sporadic nature of the records from the Atlantic Coast certainly support this contention. Most of the turtles which pass through the straits are probably lost to the population. Some may make it back to the nesting grounds. This seems possible if we consider the long migrations from the crab-rich grounds off Ecuador to nesting grounds in Mexico made by *L. olivacea*.

Thirdly, temperatures are favorable in both areas for the ridley. The Mississippi River has built a ramp across the shelf, and the water temperatures are not subject to as much fluctuation as elsewhere in the western Gulf. These waters support a winter population of king mackeral, *Scomberomorus cavalla*, so feeding ridleys can live there.

Fourthly, the offshore drift lines of logs and other debris from the rivers should provide hiding and feeding places for the young juveniles. There are accounts of large numbers of small turtles in such areas. These small turtles have not been caught and identified, but their location points to the ridley.

Fifthly, many young ridleys were formerly taken in shrimp trawls in shallow water near the outer Gulf beaches. Liner (1954) did not give catch rates for the 11 ridleys caught off Terrebonne Parish in 1952 in 4 m of water. However, these data suggest a catch rate of 1 ridley per trawler per day during the spring of the year. His turtles ranged from 3 to 26 kg; many of the ridleys caught off Louisiana, now and in the past, weigh under ten pounds. The presence of immature ridleys in the Tabasco-Campeche white shrimp grounds is supported by my observations and fishermen's statements at Dos Bocas, Tabasco and by Fuentes (1967).

Sixthly, the use of both areas as feeding grounds by mature adults has been demonstrated by tag returns from nesting females (Chavez 1969). The existing data from tag returns and incidental capture support the concept that the species migrates primarily along shore rather than in the open Gulf. Mature turtles probably frequent deeper water than the immatures. Carr and Caldwell (1958) reported a mature female from 26 m off Terrebonne Parish.

New information will be difficult to obtain because the present law on endangered species has virtually dried-up all information from the fishermen who accidently catch the species, and this makes tagging programs hardly worthwhile in elucidating migrations and mortality.

Tortuga Blanca or Green Turtle, *Chelonia mydas*

The history of the green turtle fishery in the western Gulf of Mexico still remains to be written. The fishery was the first to develop in the new state of Texas, and it was the first to disappear. It was little more than a memory by 1900. The abundance of large green turtles in the bays was commented upon by the first European sttlers. When trade started with markets outside the State of Texas is uncertain, but it must have been shortly after independence from Mexico. Turtles could be shipped alive by schooner to New York, or they could go by steamer to New Orleans and then be transhipped to other points. The other method was to process the turtles into meat and soup which could be transported as a canned product. Again there is some question when the first cannery was established. One was in operation in 1859 when $15,000-worth of turtle soup was canned at Indianola. However, there is an indication that the first cannery was established in 1849. The cannery ran an ad in the Corpus Christi Ranchero for 4 months in 1860 and paid $4.00 for every turtle delivered to Indianola. No mention was made of size or species. This cannery disappeared early in the Civil War years. After the war and the yellow fever epidemic of 1867, there was again interest in food processing in Texas. Turtle canning came to be closely associated

with the beef packeries. Ray Stephens (personal communication) informed me that the waste from the packing plant was deposited in the bay, and it attracted large numbers of turtles. I assume that the packers thought if they were going to fatten the turtles they might as well can them for a profit. Turtle canneries were reborn at Fulton, Texas, probably in 1872. In 1877 the cannery was buying turtles at $0.02 a pound. A catch of 11 turtles in 1 week at Shamrock Point during the last half of September 1877 was recorded in Ed Mercer's diary (Local History Collection, Corpus Christi Library).

Charles Stevenson (1893) surveyed the Texas fisheries for the U.S. Commission of Fish and Fisheries. He reported a catch of 265,000 kg of green turtle for the entire coast of Texas. Nearly all the turtles were caught in Aransas Bay, Matagorda Bay, and the lower Laguna Madre. Most of the turtles were caught in turtle nets—222,000 kg in Aransas Bay and 22,000 kg in the lower Laguna Madre. In addition 20,000 kg were caught in fish seines in Aransas Bay and 900 kg in Galveston Bay. The main fishing town on Matagorda Bay, Indianola, was destroyed by a hurricane in 1886, and the city was not rebuilt. Consequently the Matagorda Bay statistics for 1890 are included in the figures given above for Aransas Bay, the point where the landings took place.

The scattered accounts of the fishery show turtles were caught primarily from April to November. The turtles were said to be in poor condition in the early part of the year, but fat from August to November. Whether the turtles migrated southward in the winter is not clear. John Priour (personal communication) told me that after severe cold waves a few people would take wagons along the south shore of Corpus Christi turning moribund turtles on the way out and loading them into the wagons on the way back. The turtles were carted to John Superach, a local restaurant owner, who would buy them. One might wonder why the fishery was so intense when the price was never more than $0.04 a kg, and the average catch was less than 1 turtle a day. According to John Priour in other types of work you worked from sunup to sundown for $0.50 a day, so turtle fishing, even if only one 180 kg turtle was caught a week, was attractive to a number of people.

Mostly the turtle nets were set near the major passes but within the bay. The majority of the turtles were caught as they returned to their feeding grounds from their nightly resting places in the deeper water of the bay. In the lower Laguna according to Viktor Delgado (personal communication) they used a different method. A man was placed in the mast of a Port Isabel scow to find the turtles and determine the direction they were moving in the clear water. They would sail around the turtle and set their nets across its path.

The turtle cannery which packed 900 green turtles weighing 110,000 kg in 1890 (Stevenson 1893) moved to Tampico in 1896 apparently because of a greater supply of turtles in that area. The fishery deteriorated badly in the last half of the 1890s. The severe freeze of 1894–95 was a disaster, and the much more severe freeze of 1899 dealt the coup de grace. Some blamed overfishing, particularly on the nesting grounds, for the failure of the fishery to recover from the freeze. Still others placed the blame on the jettying of unjettied passes or the shoaling of passes like Cedar Bayou after 1899. Nevertheless, a few people continued to turtle in a desultory fashion. Harry Mills (personal communication) hung up his turtle nets for the last time in 1935. He told me that he thought he was the last turtler on the coast. A few were marketed as a bycatch by fishing and shrimping crews until it became unlawful in 1963.

Green turtles still inhabit the same meadows they did before the turn of the century but in greatly reduced numbers. The greatest concentration is in the lower Laguna Madre near Port Isabel. A fisherman with a trot line and good location might catch 5 in a year, all small. They are usually foul hooked in the flipper and can be readily released.

The nesting grounds of the green turtle are not well known in the Gulf of Mexico and the nesting grounds for the greens which supported the fishery in the nineteenth century in Texas were never identified. Some still nest on Cayo Arcas, Cayo Arenas, Arrecife Alacranes and Arrecife Triangulos on Campeche Bank. An occasional green still nests at Rancho Nuevo. Repeatedly, individuals have told me that the species regularly nested at Playa Washington prior to the second world war. This location is approximately 19 km south of the mouth of the Rio Grande. Neck (1978) reported green turtles nesting at the mouth of the Rio Grande in 1889. I believe this is in error and that these turtles were ridleys. The most probable nesting place for Texas green turtles are the beaches between Boca Jesus Maria and Tuxpan. If the movement of a turtle cannery from Fulton, Texas to Tampico in 1896 made sense, it was because it was near the nesting ground for the green turtle. No significant feeding grounds are found there.

Status and Outlook

In this section I will review the turtle population in each state in the western Gulf of Mexico. Again, I must point out as in the species accounts that there is a paucity of data.

Louisiana

Kemp's ridley could be logically labeled the Louisiana

turtle because its greatest abundance is found there. It is beyond a doubt the commonest marine turtle in the state. However, it is concentrated in the shallow water from Marsh Island to the Mississippi Delta. Based on information supplied by shrimpers it has declined greatly in abundance during the past 25 years. There appears to be little prospect for a quick improvement in its survival status.

One would expect the highly productive waters of Louisiana to support a significant number of leatherbacks at least seasonally, but there are no supporting data.

Louisiana is not now and probably never was a major nesting area for marine turtles.

Texas

The most important species in Texas was and is the green turtle which fed in the seagrass meadows from Matagorda Bay to the lower Laguna Madre. It is probable that the population is now increasing, but this is based solely on the number of reports we receive concerning the species. It is possible that the increased population and head-starting in Isla Mujeres has resulted in emigration to Texas. The greatest threat to an improved situation in Texas may be a reduction in the acres of grass beds by dredging.

The subadult loggerhead population is obviously under stress because of heavy mortalities due to trawling. Under present fishing pressure along the coast, one would expect the mortality to increase.

The ridley occurs in Texas in small numbers, and it is probable that all adult ridleys moving from Louisiana to the nesting grounds stay near the coast. As in Louisiana and Tamaulipas, they are subject to loss in shrimp trawls.

The leatherback feeds on cabbage head jellyfish, and although it may be locally abundant, it is not greatly affected by human activity in Texas.

The sand beaches of Texas are now and apparently always were of minor importance as nesting beaches. Two, *Lepidochelys kempi* and *Caretta caretta*, of the 3 species that formerly nested in the state still do, but in smaller numbers.

Tamaulipas

Tamaulipas has been known for years as an important nesting area. The only major rookery for Kemp's ridley occurs at Rancho Nuevo. Its beaches were also nesting sites for the loggerhead and the green, although today few use them. The commercial landings of turtles in the state have apparently always been small. On the other hand, the eggs have been heavily exploited. Very few nests are overlooked by man outside the heavily protected area at Rancho Nuevo.

Veracruz

In contrast to the desolate coast of Tamaulipas, many people live near the coast in the state of Veracruz. All 5 species nested along the coast, and the eggs, juveniles and adults were subject to intense exploitation by man. The northern part of the state around Cabo Rojo was probably an important nesting site for the green turtle and possibly for the loggerhead. The area from Isla Lobos to Alvarado was a good nesting and feeding ground for the hawksbill.

The catch, according to official records, has always been small. However, the fishery, although of a subsistance nature, has always been very intense. Turtle nets are still used near the city of Veracruz although the expectation of the fishermen is very low. For example in 1 village 5 turtles were caught during the season—2 green turtles while I was in the area at the end of October 1979.

Tabasco

The fishery in Tabasco has always been small. The principal species is Kemp's ridley. No major nesting beaches are known in the state.

Campeche

Campeche has for a number of years been the most productive state in harvested turtle resources in the Gulf of Mexico. In part, this is due to 2 major fishing ports and more qualified fishermen than any other state on the east coast of Mexico, but it is also due to more productive waters. In addition to nesting beaches at Isla Aguada and Isla Carmen, there are extensive feeding grounds for green turtles, loggerheads and ridleys. The catch has declined considerably in recent years, and there seems little prospect for improvement in the near future.

Yucatan

The catch has always been small in the state and the few active nesting grounds are located on offshore cays.

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