Chelonian Conservation and Biology, 1999, 3(2):200–224

Status Justification for Listing the Hawksbill Turtle (*Eretmochelys imbricata*) as Critically Endangered on the 1996 *IUCN Red List of Threatened Animals*

ANNE B. MEYLAN[1] AND MARYDELE DONNELLY[2]

[1]*Florida Department of Environmental Protection, Florida Marine Research Institute, 100 Eighth Avenue Southeast, Saint Petersburg, Florida 33701 USA [Fax: 727-893-9176; E-mail: ameylan@mindspring.com];*
[2]*IUCN/SSC Marine Turtle Specialist Group, 1725 DeSales Street, N.W., Suite 600, Washington, D.C. 20036 USA [Fax: 202-872-0619; E-mail: mdonnelly@dccmc.org]*

ABSTRACT. – The hawksbill turtle (*Eretmochelys imbricata*) meets the 1996 IUCN *Red List* criteria for a Critically Endangered species, based on global population declines of 80% or more during the last three generations (105 years) and projected declines over the next three generations. Most populations are declining, depleted, or remnants of larger aggregations. Only five regional populations remain with more than 1000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia). Hawksbills were previously abundant, as evidenced by high-density nesting at a few remaining sites and by trade statistics. Of all the species of marine turtles, the hawksbill has endured the longest and most sustained history of exploitation. In addition to all the threats shared with other marine turtles, hawksbills are exploited for tortoiseshell — long considered a precious material. While the species is not expected to become extinct in the foreseeable future, individual populations from around the world will continue to disappear under the current regime of exploitation, loss of habitat, and other threats. Hawksbills are closely associated with coral reefs, one of the most endangered of all marine ecosystem types. The Convention on International Trade in Endangered Species (CITES), with good enforcement, is an effective tool to implement hawksbill conservation. For more than any other marine turtle species, international trade remains the most serious threat.

KEY WORDS.—Reptilia; Testudines; Cheloniidae; *Eretmochelys imbricata*; sea turtle; Critically Endangered; Endangered; tortoiseshell; global status; conservation; population; exploitation; trade; Caribbean Sea; Atlantic Ocean; Indian Ocean; Pacific Ocean

The hawksbill turtle, *Eretmochelys imbricata* (Linnaeus, 1766) (Fig. 1), is circumtropically distributed in coastal waters; it is found in the waters and on the beaches of 82 geopolitical units and may occur in 26 others (Baillie and Groombridge, 1996). Nesting occurs on beaches in at least 60 countries, although much of this nesting occurs at low density (Groombridge and Luxmoore, 1989). No major rookeries have been documented in the eastern Atlantic Ocean; along the Pacific coast of North, Central, or South America; or in the Central Pacific (Groombridge and Luxmoore, 1989; Eckert, 1993; Limpus, 1995a).

Hawksbills spend their first years of life in pelagic habitats at the surface of the ocean. Larger juveniles and adults are closely associated with coral reefs, but they also forage on other hard bottom habitats throughout the tropics and, to a lesser extent, the subtropics. They nest on insular and mainland sandy beaches.

The hawksbill was first listed as an endangered species by IUCN (International Union for the Conservation of Nature, now the World Conservation Union) in 1968 (IUCN, 1968) and retained this listing in all subsequent publications of the *Red List* until 1996, when its status was changed to Critically Endangered (Baillie and Groombridge, 1996 — *IUCN Red List of Threatened Animals*). The species was included in the Appendices of CITES in 1975 (Atlantic population in Appendix I and Pacific population in Appendix II; in 1977 the Pacific population was included in Appendix I). In a review of the global status of hawksbills sponsored by CITES, Groombridge and Luxmoore (1989) concluded that hawksbill populations were depleted or declining in 56 of the 65 geopolitical units for which some information on nesting density was available, with declines well substantiated in 18 of these areas and suspected in the remaining 38. A worldwide ban on international trade has gradually taken effect as major importing and exporting countries have come into compliance with CITES. Nevertheless, legal CITES trade did not cease until the end of 1992, when Japan adopted a zero import quota on its reservation on *E. imbricata*. Trade between non-signatory nations remains legal, and public sale of products, mainly for international tourists, occurs in many countries. The hawksbill is also listed in Appendix I and Appendix II of the Convention on Migratory Species (CMS).

In 1995, the IUCN/SSC Marine Turtle Specialist Group (MTSG), headed by Karen A. Bjorndal, reviewed the status of the hawksbill with respect to IUCN's newly defined criteria for status designations. Data on the numbers of animals in trade were also reviewed to assess levels of

Figure 1. Hawksbill turtle, *Eretmochelys imbricata*, at Mona Island, Puerto Rico; a tagged juvenile in its preferred coral reef habitat (see also journal cover). Photo by R.P. van Dam.

exploitation. Based on data supplied by MTSG members and hawksbill experts worldwide, the MTSG Executive Committee concluded that the hawksbill was Critically Endangered on the basis of the following IUCN *Red List* criteria (IUCN Species Survival Commission, 1994; Baillie and Groombridge, 1996):

A. *Population reduction in the form of either of the following:*

1. *An observed, estimated, inferred or suspected reduction of at least 80% over the last 10 years or three generations, whichever is longer, based on (and specifying) any of the following:*

(a) *direct observation*

(b) *an index of abundance appropriate for the taxon*

(d) *actual or potential levels of exploitation.*

2. *A reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying):*

(b) *an index of abundance appropriate for the taxon*

(c) *a decline in area of occupancy, extent of occurrence and/or quality of habitat*

(d) *actual or potential levels of exploitation.*

In response to a challenge to this listing, we prepared the following written justification in 1997–98 at the request of the MTSG, with input from numerous members of the MTSG and other colleagues. The draft justification was circulated among the MTSG Executive Committee and subsequently sent out for wider review to more than 50 members of the MTSG and other experts, and to members of the Species Survival Commission within the IUCN. This final justification document represents the official position of the MTSG on the status of the hawksbill turtle.

POPULATION ESTIMATION

As are all highly mobile, marine vertebrates, sea turtles are difficult to census. For reasons of accessibility, the most commonly used method of monitoring population trends is to count the number of females arriving annually at nesting beaches (Meylan, 1982). Population estimation is complicated by the fact that females nest several times within a breeding season, they typically follow a non-annual breeding schedule (intervals of which may vary in length), and they may be reproductively active for decades (Carr et al., 1978; FitzSimmons et al., 1995; Mortimer and Bresson, 1994a, 1999). Large annual fluctuations in the number of females arriving at a nesting beach are common for some species and are apparently linked to environmental conditions on the feeding grounds (Limpus and Nicholls, 1988, 1992). Long-term monitoring is thus essential to document true population change. Limited access to reproductive

males and to all non-reproductive segments of the population makes it difficult to estimate total population size.

Long generation times (calculated as the age at sexual maturity plus half of reproductive longevity (Pianka, 1974) in marine turtles also have implications for population trend analysis (Congdon et al., 1993). Estimates of age-at-maturity for wild marine turtles are as high as 40 to 60 years for green turtles (*Chelonia mydas*) (Balazs, 1982; Bjorndal and Zug, 1995), with estimates of age-at-maturity for hawksbills ranging from 20 to 40 years (Boulon, 1983, 1994; Limpus, 1992, *pers. comm*.; Mortimer, 1998; Diez and van Dam, in prep.). One result of long generation times is that nesting beach surveys more accurately measure the reproductive success of nesting females of the previous generation (and the survival of their offspring) than the status of the current population. Future trends are determined by individuals that have not yet reached maturity. Nesting beach surveys fail to detect changes in the juvenile and subadult turtle populations that result when overharvest of eggs or females at the nesting beach interferes with the production of new offspring. When such overharvest is intense, the decline in numbers of nesting females is delayed until after the juvenile and subadult age classes have been virtually eliminated (Bjorndal, 1985; Mortimer, 1995a). By the time the number of nesters begins to decrease, the entire population is already well into decline.

The IUCN criteria for assessing the status of a species call for evaluation of population change over 10 years or three generations, whichever is longer. Generation time for hawksbills is herein estimated to be 35 years based on growth and reproductive longevity data from around the world (see below). Evaluation of population trends of hawksbills thus requires population data extending back 105 years. Unfortunately, scientific monitoring of marine turtle populations on nesting beaches began only in the mid-1950s, and for reasons discussed below, relatively few projects have focused on the hawksbill. To gain an understanding of what has happened to hawksbill populations over the last century, the historical literature, trade statistics, and qualitative information must be considered in addition to the nesting beach monitoring data that do exist.

One of the biological characteristics of the hawksbill that must be considered in the following discussion is that adult females return to nest on beaches within the region where they were born, and consequently, once a population is depleted, it will not be replenished by females from other rookeries within realistic time frames (Broderick et al., 1994; Bass et al., 1996; Broderick and Moritz, 1996; Bowen et al., 1996; Bass, 1999). These nesting populations must, therefore, be treated as independent management units. Hawksbills are migratory and may cross national jurisdictional boundaries, and in many cases, international cooperation will be required if conservation efforts are to succeed (Meylan, 1999b).

To understand the impact of trade on hawksbill populations, it is necessary to know the conversion factor that relates the weight of shell scutes (the tortoiseshell of commerce) to the approximate number of individual turtles. Based on the weights of tortoiseshell from various countries provided by Japanese bekko dealers, Milliken and Tokunaga (1987) calculated average weights of shell obtained from adult hawksbills: the global average for the amount of tortoiseshell obtained from an adult hawksbill is 1.06 kg (2.3 lb); for Caribbean hawksbills, the average is 1.34 kg; Indian Ocean and East Africa, 0.74 kg; Asia, 0.75 kg; and Oceania, 0.88 kg. These conversion factors were used to convert the weight of scutes to number of individuals in the trade statistics in the following sections.

HISTORICAL PERSPECTIVE

The richly patterned scutes that cover the carapace and plastron of the hawksbill are called tortoiseshell or bekko. They have been considered a precious material — on a par with ivory, rhinoceros horn, gold, and gems — for thousands of years. Parsons (1972) chronicled the ancient and modern history of trade in tortoiseshell beginning with the expeditions of Queen Hatsheput in the 15th century B.C. Tortoiseshell was revered by the ancient Egyptians, Romans, Arabs, and Chinese, and major trading centers were located from the Mediterranean to Guangzhou (Canton). It was one of the most frequently mentioned commodities in a guide to Eastern trade written between 40 and 70 A.D. (Parsons, 1972). In the Middle Ages, Sri Lanka served as a center of trade and transshipment for the Indian Ocean region, employing Arab, Indian, Javanese, and Chinese traders (Parsons, 1972). Tortoiseshell was used for a variety of purposes, including the manufacture of combs, brooches, and other items of adornment, and as a veneer or inlay in furniture and woodwork. Hawksbills used in the ancient trade were drawn from remote corners of the world, including Borneo, Sulawesi, the Moluccas, and the eastern coast of Africa (Parsons, 1972).

Hawksbill remains excavated from the middens of pre-Columbian cultures in the Caribbean document the capture and use of hawksbills during pre-historic times in the New World (Wing and Reitz, 1982; Versteeg and Effert, 1987). Columbus witnessed the hunting of hawksbills in 1494 when he visited the south coast of Cuba (De Sola, 1932), and indigenous peoples on the coast of Yucatán (Mexico) were observed to carry shields made of tortoiseshell in 1517 (Parsons, 1972). De Rochefort (1666) commented on the plentiful hawksbills in the Yucatán and on the islands of the Gulf of Honduras. Tortoiseshell was a significant trade item in St. Thomas (now part of the U.S. Virgin Islands) as early as 1690 (Kellenbenz, cited in Parsons, 1972) and along the Miskito coast of Central America in 1722 (Parsons, 1972). Exports of tortoiseshell from the Central American coast in the early 18th century averaged 6000 to 10,000 pounds (2035–3392 individuals) per year (Hodgson, 1822). An American schooner bound for New York from this area in 1823 carried 1313 pounds of tortoiseshell (445 individuals) valued at $10,300 (Parsons, 1956).

France had a listed duty for tortoiseshell as early as 1664 (Parsons, 1972). Import records for Britain in the 19th century document that 50,000 to 60,000 pounds of tortoiseshell (16,961–20,353 adult turtles) were imported annually. Comparable amounts were imported to France (Parsons, 1972). World trade for the year 1920 is estimated to have been 90,000 to 100,000 pounds (30,500–33,900 turtles) (Parsons, 1972).

Primary commercial centers for the tortoiseshell trade in modern times have been London, Paris, and New York in the West; Sri Lanka in the Indian Ocean; and Ujung Pandang (Sulawesi, Indonesia), Guangzhou, Hong Kong, Taipei, and Nagasaki in the Orient. In the 20th century, the price of tortoiseshell has at times rivaled that of ivory (Mack et al., 1979) and the trade has involved very large numbers of turtles. Further details of the tortoiseshell trade in recent decades are given below.

Parsons (1972) wrote that of the various species of marine turtles, the hawksbill has experienced the longest and most sustained history of exploitation. The duration and intensity of the demand for tortoiseshell around the world have clearly had a profound effect on this species (Carr, 1972; Parsons, 1972; Nietschmann, 1981; Mortimer, 1984; Meylan, 1989; Eckert, 1995). We suggest that the true magnitude of this effect has not been previously recognized and that our current perception of the population status of this species has been affected by the shifting baseline syndrome (Pauly, 1995; Sheppard, 1995; Jackson, 1997). This syndrome refers to the tendency for humans to measure change against what they consider to be a starting or baseline condition, usually that point during their lifetimes at which they themselves first viewed the phenomenon in question. Baselines are thus constantly (and unconsciously) reset, leading to the loss of historical perspective.

In modern times, the hawksbill has frequently been described as being naturally rare (e.g., Groombridge and Luxmoore, 1989, and others) and as having a more dispersed nesting pattern than other species. We suggest that this perception is due to the fact that hawksbill populations were already drastically reduced by centuries of exploitation before biologists ever took stock of them. The historical record speaks for itself — literally millions of hawksbills have passed through channels of world trade, and today, with few exceptions, they are represented only by small populations.

Carr (cited in Bustard, 1973) may have presaged our conclusion about shifting baselines for the hawksbill turtle in his comment that the modern distribution of the hawksbill is a ghostly outline of its primitive range. Limpus (1995b) also concluded that the dispersed nesting observed today is the result of the overharvest of previously large colonies. Further support for the shifting baseline effect is that a few sites of aggregated nesting still remain. Salm et al. (1993) presented data that indicated a nesting density of 660 nests/km/season in the Daymaniyat Islands of Oman in 1986. Nesting density on Shitvar Island, Iran, was estimated to be 396 nests/km/season (Groombridge and Luxmoore, 1989). Approximately 200 nests/km/season are constructed on Cousin Island in the Seychelles, and historically many other islands in Seychelles had aggregated nesting (J. Mortimer, *pers. comm.*). On Milman Island, Australia, 365 females were tagged on a 2.4-km nesting beach in 76 nights, and nesting at this site occurs year-round (Dobbs et al., 1999). In Mexico, hawksbill nesting density at San Lorenzo beach in Campeche was recorded to be 143 nests/km in 1994, 110 nests/km in 1995, and 64 nests/km in 1996 (Guzmán et al., 1995; Garduño-Andrade et al.,1999). These and other cases contradict the widely accepted doctrine that hawksbills nest only solitarily (Hendrickson, 1980).

One consequence of biologists having only remnants of hawksbill populations to study in modern times is that few nest-monitoring projects have ever been carried out (Meylan, 1999a). This leads to weak population estimates and poor tracking of population change throughout most of the range of the hawksbill. Data on hawksbills are frequently collected ancillary to studies of other marine turtle species. In the discussion of population trends presented below, these constraints must be kept in mind, as must the important distinction between population changes that have occurred in the last two to four decades (the most usual frame of reference) and those that have transpired in the last 105 years, which are actually those of most relevance to the IUCN *Red List* criteria. Some populations that have already declined significantly earlier in the century now appear to be stable or are even showing signs of increase. However, because of previous declines, their contribution to the long-term survival outlook of the species remains limited.

GENERAL OVERVIEW OF THE STATUS OF THE HAWKSBILL

Atlantic Ocean

Western Tropical Atlantic Ocean, Caribbean Sea, and Gulf of Mexico

The status of hawksbill populations in this region (Fig. 2) has been the subject of numerous recent reviews. In an evaluation of the global status of the hawksbill and green turtle undertaken for the CITES Secretariat, Groombridge and Luxmoore (1989) concluded that in the case of the hawksbill, "the entire Western Atlantic-Caribbean region is greatly depleted." Calculations from Groombridge and Luxmoore's (1989) rankings of populations produced a maximum estimate of 4975 nesting females in the wider Caribbean (Meylan, 1989). Meylan (1989) reviewed the status of hawksbills for the Second Western Atlantic Turtle Symposium and concluded that nearly all countries in the wider Caribbean each hosted fewer than 100 nesting females per year. The largest remaining population was in Mexico.

Meylan et al. (1997) produced a draft report reviewing the biology and status of the hawksbill in the Caribbean. Meylan (1997, 1999a) reviewed the status of hawksbills in the 35 geopolitical units that make up the wider Caribbean region. Hawksbill populations were reported to be declining

Figure 2. Caribbean Sea, Gulf of Mexico, and western tropical Atlantic Ocean. Some of the localities mentioned in the text are labeled.

or depleted in 22 of the 26 geopolitical units in the Caribbean for which status and trend information were available (no nesting occurs in 3 additional units) (Barmes et al., 1993; Bjorndal et al., 1993; Burnett-Herkes, 1987; Butler et al., cited in Groombridge and Luxmoore, 1989; Carr et al., 1982; Cordoba, 1997; Cruz and Espinal, 1987; d'Auvergne and Eckert, 1993; Dropsy, 1987; Eckert, 1995; Eckert et al., 1992; Eckert and Honebrink, 1992; Edwards, 1984; Finley, 1984; Fletemeyer, 1984; Fuller et al., 1992; Groombridge and Luxmoore, 1989; Higgs, 1984; Horrocks, 1992; Hunte, 1984; Incer, 1984; Kaufmann, 1975; Lescure, 1987; Medina et al., 1987; Meylan, 1983; Moll, 1985; Morris, 1984; Murray, 1984; Nietschmann, 1981; Ottenwalder, 1981, 1987, 1996; Rosales-Loessner, 1984; Scott and Horrocks, 1993; Smith et al., 1992; Sybesma; 1992; Wilkins and Meylan, 1984).

United States. — In a recent review of the status of hawksbills in U.S. jurisdictional waters within the Atlantic Ocean and Caribbean Sea (Florida, Puerto Rico, U.S. Virgin Islands), Eckert (1995) concluded that these populations, which she described as depleted, are not currently declining, but neither are they showing signs of recovery after more than a decade of legal protection. Eckert (1995) estimated that the area hosts a minimum of 650 nests per annum or approximately 130-216 nesting females. This estimate should be raised slightly upwards in light of recent increased nesting on Mona Island (Diez et al., 1998; C. Diez and R. van Dam, *pers. comm*.) and data from new monitoring efforts on mainland Puerto Rico (K. Hall, *in litt*.; C. Diez, *in litt*.).

The hawksbill nesting population at Mona Island, Puerto Rico, is considered to be increasing, with a record number of nests (537, representing 107–179 females) having been documented in 1998 (Diez et al., 1998; C. Diez and R. van Dam, *pers. comm*.) Variations in survey effort from year to year at Mona make it difficult to infer the long-term trend. The nesting population at Buck Island Reef National Monument, U.S. Virgin Islands, appears to be stationary (see Meylan, 1999a, for annual totals) with a peak year of 135 nests. Only 1–2 nests are recorded annually in Florida (Meylan et al., 1995).

Mexico. — Mexico is one of only a few countries in the wider Caribbean reporting an increased number of nests in recent years (Guzmán et al., 1995; Garduño-Andrade et al., 1999). A total of 4522 nests were recorded in the states of Campeche, Yucatán, and Quintana Roo in 1996, representing a 56-fold increment compared to the number of nests protected in 1977 (Garduño-Andrade et al., 1999). This represents 940–2200 nesting females, assuming the range of 2.1–4.8 nests per female per season adopted by Garduño-Andrade et al. (1999). [Note that an average of 3 to 5 nests per female per season has been used elsewhere in this document on the basis of data reported by Richardson et al.,

1989; Hillis, 1995; Guzmán et al., 1995; Dobbs et al., 1999; Mortimer and Bresson, 1999; Pilcher and Ali, 1999.] During this time period, there was a seven-fold increase in survey area; Garduño-Andrade et al. (1999) considered the increased nesting levels during the period 1977–92 to be best explained by increases in monitoring efforts, but attributed increases from 1993 to 1996, when beach coverage was maximized, to true population change. Guzmán et al. (1995) concluded that the increased number of nests recorded in the state of Campeche in recent years was a sign of gradual, effective recovery and noted that the increase had come after 17 years of protection of the beaches.

Two of the factors affecting the interpretation of the data are that Mexico imposed a total ban on the harvest of all sea turtles in 1990, and harvest on the foraging grounds in adjacent Cuba has been greatly diminished since 1993 after Japan, the primary market for Cuban tortoiseshell, adopted a moratorium on hawksbill imports (Donnelly, 1991; TRAFFIC, 1994). Both of these actions would have allowed more immature turtles to survive long enough to nest, and they also would have allowed turtles that were already reproductively active to complete more nesting cycles. The Mexican regional population — which accounts for several thousand nests annually — is the only one of this size remaining in the Western Hemisphere.

Barbados and Antigua. — Although populations in Barbados are considered to be depleted, J. Horrocks (*in litt*.) reports that the small nesting population may be showing signs of increase based on recent levels of nesting, but cautions that this increase is at least partially a result of greater survey effort and better reporting by the public. Approximately 50 females were tagged on nesting beaches in Barbados in 1997. The nesting population at Jumby Bay, Antigua, appears to be stationary (Meylan, 1999a; Richardson et al., 1999), with a peak year of 135 nests, and an estimated population of 78 adult females (Richardson et al., 1999).

Cuba. — Cuba has not previously been included in most estimates of Caribbean hawksbill populations because of insufficient information (Groombridge and Luxmoore, 1989; Meylan, 1989), but it has been suspected to host significant nesting populations based on the large volume of exports of tortoiseshell during the last several decades, and the presence of significant numbers of hawksbills on the foraging grounds (as reflected by harvest data). Data on the Cuban population were subsequently presented in draft format for the 1997 CITES meetings (Republic of Cuba, 1997).

On the basis of recent survey data, Moncada et al. (1999) suggested that although Cuba has extensive shoreline that appears suitable for nesting by hawksbills, most nesting activity is confined to small beaches on offshore islands. The most important nesting area identified to date is the Doce Leguas Cays which lie 60 km off the southern coast (Camagüey Province) (Moncada et al., 1999). The total number of nests documented annually in the Doce Leguas Cays during the 1994–95 to 1997–98 seasons has ranged from 105 to 251 nests (Moncada et al., 1999). The authors cautioned that these totals did not reflect all nesting activity and that the true total was undoubtedly higher; they estimated that a maximum of 409 nests were laid annually on 47 beaches during the period 1994–98. However, they also reported that nesting activity by hawksbills on 10 monitored beaches appeared to be reduced in Doce Leguas in 1997–98 compared to spot checks conducted in previous seasons, and attributed the decrease to human disturbance and beach erosion. Hawksbills also nest in other areas of Cuba (Moncada et al., 1999), and the authors concluded that the full extent of nesting by hawksbills in Cuba remained unknown and could not reliably be estimated. However, using a series of extrapolations, they proposed an estimate of 1700–3400 nests annually (representing 425–850 females, based on 4 nests/female/year).

The importance of Cuban feeding grounds for hawksbills has long been established. Doce Leguas Cays (formerly known as the Archipelago of Jardines de la Reina), off the south coast of Cuba, was known as an early center for tortoiseshell trade and is believed to be where Cayman fishermen used to net hawksbills (Parsons, 1972). Recent genetic research has revealed that feeding ground populations there include hawksbills from Belize, Mexico, Puerto Rico, the U.S. Virgin Islands, and Antigua (Bass, 1999). An organized hawksbill fishery has existed in Cuba since 1968. The Cuban Ministry of Fishing Industry supports an extensive program of research and data collection for the hawksbill fishery (Republic of Cuba, 1997; Carrillo et al., 1999). Between 1968 and 1990, annual harvest for shell and local meat consumption averaged 4744 animals per year (Carrillo et al., 1999). After 1990, the harvest quota was phased down to 500 animals (a reduction of 90%).

J. Frazier (*in litt*.) has noted that increased records of hawksbills nesting in Mexico have coincided with the decreased harvest in adjacent Cuban waters. Although the decreased Cuban harvest may be a possible contributing factor, increased recruitment into the reproductive stock of hatchlings produced in Mexico, and higher survival rates of juveniles, subadults, and adults due to local conservation measures, are considered to be the primary causes of increased nesting in Mexico (Garduño-Andrade et al., 1999; Carrillo et al., 1999).

Current Population Estimate for the Western Atlantic Ocean and Caribbean Sea

Based on the earlier work by Groombridge and Luxmoore (1989), Meylan (1989), and Eckert (1995), and on recent data, Meylan (1999a) estimated that a maximum of 5000 hawksbills nest annually in the Caribbean region, excluding Guyana, French Guiana, Suriname, and Brazil. A maximum of 600 hawksbills are estimated to nest in these four countries, based on the following estimates: 1–5 nests/yr in French Guiana (Fretey, 1987, *pers. comm.*), 30 nests/yr in Suriname (Reichart and Fretey, 1993), and 1200–1500 nests/yr in Brazil (M. Marcovaldi, *pers. comm.*). Nesting by hawksbills occurs at low densities in Guyana; a countrywide estimate is not available.

Long-Term Trends in the Western Caribbean Sea

Long-term changes (i.e., over 100 years) in the status of hawksbill populations are difficult to evaluate because formal monitoring programs have existed for only a few decades. To gain a long-term perspective, it is necessary to evaluate data (e.g., numbers of nesting females, change in size of nesting females, numbers of individuals involved in trade, changes in capture rates at sea) from a variety of sources. Wherever these data exist for the Caribbean region, they suggest significant declines. Following are several specific cases from the Caribbean.

Central American Mainland and San Andrés Archipelago. — Parsons (1972) identified the area from the Yucatán Peninsula to Panama as one where "the hawksbill has been especially abundant and the trade best developed." He reported further that the major concentrations of hawksbill turtles which have supported the principal American trade since the end of the 17th century have been found along the coast of southern Central America, from Bluefields, Nicaragua, to the Gulf of Urabá, northwestern Colombia. In the first half of the 18th century, Jamaican vessels frequented the Central American coast, trading for tortoiseshell largely with the Miskito Indians, who occupied what is now northern Nicaragua (Helms, 1971); exports were 6000 to 10,000 pounds of tortoiseshell (2000–3400 turtles) per year (Hodgson, 1822). By the mid-1800s, Cayman fishermen had largely replaced the Jamaicans; they continued to focus on the Miskito Shore and also turned their attention to Roncador, Serranilla, and Serrana Banks, small sand cays 120–160 km northeast of the Colombian islands of San Andrés and Providencia (located off Nicaragua's eastern coast) (Parsons, 1956). These islands were also the fishing grounds for fishermen from Providencia, who along with the Caymanians, specialized in fishing hawksbills, taking them off the nesting beaches and with nets (Parsons, 1956).

Between 1932 and 1939, exports of tortoiseshell from the Cayman Islands averaged about 5000 pounds (1700 turtles) annually, and were presumably derived in large part from Colombian waters, including the Colombian islands off Nicaragua (Parsons, 1972).

In 1969, a Colombian research cruise visited Providencia and the adjacent banks of Quitasueño and Serrana to assess the status of marine resources (Ben-Tuvia and Rios, 1970). Fishermen interviewed by the investigators reported catching up to 100 hawksbills per day previously in their lifetimes (exact time frame not given). As part of the research mission, local divers were hired to catch hawksbills. Four divers working for seven hours captured one hawksbill at Quitasueño Bank (capture rate of 1 hawksbill per 28 man-hours); three worked eight hours to catch six hawksbills on Serrana Bank (1 hawksbill per 4 man-hours).

Archie Carr conducted interviews and ground surveys in the San Andrés Archipelago (specifically the islands of San Andrés and Providencia and the four atolls of East Southeast Cays, Albuquerque Cays, Roncador Bank, and Serrana Bank) in 1980 and also reported that hawksbills were depleted there (Carr et al., 1982). Combined takes of hawksbills and loggerheads had declined from 100 turtles per boat per season to 25 (75% decline), according to interview data. Carr identified a crucial problem for the hawksbill during his visit: divers spear-fishing for snapper and grouper and snaring lobsters were also taking hawksbills incidentally and would continue to do so even when the hawksbills became very scarce (Carr et al., 1982). This phenomenon pertains elsewhere around the Caribbean and throughout the tropics because of the overlapping of habitats among these valuable, reef-dwelling species and the relative ease with which hawksbills are captured (Carr and Meylan, 1980). Thus, overharvest may lead to absolute extirpation, not just "commercial extinction."

Cordoba (1997) surveyed for hawksbills in the San Andrés Archipelago in 1996, including San Andrés, Providencia, Catalina, Bolivar, Albuquerque, Roncador, Serrana, and Serranilla. During beach surveys conducted from mid-April to the end of November (encompassing the nesting season), a total of 21 hawksbill nests (representing 4–7 females) were recorded (Cordoba, 1997; Cordoba et al., in press).

Nicaragua. — Data are available on changes in hawksbill capture rates from 1969 to mid-1997 along Nicaragua's east coast. Nietschmann (1981) estimated that 1000–1200 hawksbills were harvested annually along this coast in the late 1960s and early 1970s. Lagueux (1998) recorded minimum landings of 86, 109, and 53 hawksbills in 1994, 1995, and 1996, respectively (avg. = 83), at eight of the principal turtling communities and Caribbean coastal commercial centers from Sandy Bay in the north to Set Net in the south (just north of Bluefields). This coverage represents the majority of the area where harvesting occurs; it does not include landings by Rama Indians in the southern part of the country. Lagueux's recorded minimum landings represent a decline in capture rate of 92% in 28 years (less than one generation time for the hawksbill).

Lagueux (1998) also compared total landings of hawksbills in the community of Tasbapaune during the same six-month period in 1968 and 1971 (Nietschmann, 1972, 1973) with those from the same six-month period in 1995, 1996, and 1997. The average number for 1968 and 1971 was 67; for 1995, 1996, and 1997 it was 14 hawksbills per year, a decline of 79%. Lagueux (1998) attributed the change to a decline in the hawksbill population rather than to a decline in the demand for hawksbill shell. She reported that the tortoiseshell market in Nicaragua remained active, with demand for shell created by cottage-based industries and retail jewelry stores. Tortoiseshell products are sold throughout the country, including at the international airport.

Costa Rica. — Another site in Central America for which relatively long-term data are available on hawksbill populations is Tortuguero, Costa Rica. This nesting beach is 35 km long and is located within the boundaries of Tortuguero National Park, established in 1975. It has been monitored since 1955, primarily for the green turtle (Carr and Giovannoli, 1957), although nesting events by all species encountered are recorded. Carr and Stancyk (1975) compared the number

of hawksbills encountered per unit of patrol effort for two four-year periods. Encounters decreased substantially from 2.3 hawksbills per unit of patrol effort in 1956–59 to 0.60 in 1970–73. The equivalent value for 1988–91 was calculated by Bjorndal et al. (1993) to be 0.35 hawksbills, a decline of 85% from the 1956–59 levels in less than one generation time. Mean carapace length of nesting hawksbills at Tortuguero was found to have decreased significantly from 1955 to 1977 ($p = 0.0005$), indicating population instability (Bjorndal et al., 1985). An analysis of the data from 1972 to 1991 (encompassing years with standardized patrol effort) revealed a significant downward trend ($p = 0.014$), which led the researchers to conclude that the Tortuguero nesting population has been declining continuously since monitoring began in 1956 (Bjorndal et al., 1993). During the last 18 years (1980–97), fewer than a dozen hawksbills have been recorded on the 8 km of patrolled beach each year in an area that up to the mid-1960s supported a hawksbill fishery (Carr et al., 1966; Carr and Stancyk, 1975; Meylan, 1999a).

Panama. — Chiriquí Beach, Bocas del Toro Province, Panama, was described by Carr (1956) as the most important hawksbill nesting beach in the Caribbean. Records of the beach date back to at least the early 1800s, when Roberts (1827) mentioned its importance in his account of bartering for tortoiseshell in the region in 1815. The yield of hawksbills from this 29 km beach has been sufficiently important to the local economy during the 20th century that the beach was divided into approximately one-mile sections and leased out by the government. *Veladores* or "stayers awake" paid a head tax for the rights to all female hawksbills nesting on their section of the beach. Former *veladores* interviewed in the 1980s independently reported capturing as many as 35 to 50 hawksbills on their one-mile section per night in the early 1950s (A. Meylan and P. Meylan, unpubl. data). Assuming the nesting density was equal throughout the beach, this would represent a maximum of 900 females nesting on a single night. One section called Satu produced a total of 200–300 hawksbills in 1942. These same *veladores* estimated that one could catch only between 1–5 hawksbills per night in 1980, a 90% decline from the early 1950s. The government's leasing system was no longer in effect in 1980, although the Ngobe Indians still had a system of allocating rights to hawksbills nesting on Chiriquí Beach. Ground surveys of the entire beach in 1980 and 1981 during the nesting season revealed 17 and 13 tracks, respectively; the tracks were of various ages and included both successful and unsuccessful nesting attempts (Carr et al., 1982). Assuming a maximum of 17 nests for the entire beach, this would represent a decline of 98% from 1950 levels. Aerial surveys of the beach from 1979 to 1981 also did not reveal any significant nesting. A ground survey of the entire beach during the 1990 nesting season documented one hawksbill nest and two non-nesting emergences (A. Meylan and P. Meylan, unpubl. data). Six groups of Ngobe Indians were encountered on the beach looking for hawksbills during the night of the survey. This nesting aggregation can be considered severely depleted.

Eastern Atlantic Ocean and Mediterranean Sea

The status and distribution of hawksbills in the eastern Atlantic are poorly known. Groombridge and Luxmoore (1989) found no data to suggest that there was significant nesting, but there is a recent report of 200 females nesting annually in the Meio Islands, Guinea Bissau (Paris and Agardy, 1993) that needs to be corroborated. Fretey (1998) commented on the great importance of this site, should it be verified. In summarizing occurrence and nesting records for the west coast of Africa, Fretey (1998) described the hawksbill's distribution along the Atlantic coast of Africa as sporadic, with nesting also occurring in the Cape Verde Islands, Mauritania, Senegal, Bioko, São Tomé, and Príncipe. São Tomé and Príncipe in the Gulf of Guinea were recognized in the late 1800s as sites where nesting by hawksbills occurred and where tortoiseshell items were manufactured and traded (Greef, 1884). Recent data from São Tomé, Príncipe, and Bioko confirm that nesting still occurs, but no estimates of the number of nests exist (Castroviejo et al., 1994). The hawksbill population is described by these authors as being severely depleted due to overexploitation for the shell trade. Graff (1996) reported that the harvest of turtles in São Tomé remained unregulated, and tortoiseshell items were sold to tourists.

No estimate of the total number of hawksbills nesting in the eastern Atlantic has been published. On the basis of current information, it appears that only a few hundred animals nest in the region annually.

Nesting by the hawksbill has never been reported in the Mediterranean Sea, and documented reports of sightings at sea are almost nonexistent (Groombridge, 1990).

Indian Ocean

The Indian Ocean (Fig. 3) has historically been an extremely important area for the hawksbill turtle. Populations in the Red Sea have been described as having once been "immense" (Hirth and Abdel Latif, 1980); hawksbills once occurred in the Seychelles in "prodigious quantities" (Parsons, 1972). Perhaps the best indication of the former importance of Indian Ocean hawksbill populations is the fact that three of the six geographical classes of tortoiseshell recognized in the European tortoiseshell trade originated in the Indian Ocean: Zanzibar-Bombay, Mauritius-Seychelles, and Sri Lanka (Parsons, 1972). Madagascar, Seychelles, Mauritius, the Chagos Archipelago, the Maldives, the Lakshadweep Islands (formerly the Laccadives), and the south coast of Sri Lanka have been important producers of shell over the years (Parsons, 1972).

The volume of trade in tortoiseshell in the Indian Ocean gives an indication of the size of hawksbill populations during the 20th century. Between 1970 and 1986, exports of tortoiseshell from the western Indian Ocean (Kenya, Tanzania, Somalia, Maldives, Ethiopia, Madagascar, Mozambique, Réunion, and the Comoros) to Japan, one of several major

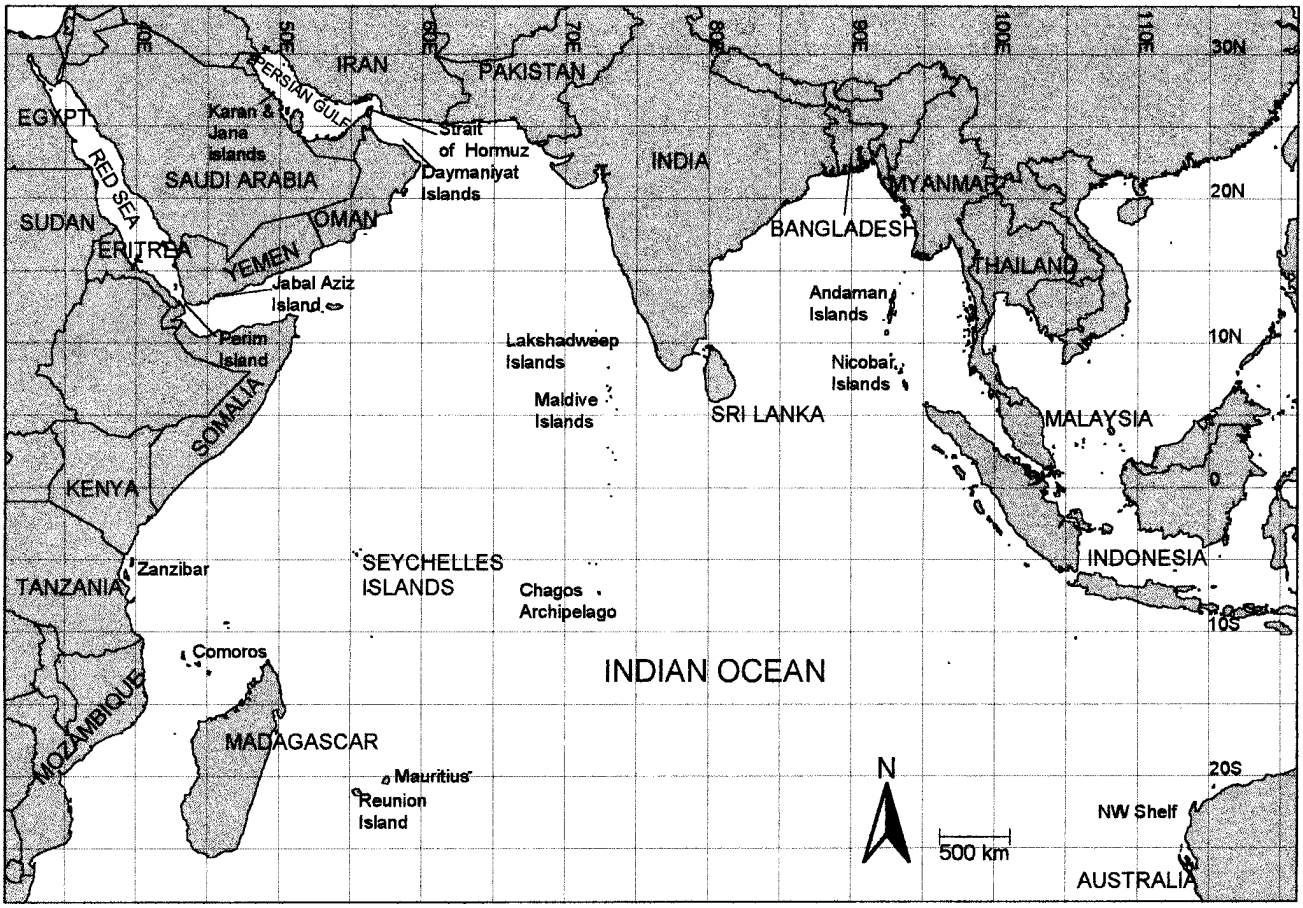

Figure 3. Indian Ocean. Some of the localities mentioned in the text are labeled.

importing countries, totaled 67,331 kg (representing 90,987 hawksbills) (Milliken and Tokunaga, 1987).

Few long-term monitoring programs for hawksbills exist in the Indian Ocean, but faunal surveys and trade records indicate that populations have declined throughout the region. As described below, these declines have been very large in some cases, and there are areas where nesting females have been nearly extirpated from traditional nesting sites. Only two populations (Seychelles and the Northwest Shelf of Australia) are documented to comprise more than 1000 females nesting annually (Mortimer, 1984; Limpus, 1997); a third (Iran) was roughly estimated to number 1000 nesting females based on surveys conducted 27 years ago (Kinunen and Walczak, 1971). The Seychelles population was already considered depleted in 1984 (Mortimer, 1984) and is believed to have declined further since then (Mortimer, 1998). The current status of the Iranian population is unknown.

Western Indian Ocean

Frazier (1982) reviewed the status of hawksbill populations in the central western Indian Ocean based on preliminary surveys conducted in the late 1960s and early 1970s and estimated the number of hawksbills nesting annually as follows: Seychelles, 600; Comoros, 50; Mayotte 25; Tanzania, 50; Kenya 50; and Somalia, unknown (altogether approximately 800 hawksbills nesting annually throughout this region).

Frazier (1982) estimated that 300 hawksbills nested annually in the British Indian Ocean Territory, which consists of the isolated Chagos Archipelago and the southernmost islands in the Laccadive-Maldive Ridge. Mortimer and Day (in press) revised this estimate upwards to 300–700 females per year on the basis of more extensive surveys.

More recent data on the western Indian Ocean are available in national reports on the status of sea turtle populations of Eritrea, Kenya, Tanzania, Zanzibar, Mozambique, South Africa, Madagascar, Seychelles, Mauritius, Comoros, Mayotte, and the Iles Eparses (Réunion, Tromelin, and Europa) presented at a regional workshop in 1995 (Humphrey and Salm, 1996). According to the reports, the hawksbill is known to nest in small numbers in all of these geopolitical areas except South Africa, but the only significant population known to exist today is in the Seychelles (see below). Nearly all other national reports mentioned data indicating depleted or declining hawksbill populations and continuing exploitation (Humphrey and Salm, 1996). Mangar and Chapman (1996) reported that the last known turtle nesting attempt on the main island of Mauritius — where nesting turtles were reported by community elders to have once been a common sight — was in the mid-1970s. In Tanzania, some former nesting sites of marine turtles are no longer being used (Howell and Mbindo, 1996).

Seychelles. — The largest hawksbill populations remaining in the western Indian Ocean occur in the Seychelles, where an estimated 1230–1740 females nested annually in the early 1980s (Mortimer, 1984). Since then, however, populations have suffered further declines due to the nearly complete harvest of nesting females that occurred at most islands during the 30 years prior to 1994, when a total legal ban on turtle harvest was implemented (Mortimer, 1998). An exception to the downward trend is the small (30–80 females/year) nesting population at Cousin Island, which has been well protected since 1970. The Cousin Island population is showing signs of increase (Mortimer and Bresson, 1994b; Mortimer, 1995b; Mortimer and Bresson, 1999), but represents only 2–7% of the estimated total number of hawksbills that nested in Seychelles during the early 1980s (Mortimer, 1984). The exploitation of hawksbill turtles in Seychelles became particularly intense after the mid-1960s with the advent of the mask and snorkel, spearguns, underwater lights, outboard engines, and the high prices paid for raw shell (Mortimer, 1984). Mortimer (1984) estimated that 47–71% of the total estimated annual nesting population in the granitic Seychelles Islands was killed during the 1980–82 nesting seasons. As evidenced by a recent seizure of raw shell at the airport (Anonymous, 1997), slaughter of hawksbills for meat and shell and illegal export of tortoiseshell had continued in the Seychelles but at a lower level than previously (Mortimer, 1998). Destruction of breeding and foraging habitat, especially in the granitic Seychelles, is an increasingly serious problem (Mortimer, 1998).

Madagascar. — Declines of hawksbill populations in Madagascar have been described as "drastic" and were noted as early as 1930 (Hughes, 1973). The declines are attributed to extensive human exploitation. The long-term trend of Madagascar's hawksbill population is well documented. Tortoiseshell was recognized as an important export as early as 1613 (Decary, 1950). It remained important throughout the 19th century, with 4000 kg being exported annually during the 1850s. The first signs of a drastic decline were observed shortly after World War I (Petit, 1930). By the mid-20th century, exports declined to around 1000 kg/yr and by 1973 the trade had no economic importance (Hughes, 1973). Hughes (1973) attributed the collapse of the population to overexploitation and calculated that at least 1600 adult turtles must have been killed annually for a period of 100 years. Groombridge and Luxmoore (1989) questioned Hughes' (1973) interpretation of population trends between the end of World War II and 1973, speculating that decreased exports of raw shell may have, in part, been compensated by increased exports of worked shell. These authors noted that the increased harvest of immature turtles in recent years would be likely to have a long-term effect on the remaining populations. Rakotonirina and Cooke (1994) reported that although the absolute numbers of hawksbills harvested in Madagascar had declined, trade was still continuing and was being promoted by the growth of the tourism industry. Stuffed hawksbills sold for as much as US $100 to European tourists visiting on cruise ships. In March 1997, worked hawksbill shell curios were widely available for sale to tourists in the Nosy-Bé area (J. Mortimer, *pers. comm*.).

Red Sea and Gulf of Aden

Hawksbill populations in the Red Sea and Gulf of Aden have been insufficiently surveyed, but there are data suggesting that the species nests widely on islands off the coasts of Egypt (Frazier and Salas, 1984), Sudan (Moore and Balzarotti, 1977; Hirth and Abdel Latif, 1980), and possibly Eritrea (Hillman and Gebremariam, 1996). Frazier and Salas (1984) made an order-of-magnitude estimate of 500 individuals nesting annually in Egypt. Moore and Balzarotti (1977) estimated that 300–350 hawksbills nested annually in Sudan, but Groombridge and Luxmoore (1989) suggested that this estimate might be somewhat conservative. No estimates are available for Eritrea. Aerial surveys of the Red Sea coast of Saudi Arabia revealed low-density nesting by hawksbills from the islands of the Farasan Archipelago to Tiran Island at the Gulf of Aqaba (Miller, 1989). Perim Island and Jabal Aziz Island in Yemen are considered important hawksbill nesting sites (Hirth and Carr, 1970). Ross and Barwani (1982) estimated that a total of 500 females nested annually in Yemen. Most of the surveys in the Red Sea and Gulf of Aden were carried out 15 or more years ago; new surveys are badly needed in this area.

Arabian Sea, Gulf of Oman, and Arabian Gulf

An estimated 600–800 hawksbills nest annually in Oman, primarily along the beaches of the Gulf of Oman (Salm et al., 1993; Baldwin and Al-Kiyumi, in press). The Daymaniyat Islands account for 250–350 of these nesting females. Due to the protected status of these islands and the high pollution levels that exist in the Arabian Gulf, Salm et al. (1993) considered this the last sanctuary of any real value to hawksbills in the region.

Hawksbill nesting in Saudi Arabia is concentrated on two islands in the Arabian Gulf: Jana Island and Karan Island (Miller, 1989; Pilcher, 1999). Ross and Barwani (1982) estimated that approximately 100 females nested annually in Saudi Arabia. This estimate needs to be revised upward, as Pilcher (1999) was able to tag 164 and 127 nesting females on Jana, Karan, and Kurayn islands in 1991 and 1992, respectively. Pilcher (1999) stated that the only hawksbill nesting aggregation in Saudi Arabia was located on the four small islands in the Arabian Gulf that include Jana and Karan. An aerial survey in 1991 and ground surveys from 1989 to 1992 revealed no major nesting areas along Saudi Arabia's 1742 km coast on the Red Sea, or along the 450 km mainland coast of the Arabian Sea (Pilcher, 1999).

Data on hawksbill nesting in Iran come from older surveys (Kinunen and Walczak, 1971). From these data, Groombridge and Luxmoore (1989) estimated that approximately 50–100 females nest at Queshm, Larak, and Hormuz

islands in the Straits of Hormuz. Another 300 females were estimated to nest on Shitvar and Lavan islands in the Arabian Gulf, with an estimated total of 1000 females nesting annually in all of Iran (Ross and Barwani, 1982). The status of the Iran population is totally unknown at this time, but if the population still exists, it may be one of the most important in the Indian Ocean. Groombridge and Luxmoore (1989) indicated that exploitation and disturbance of marine turtles appeared to be significant, and they mentioned the threat posed to sea turtle habitats by oil-loading facilities and warfare.

Central Indian Ocean

Maldives. — The Maldives have been a source of tortoiseshell for centuries and were well known for this trade as early as the 12th century (Parsons, 1972; Frazier et al., 1988). They were one of the principal sources of tortoiseshell for the artisan carving industry in Sri Lanka. An average of 3135 kg of tortoiseshell (representing 4237 individuals) were exported annually from the Maldives during the period 1970–79 (Groombridge and Luxmoore, 1989). Frazier et al. (1988) reported a major tourist trade existed for curios and stuffed turtles, and shell was also exported. In surveying nesting populations, Frazier et al. (1988) noted that nesting data were inadequate; they concluded that nesting was widespread but not concentrated and estimated that the annual breeding population of the islands numbered in the hundreds. They observed that on many uninhabited islands it was likely that every nesting turtle was killed. Based on past and ongoing exploitation, Frazier et al. (1988) concluded that the population had declined dramatically. A ten-year moratorium on the catching or killing of any turtle in the territorial waters of the Maldives went into effect in June 1995, but the taking of eggs is still allowed (Zahir and Hafiz, in press).

Pakistan. — There are no records of hawksbill nesting in Pakistan. Preliminary surveys of Baluchistan in 1987 did not reveal nesting by this species (Groombridge et al., 1988; Groombridge and Luxmoore, 1989).

India. — Nesting by hawksbills on mainland India appears to occur at extremely low levels and is of little national or regional significance (Groombridge and Luxmoore, 1989). Bhaskar (1993) estimated that 250 hawksbills nest annually in the Andaman and Nicobar islands, with the majority in the Andamans. India has been a major exporter of tortoiseshell (Mack et al., 1979), although it is not known whether India was the site of origin for this shell or served as a conduit for its trade. Currently known populations would not seem to account for the volume of trade reported.

Sri Lanka. — Sparse nesting by hawksbills occurs around Sri Lanka, but the species is considered uncommon (Dattatri and Samarajiva, 1983). During July 1995 to June 1996, only 403 hawksbill eggs (probably 3 nests) were moved to the hatcheries along Sri Lanka's western, southwestern, and southern coasts (Amarasooriya, 1996); only 10 nests were reported along the south coast of Sri Lanka during 1994–96 (Jaywaradene, 1996). No recent data are available for the northern and eastern coasts of Sri Lanka because of political unrest, but the historical nesting beaches were located on the southern coast. Hawksbills are said to have nested in abundance along the south coast in the 19th century. Dattatri and Samarajiva (1983) reported that the species is probably continuing to decline.

Since the Middle Ages, Sri Lanka has been a trading center for Arab, Indian, Javanese, and Chinese traders seeking tortoiseshell (Parsons, 1972). Tortoiseshell has been imported for local manufacture — in recent centuries, largely from the Maldives — but in the past raw shell was also exported by Sri Lanka (Bennett, 1843; Deraniyagala, 1939; Parsons, 1972; Jaywaradene, 1996). Deraniyagala (1939) reported that hawksbills were depleted in Sri Lanka by the time of his writing and referenced a historical account by Bennett (1843) of dense nesting by hawksbills on the southeast coast in the middle of the 18th century. Bennett (1843) reported that hawksbills nested in such abundance that the government leased out the right to individuals to harvest the shell from nesting turtles (apparently similar to the *velador* system described above for Caribbean Panama). He stated that "any quantity of 'tortoiseshell' of the harvest may be purchased of the fish renter." Although the tortoiseshell trade still exists in Sri Lanka, most of the raw shell is now smuggled in from the Maldives (Jaywaradene, 1996).

Eastern Indian Ocean

Myanmar. — Hawksbills are considered rare in Myanmar (Burma); an estimated 30 females nested in the Bawmi area, Bassein district, in the early years of the 20th century (Groombridge and Luxmoore, 1989). Populations are believed to have declined, as have green turtles (by 90%) over the present century (Groombridge and Luxmoore, 1989).

Malaysia, Thailand, Indonesia, and Australia have some nesting beaches that are in the eastern Indian Ocean, but these are described in the Pacific Ocean section to allow a single treatment of geopolitical units.

Current Population Estimate for the Indian Ocean

On the basis of current knowledge of nesting by hawksbills in the Indian Ocean, we estimate that a maximum of 6000 to 7000 females nest annually in the region, including the females nesting on the Indian Ocean beaches of Thailand and Malaysia, but excluding the females that nest on the Indian Ocean beaches of Indonesia and Australia.

Long-Term Trends in the Indian Ocean

The Indian Ocean once hosted large populations of hawksbills that probably included tens of thousands of females nesting annually. There has been a long history of exploitation of both nesting females and eggs throughout the region, however, with reports of significantly reduced popu-

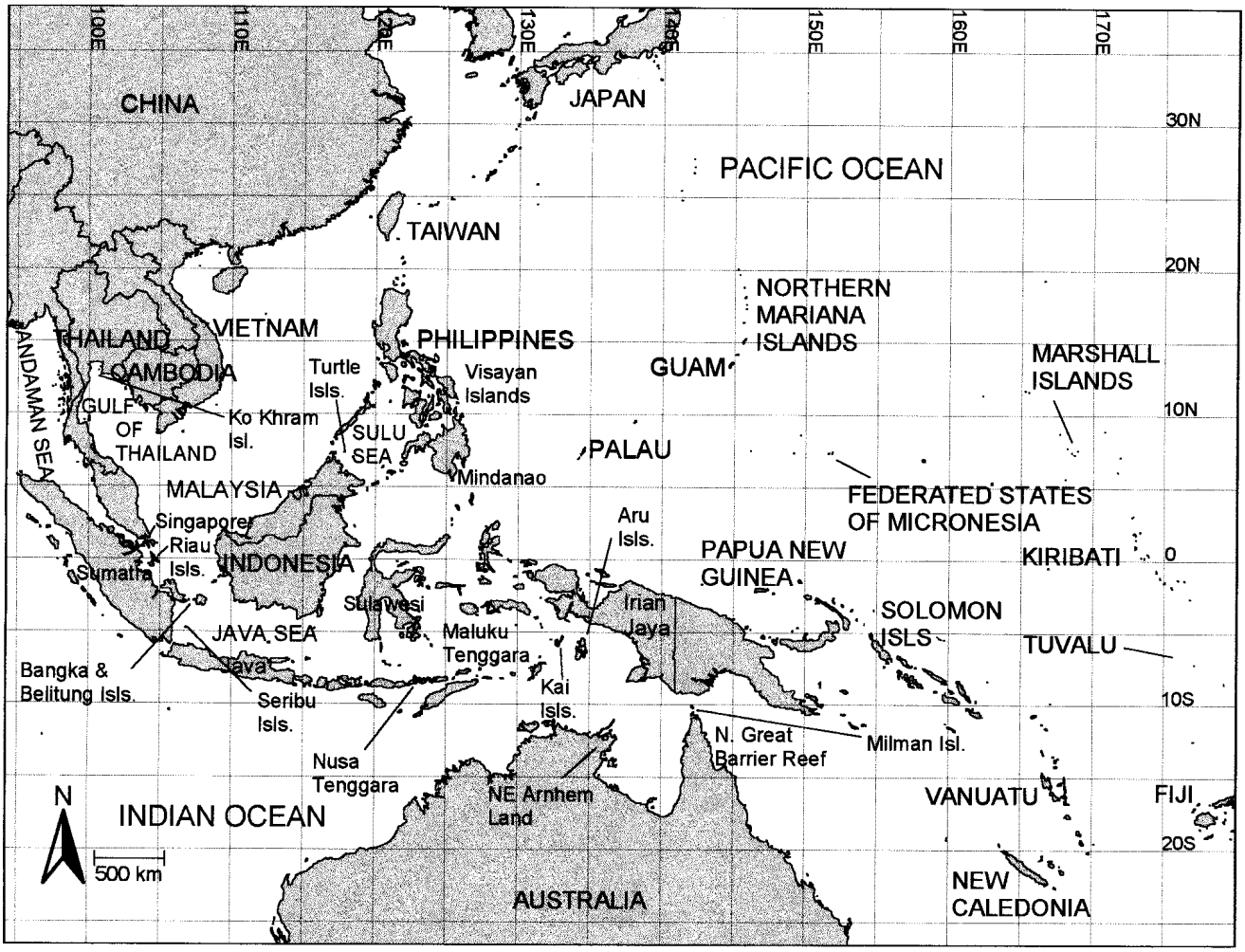

Figure 4. Western Pacific Ocean. Some of the localities mentioned in the text are labeled.

lations. Hawksbill nesting populations on mainland Africa and Asia and most islands have declined dramatically in the last 100 years (Dupont, 1929; Petit, 1930; Hughes, 1973; Polunin, 1975; Ginsberg, 1981; Frazier, 1982; Salm, 1984; Schulz, 1984, 1987, 1989; Mortimer, 1984; 1988; Groombridge and Luxmoore, 1989; Humphrey and Bain, 1990; Humphrey and Salm, 1996).

Pacific Ocean

Western Pacific Ocean

As noted earlier, Malaysia, Thailand, Indonesia, and Australia also have eastern Indian Ocean nesting beaches that are described in this section on the Pacific Ocean (Fig. 4) to allow a single treatment of geopolitical units.

Thailand. — Hawksbills nest on the west coast of Thailand in the Indian Ocean (Andaman Sea) and on the east coast in the Gulf of Thailand. The decreased number of eggs harvested during the last 40 years indicates that populations of all species have declined significantly throughout the country as a result of egg collection, incidental catch in fisheries, killing of adults, and destruction of nesting habitat (Polunin, 1975; Ginsberg, 1981; Mortimer, 1988; Groombridge and Luxmoore, 1989; Humphrey and Bain, 1990; Monanunsap, 1997; Chantrapornsyl, in press).

In the Indian Ocean, hawksbills are known to nest in the Sulin Islands, the Similan Islands, and within Tarutao National Park (Ko Klang and Ko Kai), but there is no indication of other than low-level nesting (Mortimer, 1988; Monanunsap, 1997; Chantrapornsyl, in press). Ginsberg (1981) noted that a particularly rapid decline in levels of nesting by sea turtles had occurred at Tarutao National Park by 1980; fewer than 100 nests of all species combined were estimated in the park during the 1980–81 nesting season (Congdon and Ginsberg, 1981). Between 1993 and 1996, an average of 64 nests (representing 13–21 females) were constructed by all species in the main nesting areas of the Andaman Sea (Monanunsap, 1997; Chantrapornsyl, in press).

In the Gulf of Thailand, Ko Khram (and adjacent islands) and Ko Kra have long been recognized as important nesting areas shared by green turtles and hawksbills. Whereas hawksbills today nest at Ko Kra only in small numbers, the nesting populations at Khram Island are considered the most concentrated in all of Thailand (Mortimer, 1988; Monanunsap, 1997; Chantrapornsyl, in press). Licensed egg

collection in these islands has been extensive (Groombridge and Luxmoore, 1989). On the basis of the known egg harvest at Ko Khram in the mid-1950s, Groombridge and Luxmoore (1989) calculated that approximately 100 hawksbills nested there each year during that period. This estimate agrees well with the annual nest total for Ko Khram during 1956 reported by Monanunsap (1997). In 1956, 224 hawksbill nests (45–75 individuals) were recorded. Between 1973 and 1995, the annual number of nests ranged from 27 to 126 (representing a maximum of 9–42 individuals) (Monanunsap, 1997). During 1990–95, an average of 55 nests was recorded, representing 11–18 females. This would indicate a decline of 76% during the last 40 years. Despite this long-term decline, the Ko Khram hawksbill nesting population is considered to have been stable in recent years (Limpus, 1997). Monanunsap (1997) reported that this nesting population has not declined significantly in recent years.

Thailand has figured prominently in reported imports and exports of tortoiseshell (Mack et al., 1979), although Groombridge and Luxmoore (1989) suggested that reported "tortoiseshell" exports may actually be the shell of freshwater turtles. However, Ginsberg (1981) reported that hawksbills were extensively exploited for shell, so it is possible that at least some of the exports in question were hawksbill shell.

Malaysia. — Mortimer et al. (1993) compiled estimates of the number of hawksbill nests constructed annually in each of the states of Malaysia in which this species is known to occur; the sum of these estimates was a maximum of 1325 hawksbill nests (265–442 females). The Turtle Islands in the state of Sabah (Sulu Sea) and beaches in the state of Melaka are recognized as the two most important national rookeries (Mortimer, 1992; Mortimer et al., 1993; Pilcher and Ali, 1999; Chan and Liew, 1999; Liew, in press). Limpus (1997) considered the Turtle Islands, with several hundred females nesting annually (see also Trono, 1994; Pilcher and Ali, 1999), to be the largest remaining hawksbill rookery in Southeast Asia. This hawksbill population is also considered to be the only one in Southeast Asia that may be increasing in size, although Mortimer urged caution in interpreting the data because of incomplete record-keeping in early years of the program there (Limpus, 1997). More than 350 nests were estimated annually in the state of Melaka (Mortimer et al., 1993), a figure consistent with an estimate of fewer than 100 females nesting annually in this state (Limpus, 1997). Fewer than 25 nests/yr were estimated for each of the states of Kedah, Pulau Pinang, and Perak. In combination with the estimate for Melaka, this represents a total of fewer than 425 nests for the west coast of peninsular Malaysia (in the Indian Ocean) (Mortimer et al., 1993). Limpus (1997) reported fewer than 100 females nesting annually in Johor, but in fact, the actual number may be significantly lower, based on the estimate of 100–200 nests reported by Mortimer et al. (1993). Low-density nesting also occurs in Terengganu and Pahang (Mortimer et al., 1993; Liew, in press); between 12 and 72 nests have been recorded annually in Terengganu during 1987–96 (Chan and Liew, 1999).

Numerous reports have been written about the significant decline of sea turtle populations in Malaysia during this century (de Silva, 1969, 1982, 1984; Siow and Moll, 1982; Mortimer, 1988; Mortimer et al., 1993; Groombridge and Luxmoore, 1989; Chan and Liew, 1996; Liew, 1997; Limpus, 1997). Large numbers of eggs have been collected for many decades, contributing substantially to these declines (de Silva, 1982; Groombridge and Luxmoore, 1989). In 1927, concern about the status of the hawksbill in Sabah resulted in a temporary ban on hunting and the introduction of a closed season (de Silva, 1982). Liew (1997) noted that although conservation efforts have been underway in Malaysia for 40 years, management efforts appear to be insufficient; apart from the populations in the Turtle Islands of Sabah, most are continuing to decline, some to near extinction. Coastal development and accidental capture of turtles in fishing gear have been identified as significant threats in Malaysia (Chan et al., 1988; Mortimer et al., 1993; Limpus, 1997; Pilcher and Ali, 1999; Liew, in press).

Malaysia has not exported substantial amounts of tortoiseshell over the years, although large quantities of turtle eggs have been traded (Groombridge and Luxmoore, 1989).

Indonesia. — The status of hawksbill populations in Indonesia is particularly difficult to evaluate because few census data exist and the extent of habitat is vast. Hawksbills occur from northern Sumatra, Riau Islands, Banka-Belitung, Java Sea, south Sulawesi, and East Nusa Tenggara (I. Suwelo, *in litt*.). Fifteen years ago, Salm (1984) estimated that 20,000 hawksbill nests (4000–6666 turtles) were constructed annually in Indonesia. Schulz (1987) calculated an estimate of 21,000 to 28,000 nests (5600–9333 turtles). Limpus (1997) reported that there are numerous areas in Indonesia where tens to hundreds of nesting females occur and estimated a country-wide total in excess of 2000 females nesting annually (C. Limpus, *in litt*).

Although this estimate is large by regional and even global standards, current hawksbill populations in Indonesia are apparently only a small fraction of their former size. Parsons (1972) described the shoal waters of the East Indian archipelago as once being the most productive for tortoiseshell of all the world's seas. The tortoiseshell trade in Indonesia was mentioned in the literature as early as 1599 (Parsons, 1972). For many decades, hawksbills have been extensively exploited for eggs, tortoiseshell, and more recently, the curio trade in stuffed specimens (Mack et al., 1979; Polunin and Nuitja, 1982; Salm, 1984; Schulz, 1984, 1987, 1989; Milliken and Tokunaga, 1987; Groombridge and Luxmoore, 1989; Greenpeace and TRAFFIC Japan, 1990; I. Suwelo, *in litt*.).

J. Schulz (*in litt*. to K. Bjorndal, 1995) concluded that declines in numbers of nesting hawksbills in Indonesia over the last 100 years may have been as great as 80%, based on his own extensive survey work and familiarity with the country as well as historical data. He personally visited 300 islands and islets in 1984–92, finding 1–10 nests per year on approximately half of them. Annual production on 15 beaches in the province of Riau, where more than 100 nests per year

were constructed before the early 1970s, had been reduced to fewer than 10 nests on each beach (a decline of more than 90%). He noted that "almost every egg is taken in virtually every nesting place in Indonesia, however small or far-off it may be" and every fisherman complained that hawksbills had become rare and large sizes were rarely caught.

In 1994 and 1995 A. Suarez (*in litt.*) interviewed more than 60 fishermen in the Kai Islands (Moluccas Archipelago) where large numbers of hawksbills were formerly taken for the shell trade. She reported that hawksbills were taken whenever they were encountered and sold to buyers who exported the shell from Ambon or Ujung Pandang; she witnessed the sale of several juvenile hawksbills to buyers visiting the villages. Although scattered nesting still occurred on some uninhabited islands, every person she interviewed noted that hawksbills had become very rare.

Kitchener (1996) described results of 13 expeditions to eastern Indonesia (Nusa Tenggara and Maluku Tenggara) between 1988 and 1995. All of the known or reported major hawksbill and green turtle rookeries examined during these surveys either had no or very low-level nesting; some rookeries appeared to have declined since 1990. Only four rookeries in these provinces had more than 10 individual turtles nesting per night.

In a recent survey of 15 of the 30 known hawksbill rookeries in the Java Sea, Suganuma et al. (1999) determined that nest predation by humans was nearly total. Of the 2000 nests recorded at 15 rookeries, only two clutches hatched naturally. Approximately 35 nests are reburied annually by the Japan Bekko Association (JBA) – Indonesian Directorate General of Forest Protection and Nature Conservation (PHPA) Project at Seribu and Segama Islands. Suganuma et al. (1999) noted that during the last decade, annual numbers of hawksbill nests at the Momperang Islands northeast of Belitung declined from 3250 (Schulz, 1987) to an estimated 400 in 1996 (an 88% decline) and that the overall regional decline in the Java Sea had been about 72%. Suganuma and Kamezaki (1997) estimated that 2900–3500 clutches were laid annually in West Java, Makassar Strait, and Karimata Strait.

Halim et al. (1997) reported that only a very few of the 108 islands of the Seribu Islands, Java Sea, are still visited by nesting turtles. Nevertheless, it is still considered an important hawksbill rookery, an estimated 300 individuals nesting annually (I. Suwelo, *in litt.* to A. Meylan). Exploitation and, in recent years, development of the tourism industry are cited as factors in the decline.

Although many beaches in Indonesia have not been surveyed, the recent reports cited above from those areas that have been covered are consistent in reporting intense egg harvest and precipitous declines in nesting. These have occurred within just the last few decades — less than one hawksbill generation.

Indonesia has served as a source for the tortoiseshell trade for centuries. Hawksbills were taken on the reefs of southern Sulawesi for trade with Arab and Chinese traders before the arrival of Europeans in the 16th century; the journals of European traders listed tortoiseshell from the Aru Islands in the 17th century (Schulz, 1989). In the 1970s, however, exploitation increased significantly. Tortoiseshell trade export data provide information about the extent of hawksbill exploitation in Indonesia. For the period 1970–86, official Japanese import statistics document that Indonesian exports of bekko (tortoiseshell) to Japan, its largest but not only trading partner, amounted to 105,479 kg (representing 140,638 adult hawksbills) (Milliken and Tokunaga, 1987). Much, if not most, of the 44,411 kg of shell shipped to Japan from Singapore during this same time period is believed to be of Indonesian origin (Milliken and Tokunaga, 1987). In addition, Indonesia has maintained a significant domestic trade in hawksbill shell (Limpus, 1986; Greenpeace, 1989, 1991; Greenpeace and TRAFFIC Japan, 1990). In a 1974 report to the Japanese Tortoise Shell Association, Kajihara estimated that about 5000 hawksbills were taken annually from the main fishing grounds before 1971; after 1972, captures increased to 30,000 per year (cited in Schulz, 1987). Declining weights of shell suggest overexploitation of larger animals. In 1987, traders reported a sharp decline in the supply of heavy scutes (Schulz, 1987). There also has been a significant curio trade in Indonesian hawksbills. Between 1970 and 1986, 428,859 stuffed juvenile hawksbills were exported to Japan from Indonesia and an additional 88,539 turtles, of probable Indonesian origin, were exported by Singapore (Milliken and Tokunaga, 1987). In total, these 1970–86 export data, which do not include Indonesian exports to all its trading partners, document trade in tortoiseshell and stuffed specimens representing more than 700,000 juvenile and adult turtles (Milliken and Tokunaga, 1987).

Philippines.—Hawksbills nest in low densities throughout the Philippines, but no major nesting aggregations have been identified (Palma, 1994, 1997). No quantitative data on nesting levels are available except for the Turtle Islands in the Sulu Sea, where hawksbills constitute a minor portion of the nesting population (the majority of hawksbills in the Turtle Islands nest on the Malaysian islands; Groombridge and Luxmoore, 1989). The Turtle Islands populations, which include both green turtles and hawksbills, have experienced an 82% decline in egg production over the last 45 years due to large and long-term harvests (Palma, 1997).

The decline of sea turtle populations in the Philippines, including the hawksbill, is well documented (Alcala, 1980; de Celis, 1982; Groombridge and Luxmoore, 1989; Palma, 1994, 1997). Populations have declined as a result of the exploitation for shell, meat, and eggs. Alcala (1980) reported that "it is probably safe to state that most, if not virtually all, nesting turtles in the Central Visayas end up on the table and in souvenir shops. There is reason to believe that a similar situation exists throughout the Philippines." Palma (1997) reported that the preference for hawksbill shell in international trade is the primary reason for the hawksbill's rarity.

The Mindanao coast and the Sulu district of the southern Philippines were a source of tortoiseshell in ancient times (Parsons, 1972). A report from 1609 (Taylor, 1921) de-

scribed tortoiseshell as a conspicuous product in the Philippines. The tortoiseshell trade apparently continued to be important up through the present century. In 1909, 2040 kg were exported, and the trade was considered to be of distinct economic importance (Taylor, 1921).

Between 1970 and 1986, the Philippines exported 32,921 kg of tortoiseshell to Japan (representing 44,488 turtles), making the Philippines Japan's third most important source for bekko in Asia (Milliken and Tokunaga, 1987). In 1982, de Celis (1982) observed that about 2000 juveniles were stuffed and exported each year from the Philippines. Between 1970 and 1986, 8698 stuffed turtles were exported to Japan (Milliken and Tokunaga, 1987).

Papua New Guinea. — Spring (1982a, 1982b) reported that hawksbills are widespread in Papua New Guinea (PNG), and described the distribution of nesting. In surveys of the coast, the presence of hawksbill turtles on reefs was reported at nearly all villages (Spring, 1982a, 1982b), but anecdotal information suggested that hawksbills are not as abundant as they once were (S. Spring, *pers. comm.*). Exploitation of marine turtles has increased as traditional hunting methods have been abandoned (Spring, 1982a, 1982b). Ulaiwi (1997) reported that marine turtle populations in PNG have declined significantly in the last 20 years.

Hawksbills are utilized for their shell, eggs, and meat in PNG (Spring, 1982a, 1982b), although they are not as favored as green turtles. Eggs are collected and eaten when found; the shell is used to make a variety of traditional *bilas* such as rings, earrings, and bracelets, as well as combs, fish hooks, and bride price items. Shells also are kept as decorations or sold in the markets and artifact shops for tourists (Spring, 1981, 1982a, 1982b). There is a small domestic trade in shell and traditional tortoiseshell ornaments and jewelry, particularly in Port Moresby (S. Spring, *pers. comm.*), but tortoiseshell has not been exported commercially since PNG acceded to CITES in 1976.

In daily surveys at Koki Market in Port Moresby from February 1979 to December 1981, Spring (unpub. data) recorded 154 hawksbill turtles for sale. In 38 market inspections carried out from February 1989 to January 1990 by Hirth and Rohovit (1992), no hawksbill turtles, meat, or shell was observed for sale in the Koki Market; eggs were observed for sale on two occasions. Kwan (1989) estimated that from 1985 to 1987, hawksbills accounted for 2–5% of the catch in the Daru turtle fishery; more recent statistics are not available.

Long-distance tag recoveries indicate that hawksbill populations in PNG are part of larger regional populations. Long-distance movements of hawksbills have been recorded between northern PNG and Australia (Miller et al., 1998), and southern PNG and the Solomon Islands (Vaughan and Spring, 1980). C. Limpus (*pers. comm.*) predicts that more hawksbill nesting beaches will be discovered as researchers visit remote areas that have not been surveyed.

Australia. — Limpus (1997) recently summarized the status of hawksbill populations in Australia. Two large hawksbill breeding aggregations exist (each consisting of several significant rookeries): 1) Northern Great Barrier Reef, Torres Strait, and northeastern Arnhem Land; and 2) the North West Shelf. An order-of-magnitude estimate for the first aggregation was previously given as more than 3000 females nesting annually; preliminary data from Milman Island suggest that this nesting population may be declining (Limpus, 1997; Limpus et al., 1997). The nesting population on the North West Shelf of Australia has not been completely surveyed in any one year but is estimated to consist of about 2000 females nesting annually (Limpus, 1997). This may be the largest remaining hawksbill nesting population in the Indian Ocean. On the basis of the above data and recent additional surveys, Limpus (*in litt.*) estimated that Australia's total annual nesting population of hawksbills numbers between 6000 and 10,000 — undoubtedly the largest populations remaining in the world. Limpus (*in litt.*) noted that these estimates are expected to increase as new and incompletely surveyed areas are reconnoitered; genetic evidence of what may be an abundant undiscovered rookery has been found by Broderick and Moritz (in press) in hawksbill foraging populations in the western Pacific.

The stability of Australian populations is unknown because of a lack of long-term census data (Limpus, 1997). However, preliminary results suggest a downward trend at Milman Island (Limpus, 1997; Limpus et al., 1997; Dobbs et al., 1999). Dobbs et al. (1999) suggest that the apparent decline may be a reflection of natural fluctuation in population abundance or environmental influences. Hawksbill eggs are eaten in the Torres Strait and Arnhem Land, but very few hawksbills are taken in Australia today (Limpus, 1997). The harvesting of animals that have migrated to adjacent countries, particularly the Solomon Islands and Indonesia, is thought to be reducing Australian populations. Limpus (1997) considered the Australian nesting populations to be vulnerable or possibly endangered because of the continuing declines in nesting in neighboring countries, high rates of harvest, and the biological constraints of the species in compensating for population losses.

Southern Pacific Ocean

Geermans and Farago (1993) presented an overview of hawksbill populations in the South Pacific region. Between 500 and 1000 hawksbills were estimated to nest annually, with several key areas identified as lacking information (Papua New Guinea, Vanuatu, Chuuk in the Federated States of Micronesia, and both American and Western Samoa). A recent study in American Samoa (Tuato'o-Bartley et al., 1993) estimated that a total of 120 green and hawksbill turtles nested there annually.

Limpus (1997) also provided an overview of South Pacific populations. The Solomon Islands are considered to be the largest nesting aggregation in the region, with several hundred females nesting annually. In recent years researchers in the Solomon Islands have discovered that more than 90% of the nesting hawksbills are first-time breeders (iden-

tified by laparoscopy), indicating that most females are not surviving to nest for more than one season (C. Limpus, *in litt.*). After eight years of tagging, no tagged females have returned to nest (C. Limpus, *in litt.*). Although census data are inadequate, Limpus (1997) estimated a decline of approximately 50% in this population in the last decade and indicated that the decline may be even greater than this. He attributed the problem to the annual take of several thousand hawksbills for local consumption and for the Japanese tortoiseshell trade. Broderick and Limpus (NMFS and USFWS, 1998) have suggested that populations of nesting hawksbills in the Solomon Islands must "in the recent past have numbered in the tens of thousands" in order to have produced the volume of tortoiseshell collected from those islands in the mid-20th century. According to government trade statistics, the Solomon Islands exported 18,650 kg of shell (representing about 20,000 adult hawksbills) between 1983 and 1990 (Geermans and Farago, 1993). The harvest in the Solomons is continuing despite the fact that there is currently no legal importation of tortoiseshell into Japan and no legal export from the Solomons (Limpus, 1997).

Hawksbills have been heavily exploited in the Pacific Islands for the export of raw shell and for the tourist curio trade (Groombridge and Luxmoore, 1989). The increase in human populations, the improvements in transportation, the accessibility to uninhabited islands, the breakdown of traditional beliefs that restricted hunting, and the growth in tourist traffic have all contributed to the increase in exploitation in recent decades. In the 1970s, egg collection and the exploitation of larger turtles were intense on many islands, and during the last 25 years nesting populations have been reported to be declining, depleted, or reduced to remnant numbers in Tonga, American Samoa, Western Samoa, Federated States of Micronesia, Tuvalu, Fiji, Tokelau, and Palau (Hirth, 1971; Bustard, 1972; Pita, 1979; Witzell and Banner, 1980; Balazs, 1982; McCoy, 1982; Pritchard, 1982a, 1982b; Johannes, 1986; NMFS and USFWS, 1998).

The Recovery Plan for US Pacific Populations of the Hawksbill Turtle (NMFS and USFWS, 1998) stated that the species is rapidly approaching extinction in the region. The Recovery Team suggested that a lack of regular quantitative surveys of distribution and status contributed to their failure to recognize how seriously depleted hawksbill populations had become in the Pacific. They noted that "the status of this species is clearly of highest concern for the Pacific and it is recommended that immediate actions be taken to prevent its extinction." The decline of nesting and foraging populations in Palau because of extensive egg collection and the harvest of adults (Pritchard, 1982b; Groombridge and Luxmoore, 1989; NMFS and USFWS, 1998) during the last 50–60 years exemplifies the vulnerability of the hawksbill in the Pacific. Nevertheless, Palau's annual nesting population of 20–50 females is considered to be the largest nesting population in Micronesia (NMFS and USFWS, 1998). Annual nesting numbers in all of Micronesia, an area that encompasses thousands of islands and atolls, may be limited to only a few hundred females (NMFS and USFWS, 1998). Few hawksbills are reported to nest in other areas, including the Northern Marianas, New Caledonia, Guam, and French Polynesia. Directed take has been identified as a primary threat in Guam, Palau, the Commonwealth of the Marianas, the Federated States of Micronesia, American Samoa, and the Republic of the Marshalls (NMFS and USFWS, 1998). Limpus (1997) reported that large numbers of hawksbills are taken on feeding grounds in Fiji and estimated that about 2000 hawksbills were harvested each year through mid-1994.

Eastern Pacific Ocean

Nesting by hawksbills in the Eastern Pacific is considered rare (Witzell, 1983). Low density nesting occurs at selected beaches along Central America's Pacific coast, but no major rookeries are known (Cornelius, 1982; Witzell, 1983; Groombridge and Luxmoore, 1989).

Current Population Estimate for the Pacific Ocean

Hawksbill nesting aggregations in the Pacific vary in size from large populations in Australia to very depleted populations in southeast Asia and the insular Pacific. Total estimates for the region are particularly difficult to make as it includes areas for which surveys are incomplete or nonexistent, such as beaches in Papua New Guinea, Indonesia, and Vanuatu. It is therefore not possible to estimate the nesting population in the Pacific with confidence.

MAJOR THREATS

Hawksbills are threatened by all the factors that threaten other marine turtles, including exploitation for meat, eggs, and the curio trade, loss of nesting and foraging habitat, incidental capture in fishing gear, ingestion of and entanglement in marine debris, oil pollution, and boat collisions (NMFS and USFWS, 1993; Lutcavage et al., 1997). These are in addition to the unique threat posed by exploitation for tortoiseshell.

The intensity and long history of the demand for tortoiseshell around the world have had a profound influence on the survival status of the species (Carr, 1972; Parsons, 1972; Mack et al., 1979; Nietschmann, 1981, Mortimer, 1984; Milliken and Tokunaga, 1987; Cruz and Espinal, 1987; Groombridge and Luxmoore, 1989; Meylan, 1989; Canin, 1991; Eckert, 1995; Limpus, 1997; Palma, 1997). Carr (1972) stated that "if the tortoiseshell trade could be killed, the hawksbill would probably survive." A similar view was expressed by Limpus (1997).

Nearly 25 years ago, the Japan Tortoiseshell Association reported that people involved in the trade claimed there were signs of hawksbill depletion (Mack et al., 1979). In 1975, in recognition of the impact of trade, the Atlantic population of the hawksbill was included on Appendix I of

CITES and the Pacific population was included on Appendix II. By 1977, the entire species was moved to Appendix I. Nevertheless, trade in hawksbill shell remained high for a number of years. In the late 1970s, at least 46 countries exported unworked tortoiseshell (Mack et al., 1979; Milliken and Tokunaga, 1987). By 1985, many exporting countries had come into compliance with CITES. Nevertheless, continuing imports by Japan, under a reservation or exception to the trade ban in its accession to CITES in 1981, fueled a continuing international trade. From 1981 to 1993, Japanese dealers imported about 30,000 kg of raw tortoiseshell per year. A zero quota was imposed on imports in 1993. Over this 12-year period, Japanese imports of tortoiseshell represented about 336,000 large hawksbills (Milliken and Tokunaga, 1987; Canin, 1991).

Although legal international trade in hawksbill shell has diminished considerably, trade continues between non-signatories of CITES. There is also considerable trade for domestic use. Hawksbills are hunted for their meat, tortoiseshell, and eggs in the majority of areas in which they are found. Exploitation has been exacerbated by technological advances in gear and the availability of outboard engines and the greater range they provide. Although Hendrickson (1980) suggested that the hawksbill's tendency to exhibit dispersed nesting distribution might confer increased ability to survive, this has not proven to be the case. Hunting pressure has intensified as coastal areas have become more densely populated, and in many areas, every nesting hawksbill is taken. Because hawksbills usually nest 3–5 times each reproductive season and often emerge more than once before successfully nesting, the chances of a given female surviving all her nesting emergences within any nesting season are very poor where hunting occurs (see Mortimer and Bresson, 1999). When first-time breeders and other females are killed prematurely, they are prevented from contributing to the survival of the species. If allowed to nest throughout her lifetime, an adult female hawksbill can be expected to lay 25 to 50 clutches of eggs over a period of 20 years (Mortimer, 1998; Mortimer and Bresson, 1999).

Hawksbills are also vulnerable to capture because of their close association with coral reefs. In many areas they are taken whenever they are encountered by fishermen targeting lobsters and other reef fish. The loss of nesting habitat to coastal development and the continuing loss and degradation of reefs around the world pose significant long-term threats to the species (Wilkinson, 1992; Jackson, 1997) that have not adequately been taken into consideration.

CONSERVATION MEASURES TAKEN

CITES has been one of the most effective conservation tools in protecting the hawksbill from the pressure of exploitation for tortoiseshell. Although tortoiseshell is used domestically in some countries, the vast majority enters international trade and thus is subject to CITES control. CITES has also reduced international trade in curios made from stuffed hawksbill turtles.

A number of countries have passed laws, designated protected areas, and developed management programs to protect hawksbills (reviewed in Groombridge and Luxmoore, 1989). However, conservation measures have been insufficient, as evidenced by the decline or depletion of hawksbills in 56 of the 65 geopolitical units for which some information on nesting density was available (Groombridge and Luxmoore, 1989). Population increases have been reported for only a few geopolitical units, and these increases have only occurred after individual nesting beaches have been strongly protected for many years. These trends indicate that hawksbill populations can be restored if protected.

Because individual hawksbills may migrate through the waters of various nations, efforts to protect individual populations must include their entire range. The failure to provide regional protection can result in conservation activities in one part of the range being undermined by exploitation or a lack of protection in another part.

STATUS JUSTIFICATION

The rationale for listing the status of the hawksbill as Critically Endangered in the IUCN *Red List* was based on the following guideline criteria as published by IUCN (IUCN Species Survival Commission, 1994; Baillie and Groombridge, 1996):

A. *Population reduction in the form of either of the following:*

1. *An observed, estimated, inferred or suspected reduction of at least 80% over the last 10 years or three generations, whichever is longer, based on (and specifying) any of the following:*

(a) *direct observation*

(b) *an index of abundance appropriate for the taxon*

(d) *actual or potential levels of exploitation.*

2. *A reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying):*

(b) *an index of abundance appropriate for the taxon*

(c) *a decline in area of occupancy, extent of occurrence and/or quality of habitat*

(d) *actual or potential levels of exploitation.*

The status justification was based on the following analyses of the specific criteria listed above.

A1. — Generation time (calculated as the age at sexual maturity plus half of reproductive longevity; Pianka, 1974) of hawksbills was estimated to be 35 years. Average age to sexual maturity was assumed to be a minimum of 25 years based on time-to-maturity estimates ranging from 20 or more years in the Caribbean (Boulon, 1983, 1994; Diez and van Dam, in prep.), to some 30 years in Aldabra in the Indian Ocean (Mortimer, 1998), and to 30 to 40 years in Australia (Limpus, 1992, *pers. comm.*). Reproductive longevity of

hawksbills was assumed to be comparable to that of other marine turtles within the family Cheloniidae, which is at least 20–30 years (Carr et al., 1978; FitzSimmons et al., 1995). Mortimer and Bresson (1994a, 1999) documented breeding by hawksbills over a period of 17–20 years. Half of reproductive longevity was estimated to be a minimum of 10 years.

Bjorndal (1999) outlined the difficulties inherent in assigning one status designation to a species that has a global distribution and a large number of genetically distinct but geographically overlapping populations. To deal with the fact that there is significant variation in status between populations, she recommended that the status of the regional (= significant) population with the most imperiled survival outlook be applied to the entire species. She pointed out that the advantage of this approach is that it embraces the precautionary principle (Lauck et al., 1998), ensuring that any error in the designation is made in favor of the species. The approach facilitates the conservation of each species so that each fulfills its ecological role in maintaining the natural structure, biodiversity, and functions of its ecosystems. The latter is a goal identified in the *Global Strategy for the Conservation of Marine Turtles* (IUCN/SSC Marine Turtle Specialist Group, 1995).

The present review indicates that the hawksbill turtle has declined more than 80% during the last 105 years at many, if not most, important breeding sites throughout its global range, including localities in the Atlantic, Indian, and Pacific oceans. It is difficult to say which region has the poorest survival outlook for the hawksbill because the situation is grave at numerous localities. Southeast Asia is perhaps the most critical because of the combined impacts of shell trade and intensive egg collection, but there are greatly diminished populations throughout the range of the species, and the threats remain active. While the species is not expected to become extinct in the foreseeable future, individual populations from around the world will continue to disappear under the current regime of exploitation, loss of habitat, and other threats. Sites with abundant hawksbill nesting are relatively few in number and are restricted largely to areas that offer considerable protection (in some cases on a large geographic scale). They are the exception rather than the rule. These cases should not overshadow the more general situation of extreme and ongoing depletion. Furthermore, a continuation of past management practices is not expected to halt declines.

A1a. — Direct observation of the number of nests constructed annually. Censuses of sea turtle populations are typically conducted on the nesting beach because of the difficulty of assessing numbers of turtles in foraging grounds (Meylan, 1982). Annual number of nests is preferred to the number of individual turtles because many projects do not involve tagging turtles, so multiple nests by the same individual cannot be distinguished. Use of annual totals also avoids the need for animals to be marked for recognition in future nesting seasons (remigrations) and makes it unnecessary to factor in geographic differences in remigration-interval frequencies. The numbers of nests constructed annually can be related to the number of female turtles nesting annually by dividing by the average number of nests per female (Richardson et al., 1989; Guzmán et al., 1995; Hillis, 1995; Dobbs et al., 1999; Mortimer and Bresson, 1999; Pilcher and Ali, 1999) . For the purposes of this review, a range of 3–5 nests per female has been used. The number of nesting females can be related to total population size (though not precisely) if appropriate data for the population are known (sex ratio, population structure). This is rarely done because of lack of sufficient information.

In a worldwide review of the status of the hawksbill turtle in 1989, Groombridge and Luxmoore (1989) concluded that hawksbill populations were depleted or declining in 56 of the 65 geopolitical units for which some information on nesting density was available, with declines well substantiated in 18 of these areas and suspected in the remaining 38. On the basis of the current review, it was determined that only five regional populations of hawksbills remain in the world in which more than 1000 females are recorded annually (in Seychelles, Mexico, Indonesia, and two in Australia). In two of these (Seychelles and Indonesia) hawksbills are considered to be badly depleted and in decline. When genetic data become available, more than one genetically distinct population may be identified within each of these regional populations. The size of the population in Iran — once estimated to number 1000 females per year — is currently unknown.

Declines in hawksbill populations of 80% and even greater have been recorded during the last three generations of hawksbills (105 years) throughout the global range of the hawksbill, including at nesting sites in the Atlantic, Indian, and Pacific oceans. Nicaragua, Panama, Madagascar, Sri Lanka, Thailand, Malaysia, Indonesia, and the Philippines are areas in which declines of this magnitude in hawksbill populations have been recorded. In several areas, population declines of 80% have transpired in less than 50 years.

Increases in hawksbill nesting populations have been documented at only a few sites: Yucatán Peninsula (Mexico), Mona Island (Puerto Rico), the Turtle Islands Park of Sabah (Malaysia), and Cousin Island (Seychelles). All of these sites have been effectively protected for nearly two decades or more.

A1b. — The total number of nests recorded annually is used as an index of abundance (see above). Estimates of population decline based on this index, however, can grossly underestimate overall decline in the general population at those sites where overharvest of nesting females or eggs has inhibited successful reproduction for long periods of time. In such cases, the resulting lack of recruitment of juvenile turtles into the population may go unnoticed until there is a collapse in the nesting population.

Another index of abundance we used to evaluate population trends is catch per unit of effort. Examples involving

capture of nesting females on the beach are fairly common, but there are also data available on capture rates on foraging grounds (see accounts for Chiriquí Beach, Panama, and San Andrés Archipelago, Colombia).

A1d. — International trade statistics provide data on the vast numbers of hawksbills that have been killed for the tortoiseshell and stuffed curio trade in recent decades. For example, Japan, the world's largest importer of hawksbill products, imported hawksbill shell and stuffed specimens from more than 50 countries between 1970 and 1986 (Milliken and Tokunaga, 1987). These imports represented the shell of more than 600,000 adult turtles and approximately 577,000 juvenile hawksbills (Milliken and Tokunaga, 1987). International trade in hawksbill shell continues today among countries that are not signatories to CITES, and there is also a large domestic use of tortoiseshell in some countries that is not registered by export statistics. Intensive collection of marine turtle eggs, including those of hawksbills, occurs in many areas, particularly in Southeast Asia. Egg collection is estimated to approach 100% in many cases. Hawksbills are easily captured on nesting beaches and at sea. Their co-occurrence in reef habitats with commercially valuable reef fish and lobsters makes them particularly vulnerable to exploitation, and it facilitates continued exploitation beyond the point of economic extinction.

A2b. — Indices of abundance used above in item A1b are applied in assessing future population reduction.

A2c. — Both terrestrial and marine habitats of the hawksbill are deteriorating and disappearing. Nesting beaches are being degraded by coastal development, with negative effects attributable to sand mining for construction, artificial lights that disorient turtles, limitation of access to appropriate areas on nesting beaches due to permanent structures (highways, buildings, seawalls, revetments, etc.), disturbance by humans, and vehicles on beaches.

Hawksbills are closely associated with coral reefs, which are one of the most fragile and threatened ecosystems types on earth. Coral reefs are also limited in extent, covering only an estimated 617,000 km^2.

Threats to hawksbill habitats are expected to increase with increases in the human population.

A2d. — Hawksbills have been exploited since at least the 15th century B.C. (Parsons, 1972), and the demand for tortoiseshell — considered a luxury item similar to gold and ivory — is not expected to abate. Nor is the collection of eggs in Southeast Asia, where this practice is considered a cultural tradition. Exploitation of the hawksbill is expected to increase with increasing human populations. Greater settlement and use of remote areas and greater travel opportunities are expected to be factors in the exploitation of the hawksbill, as are increased access to boats, motors, fisheries gear, and safer, easier navigation using Global Positioning System units (GPS). Pressure is expected to increase from incidental catch as fisheries expand. Lack of conservation awareness and lack of enforcement of protective legislation are significant problems.

In conclusion, we consider the hawksbill turtle, *Eretmochelys imbricata* (Linnaeus, 1766), to be Critically Endangered under the current IUCN criteria, based on abundant data documenting declines of at least 80% in most populations over a period of less than three generation times. Of all the species of marine turtles, the hawksbill has endured the longest and most sustained history of exploitation, due primarily to international trade for its economically valuable tortoiseshell.

ACKNOWLEDGMENTS

We wish to thank many people for their assistance in producing this manuscript. A. Abreu, G. Balazs, R. Briseño, C. Diez, J. Frazier, J. Fretey, M. Garduño, D. Graff, B. Groombridge, J. Horrocks, C. Lagueux, C. Limpus, J. Mortimer, N. Pilcher, S. Spring, I. Suwelo, H. Suganuma, M. Tiwari, and R. van Dam contributed information. A. Abreu, B. Anderes, G. Balazs, A. Bass, R. Briseño, K. Bjorndal, J. Braun, E. Carrillo, D. Crouse, C. Diez, K. Eckert, S. Eckert, H. Guada, J. Horrocks, G. Hughes, C. Lagueux, J. Leiby, C. Limpus, N. Marcovaldi, D. Margaritoulis, R. Marquez, P. Meylan, F. Moncada, G. Nodarse, J. Ottenwalder, J. Quinn, R. Salm, S. Spring, A. Suarez, and S. Troëng provided helpful comments on the manuscript. We thank two anonymous reviewers and the editors, A. Rhodin and P. Pritchard, who reviewed the manuscript for final publication in the journal. Special thanks are extended to J. Mortimer for her assistance and insightful editorial comments and for the extensive review provided by the MTSG Executive Committee. We thank K. Powell for preparing the maps and for assisting with various aspects of preparation, and D. Klugel for finding numerous (and often obscure) references. Many of the following references, especially the "gray" literature citations not necessarily easily obtainable elsewhere, have been deposited in the libraries of Chelonian Research Foundation and Chelonian Research Institute, where they are available for reference.

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Received: 2 August 1998
Reviewed: 24 January 1999
Revised and Accepted: 12 February 1999

ENDORSEMENT

This justification document represents the official position of the IUCN/SSC Marine Turtle Specialist Group regarding the global status of the hawksbill turtle, *Eretmochelys imbricata*, as determined by the review process that was followed and the unanimous consensus of its Executive Committee in March 1999.

F. ALBERTO ABREU-GROBOIS, *Chairman*
IUCN/SSC Marine Turtle Specialist Group