HAWKSBILL SEA TURTLE
(*ERETMOCHELYS IMBRICATA*)

5-YEAR REVIEW:
SUMMARY AND EVALUATION

NATIONAL MARINE FISHERIES SERVICE
OFFICE OF PROTECTED RESOURCES
SILVER SPRING, MARYLAND
AND
U.S. FISH AND WILDLIFE SERVICE
SOUTHEAST REGION
JACKSONVILLE ECOLOGICAL SERVICES FIELD OFFICE
JACKSONVILLE, FLORIDA

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U.S. Department of Commerce
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U.S. FISH AND WILDLIFE SERVICE

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1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2. Methodology used to complete the review

Dr. Jeanne A. Mortimer was contracted by the Services to gather and synthesize information regarding the status of the hawksbill sea turtle. This review was subsequently compiled by a team of biologists from the National Marine Fisheries Service's (NMFS) Headquarters Office and the U.S. Fish and Wildlife Service's (FWS) Southeast Regional Office and the Jacksonville Ecological Services Field Office. Our sources include the final rule listing this species under the Act; the recovery plan; peer reviewed scientific publications; unpublished field observations by the Services, State, and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists. The draft status review was sent out for peer review to five academic professionals with expertise on the species and its habitats. Peer reviewers were provided guidance to follow during the review process. Comments received from peer reviewers were incorporated into the status review document (see Appendix). The public notice for this review was published on April 21, 2005, with a 90 day comment period (70 FR 20734). A few comments were received and incorporated as appropriate into the 5-year review.

1.3 Background

1.3.1 FR notice citation announcing initiation of this review

April 21, 2005 (70 FR 20734)

1.3.2 Listing history

<u>Original Listing</u>
FR notice: 35 FR 8491
Date listed: June 2, 1970
Entity listed: Species
Classification: Endangered

1.3.3 Associated rulemakings

Critical Habitat Designation: 47 FR 27295, June 24, 1982. The purpose of this rule was to designate terrestrial critical habitat for the hawksbill turtle as follows: Puerto Rico: (1) Isla Mona. All areas of beachfront on the west, south, and east sides of the island from mean high tide inland to a point 150 meters from shore. This includes all 7.2 kilometers of beaches on Isla Mona. (2) Culebra Island. The following areas of beachfront on the north shore of the island from mean high tide to a point 150 meters from shore: Playa Resaca, Playa Brava, and Playa Larga. (3) Cayo Norte. South beach, from mean high tide inland to a point 150 meters from shore. (4) Island Culebrita. All beachfront areas on the southwest facing shore, east facing shore, and northwest facing shore of the island from mean high tide inland to a point 150 meters from shore.

Critical Habitat Designation: 63 FR 46693, September 2, 1998. The purpose of this rule was to designate marine critical habitat for the hawksbill turtle as follows: Mona and Monito Islands, Puerto Rico – Waters surrounding the islands of Mona and Monito, from the mean high water line seaward to 3 nautical miles (5.6 km).

Regulations Consolidation Final Rule: 64 FR 14052, March 23, 1999. The purpose of this rule was to make the regulations regarding implementation of the Endangered Species Act of 1973 (ESA) by NMFS for marine species more concise, better organized, and therefore easier for the public to use.

1.3.4 Review history

Plotkin, P.T. (Editor). 1995. National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland. 139 pages.
<u>Conclusion</u>: Retain the listing as endangered throughout its range.

Mager, A.M., Jr. 1985. Five-year status reviews of sea turtles listed under the Endangered Species Act of 1973. U.S. Department of Commerce, NOAA, National Marine Fisheries Service, St. Petersburg, Florida. 90 pages.
<u>Conclusion</u>: Retain the listing as an endangered species.

FWS also conducted 5-year reviews for the hawksbill in 1985 (50 FR 29901) and in 1991 (56 FR 56882). In these reviews, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notices stated that FWS was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notices indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the hawksbill's listing classification was recommended from these 5-year reviews.

1.3.5 Species' recovery priority number at start of review

National Marine Fisheries Service = 1 (this represents a high magnitude of threat, a high recovery potential, and the presence of conflict with economic activities).
U.S. Fish and Wildlife Service (48 FR 43098) = 1C (this represents a monotypic genus with a high degree of threat, a high recovery potential, and the potential for conflict with construction or other development projects or other forms of economic activity).

1.3.6 Recovery plans

Name of plan: Recovery Plan for the Hawksbill Turtle (*Eretmochelys imbricata*) in the U.S. Caribbean, Atlantic and Gulf of Mexico
Date issued: December 15, 1993

Name of plan: Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*)
Date issued: January 12, 1998

Dates of previous plans: Original plan date - September 19, 1984

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

Yes.

2.1.2 Is the species under review listed as a DPS?

No.

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy?

We have preliminary information that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the hawksbill. Since the species' listing, a substantial amount of information has become available on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies). The Services have not yet fully assembled or analyzed this new information; however, at a minimum, these data appear to indicate a possible separation of populations by ocean basins. To determine the application of the DPS policy to the hawksbill, the Services intend to fully assemble and analyze this new information in accordance with the DPS policy. See Section 2.3 for new information since the last 5-year review and Section 4.0 for additional information.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

No. The "Recovery Plan for the Hawksbill Turtle (*Eretmochelys imbricata*) in the U.S. Caribbean, Atlantic and Gulf of Mexico" was signed in 1993 and the "Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*)" was signed in 1998. While not all of the recovery criteria strictly adhere to all elements of the 2004 NMFS Interim Recovery Planning Guidance, they are still a viable measure of the species status. See Section 4.0 for additional information.

The recovery criteria for the two active recovery plans are identified below, along with several key accomplishments:

1993 Recovery Plan for the Hawksbill Turtle (Eretmochelys imbricata) in the U.S. Caribbean, Atlantic and Gulf of Mexico:

The U.S. populations of hawksbill turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The adult female population is increasing, as evidenced by a statistically significant trend in the annual number of nests on at least five index beaches, including Mona Island and Buck Island Reef National Monument.
   - There are eight nesting concentrations of particular interest in the Insular Caribbean, including Antigua/Barbuda (especially Jumby Bay), Bahamas, Barbados, Cuba (Doce Leguas Cays), Jamaica, Puerto Rico (especially Mona Island), Trinidad and Tobago, and U.S. Virgin Islands (especially Buck Island Reef National Monument). Of these, the rookeries that are regularly monitored (Jumby Bay, Barbados, Mona Island, and Buck Island Reef National Monument) are increasing; while at the other sites the few recent data that exist indicate a less optimistic status (especially Bahamas,

Jamaica, Trinidad (east coast) and Tobago, and U.S. Virgin Islands outside of Buck Island Reef National Monument).

2. Habitat for at least 50 percent of the nesting activity that occurs in the United States Virgin Islands and Puerto Rico is protected in perpetuity.
   - Major nesting areas for hawksbills have been identified and are being protected; however, information on the extent of nesting activity occurring on protected lands is currently insufficient to make this determination.

3. Numbers of adults, subadults, and juveniles are increasing, as evidenced by a statistically significant trend on at least five key foraging areas within Puerto Rico, USVI, and Florida.
   - In-water research projects at Mona Island, Puerto Rico, and the Marquesas, Florida, which involve the observation and capture of juvenile hawksbill turtles, are underway. Although there are 15 years of data for the Mona Island project, abundance indices have not yet been incorporated into a rigorous analysis or a published trends assessment. The time series for the Marquesas project is not long enough to detect a trend.

4. All priority one tasks have been successfully implemented.
   - The Puerto Rico Environmental Quality Board requires developers to use sediment fences to reduce upland erosion impacts on surface waters (task 126).
   - Efforts are ongoing to evaluate nest success and implement nest protection measures (task 212).
   - Efforts are ongoing to prevent poaching on nesting beaches and illegal fishing of turtles (tasks 214 and 225).
   - Population structure of nesting and foraging turtles from Mona Island, Puerto Rico, and St. Croix, U.S. Virgin Islands has been identified using DNA analysis (task 217).

1998 Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (Eretmochelys imbricata):

To consider de-listing, all of the following criteria must be met:

1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters.
   - Substantial efforts have been made to determine the nesting population origins of hawksbills assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting beach origins commonly mix in these areas.
   - A sea turtle data collection and skin sampling (for subsequent DNA analysis) project has been supported in the Marshall Islands.

2. Each stock must average 1,000 females estimated to nest annually (FENA) (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) over six years.
   - In the U.S. Pacific, about 5-10 females nest annually in Hawaii, and there are indications that the population is increasing.
   - Micronesia, with its thousands of islands and atolls, probably supports about 300 females annually. Palau Republic has the largest nesting population remaining in Micronesia with about 20-50 females nesting per year. However, the population in Micronesia is exploited for meat, eggs, and shell for local consumption, and is considered depleted and declining.
   - In American Samoa and Western Samoa, fewer than 30 females are estimated to nest annually. In Guam, only about 5-10 females are estimated to nest annually.
   - Pacific Mexico hosts remnant populations of hawksbills with fewer than 15 females estimated as nesting each year.

3. All females estimated to nest annually (FENA) at "source beaches" are either stable or increasing for 25 years.
   - Efforts to attain this goal are ongoing.
   - Nesting beach monitoring in the main Hawaiian Islands has been supported.
   - Capacity building in American Samoa, Guam, and Palau for nesting beach monitoring has been supported.
   - Nesting beach monitoring in the Commonwealth of the Northern Mariana Islands has been conducted.
   - Nesting beach monitoring and tagging of nesting females on the outer islands of Yap State, Federated States of Micronesia has been supported.

4. Existing foraging areas are maintained as healthy environments.
   - Efforts to attain this goal are ongoing.

5. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region.
   - Capacity building in American Samoa and Palau for in-water monitoring has been supported.
   - In-water monitoring in the Commonwealth of the Northern Mariana Islands has been conducted but the duration is not sufficient for trend analysis.

6. All priority #1 tasks have been implemented.
   - Efforts are ongoing to reduce directed take through public education and information (tasks 1.1.1.1 and 2.1.1.1).
   - Law enforcement activities to prevent illegal exploitation and harassment are ongoing (tasks 1.1.1.2 and 2.1.1.2).
   - Efforts are ongoing to control non-native predators of eggs and hatchlings in the main Hawaiian Islands (task 1.1.3).
   - Satellite and radio telemetry studies of post-nesting females in the main Hawaiian Islands have been conducted (task 2.1.2.1).

- Support has been given to the Marshall Islands to build sea turtle conservation and management capacity (task 2.1.4).

7. A management plan designed to maintain sustained populations of turtles is in place.
   - Not yet completed.

8. Ensure formal cooperative relationship with regional sea turtle management programs (South Pacific Regional Environment Program [SPREP]).
   - The U.S. is a party to SPREP, which has goals to promote cooperation in the Pacific Islands region and to provide assistance to ensure sustainable development for present and future generations. Sea turtles are among the focal animal groups within this program.

9. International agreements are in place to protect shared stocks.
   - The U.S. is a party to the Inter-American Convention for the Protection and Conservation of Sea Turtles, a binding agreement that has the potential to enhance the conservation of hawksbills in the U.S. Pacific and adjoining western hemisphere nations.

2.3 Updated Information and Current Species Status

The hawksbill turtle was once abundant in tropical and subtropical regions throughout the world. Over the last century, this species has declined in most areas and stands at only a fraction of its historical abundance. These declines resulted in the listing of hawksbill turtles as globally endangered under the U.S. Endangered Species Act. This ESA review is not intended to be an exhaustive review of all new information pertaining to hawksbill turtles. Rather, the section presents new information since the last status review that may indicate a change in species status or change in the magnitude or imminence of threats. In compiling this section, the best available information was used.

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Hawksbills nest on insular and mainland sandy beaches throughout the tropics and subtropics. They are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus 1997, Plotkin 2003). Early juvenile hawksbills (5-21 cm straight carapace length (SCL)) have been found in association with *Sargassum* in both the Atlantic and Pacific Oceans (Musick and Limpus 1997); and observations of newly hatched hawksbills attracted to floating weed have been made for both Caribbean (Hornell 1927; Mellgren *et al.* 1994, 1996) and Indian Ocean hawksbills (J. Mortimer, Island Conservation Society (ICS) of Seychelles, personal observation). Upon first entering the sea, neonate hawksbills are believed to enter an oceanic phase (i.e., living in the open ocean beyond 200m depth) that may involve long distance travel carried by surface gyres (i.e., circular surface rotation of ocean water), and eventual recruitment to neritic foraging habitat (i.e., found at or near the sea floor) at a carapace length of 20-25 cm SCL in the Caribbean (Boulon 1994) and at 30-35 cm SCL in the Indo-Pacific (review by Musick and Limpus 1997; J. Mortimer, ICS, unpublished data). As larger juveniles, some individuals may associate with the same feeding locality for more than a decade, while others apparently migrate from one site to another (Musick and Limpus 1997; Mortimer *et al.* 2003, unpublished data). Although adult hawksbills were once considered to be relatively non-migratory, post-reproductive tagging, telemetry, and genetic studies have revealed them to be highly mobile, traveling hundreds to thousands of kilometers between nesting beaches and foraging areas (review by Plotkin 2003).

Flipper tagging of nesting females at numerous breeding sites have shown females to have strong fidelity in their choice of nesting sites (Witzell 1983). Genetic studies have demonstrated natal homing for female hawksbills in both Atlantic (Bass 1999) and Pacific populations (Broderick *et al.* 1994), meaning that, upon reaching adulthood, the turtle returns to breed in the vicinity of its birth.

Numerous studies have addressed periodicity of nesting both within and between nesting seasons. Females at most sites typically lay clutches at approximately 2-week intervals (Witzell 1983). At sites where tagging has approached saturation, the average female lays between 3 and 5 egg clutches during a single nesting season (Beggs *et al*. 2007, Richardson *et al.* 1999, Mortimer and Bresson 1999). Remigration intervals separating consecutive nesting seasons for individual females vary from one nesting site to another, averaging 1.84 years in Sabah, Malaysia (Pilcher and Ali 1999); 2.69 years at Jumby Bay, Antigua (Richardson *et al.* 1999); 2.47 years in Barbados (Beggs *et al*. in press);2 to 3 years in Yucatán, Mexico (Garduño-Andrade 1999); 2 to 3 years at Cousin Island, Seychelles (Mortimer and Bresson 1999); 2 to 3 years at Pulau Redang, Terengganu, Malaysia (Chan and Liew 1999); 5 years at Milman Island, Australia (Limpus 2004); and 5 to 7 years at Arnavon Islands Marine Conservation Area (AMCA) in the Solomon Islands (Pita and Broderick 2005).

Until recently, hawksbills were considered to be naturally rare and to have a more dispersed nesting pattern than other sea turtle species (Groombridge and Luxmoore 1989). However, it is now believed that the dispersed nesting observed today is the result of overexploitation of previously large colonies (Limpus 1995, Meylan and Donnelly 1999). Those sites where aggregated nesting occurs, such as at the Daymaniyat Islands of Oman (Salm *et al.* 1993), Milman Island in Australia (Dobbs *et al.* 1999), the Yucatan Peninsula in Mexico (Meylan and Donnelly 1999), and at certain protected sites in Seychelles (J. Mortimer, ICS, unpublished data, as cited in Meylan and Donnelly 1999) may typify pre-exploitation levels of hawksbill nesting density.

Studies of nesting biology continue and in recent decades significant advances have also been made in our understanding of hawksbills in the marine environment at various stages in their life cycle. Hawksbill growth rate is among the topics of particular interest, with studies ongoing in the Atlantic Ocean (Boulon 1983, 1994; Diez and van Dam 2002; Leon and Diez 1999; B. Krueger, University of the West Indies (UWI), in litt. to J. Mortimer, ICS, 2006), Indian Ocean (Mortimer *et al.* 2002, 2003), and Pacific Ocean (Limpus 1992, Limpus and Miller 2000, Whiting 2000). Based on data from these studies, age-to-maturity has been estimated as 20 or more years in the Caribbean, and a minimum of 30-35 years in the Indo-Pacific. In northeastern Australia, first breeding is estimated to occur at 31-36 years for females and 38 years for males (Limpus and Miller 2000). Coupled with the recent studies of demography and survivorship, these data are paramount for developing accurate population models (Chaloupka and Musick 1997).

Information obtained from satellite telemetry of post-nesting females shows variation in the distance traveled between nesting and foraging grounds (Plotkin 2003), with some turtles making short range migrations (25-200 km) in the Caribbean (Hillis-Starr *et al.* 2000, Horrocks *et al.* 2001, Lagueux *et al.* 2003), Indian Ocean (Mortimer and Balazs 2000), and Pacific (Ellis *et al.* 2000); and other turtles making longer migrations (200 km or more) in the Caribbean (Byles and Swimmer 1994, Horrocks *et al.* 2001, Miller *et al.* 1998 as cited in Plotkin 2003, Prieto *et al.* 2001 as cited in Plotkin 2003, Lagueux *et al.* 2003) and the Pacific Ocean (Pita and Broderick 2005, Mortimer 2002).

Data on the diet of oceanic stage hawksbills are limited, but indicate a combination of plant and animal material (reviewed by Bjorndal 1997). Post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard bottom habitats, sea grass, algal beds, mangrove bays and creeks (reviewed by Musick and Limpus 1997), or mud flats (R. von Brandis, Tshwane University of Technology, unpublished data). As they increase in size, immature hawksbills typically inhabit a series of developmental habitats, with some tendency for larger turtles to inhabit deeper sites (Bowen *et al.* 2007). Studies have shown post-oceanic hawksbills to feed on sponges throughout their range (reviewed by Bjorndal 1997), but to be especially spongivorous in the Caribbean (Meylan 1988, van Dam and Diez 1997b, León and Bjorndal 2002), and rather more omnivorous in the Indo-Pacific. In Seychelles, spongivory predominates at Cosmoledo atoll (J. Mortimer, ICS, personal communication in Meylan 1984 cited in Bjorndal 1997) and D'Arros Island (R. von Brandis, Tshwane University of Technology, personal communication to J. Mortimer, ICS), but to a lesser extent in the lagoons of Aldabra (J. Mortimer, ICS, unpublished data) and Diego Garcia, British Indian Ocean Territory (Mortimer and Day 1999) where algae feature prominently, as they do in northwestern Australia (Whiting 2000). Hawksbill diving behavior and utilization of foraging habitats also have been studied at several sites (van Dam and Diez 1997a, 1997c, 1998; Houghton *et al.* 2003).

A very important subject addressed in recent years is the ecological role of turtles. Like other species of sea turtles, hawksbills contribute to marine and coastal food webs and transport nutrients within the oceans (Bouchard and Bjorndal 2000). Hawksbills have been found to support healthy reefs by controlling sponges, which would otherwise outcompete reef-building corals for space (Hill 1998, León and Bjorndal 2002, Bjorndal and Jackson 2003).

Despite these advances, numerous gaps remain in our understanding of hawksbill biology. Sufficient information on basic demographic aspects such as growth and age-to-maturity for the vast majority of global subpopulations is lacking. Information on annual reproductive output is similarly scant for many sites. In the marine environment, the oceanic phase of neonate juveniles (i.e., the "lost years") remains one of the most poorly understood aspects of hawksbill life history, both in terms of where turtles occur and how long they remain oceanic. At-sea mortality in fisheries is also an area for which few data are available. The paucity of information regarding these aspects continues to inhibit effective modeling of populations and prevents a full understanding of which nesting concentrations are most at risk.

Recent efforts to characterize the status of hawksbill turtles have underscored the need to address these deficiencies (Meylan and Donnelly 1999, Kinan 2005, Mortimer and Donnelly in review), which will require a concerted effort from biologists, modelers, and wildlife managers throughout the world (Kinan 2005). Obtaining additional demographic information will require rigorous tagging programs along with the use of molecular tools such as genetics and stable isotopes. Achieving recovery of depleted hawksbill populations will require international partnerships and information exchange, as well as protection strategies that encompass all life history stages.

2.3.1.2 Abundance, trends, demography, and demographic trends:

2.3.1.2.1. Abundance and trends

In this section, the current nesting abundance is provided for 83 nesting concentrations among 10 ocean regions around the world (Figures 1 and 2). The information presented is derived from Mortimer and Donnelly (in review). Recent nesting abundance trends (within the past 20 years) were determined for 42 of these sites, and historic trends (within periods of >20 to 100 years) for 58 sites. These include both large and small rookeries and are believed to be representative of the overall trends for their respective regions. Although the smaller sites may not contribute much to the overall number of turtles nesting, they represent genetic diversity within each region and their status is therefore highly relevant to this evaluation. The ocean regions include Insular Caribbean, Western Caribbean Mainland, South Western and Eastern Atlantic Ocean; South Western, North Western, and Central and Eastern Indian Ocean; and Western, Central, and Eastern Pacific Ocean.

There is a near total lack of long-term trend data at foraging sites, primarily because these data are logistically difficult and relatively expensive to obtain. Therefore, the primary information source for evaluating trends in global hawksbill populations is nesting beach data.

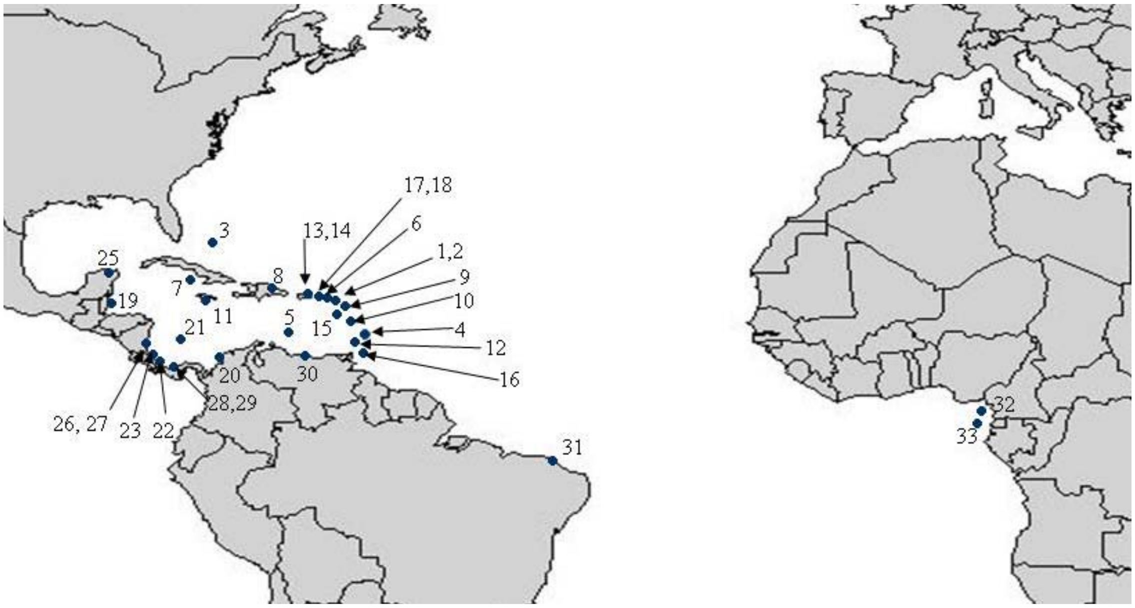

Figure 1. Map showing the Atlantic Ocean locations of 33 of the 83 hawksbill nesting concentrations on which this evaluation is based. See Table 1 for site names and current estimated annual nesting levels.

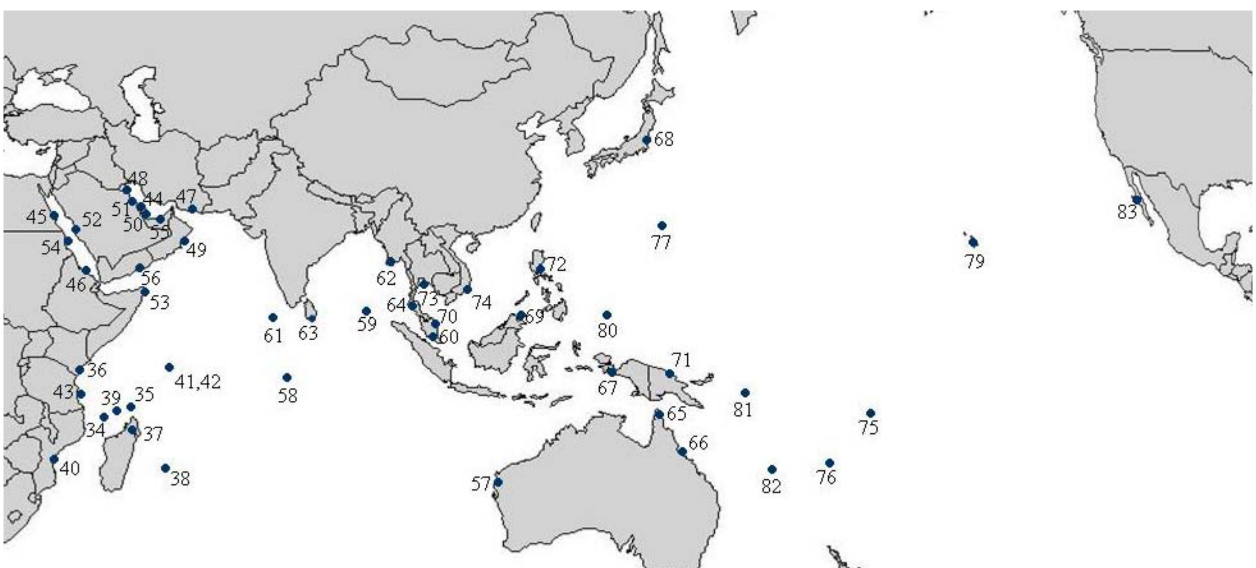

Figure 2. Map showing the Indian and Pacific Ocean locations of 50 of the 83 hawksbill nesting concentrations on which this evaluation is based. See Tables 2 and 3 for site names and current estimated annual nesting levels.

Figures for current and historic abundance are largely based on estimated annual reproductive effort (i.e. numbers of nesting females, egg clutches laid, or nesting emergences recorded at each site); and in some cases evidence of historic abundance are based on tortoiseshell export statistics (see review by Mortimer and Donnelly in review). Data were recorded during beach monitoring programs in which reproductive effort was quantified on a fixed length of beach over the course of a nesting season (Schroeder and Murphy 1999). Insofar as possible, because hawksbill nesting activity at a given beach can vary from year to year (Miller 1997), estimates of abundance are based on mean nesting activity over the course of multiple nesting seasons for which data are comparable.

In addition to current abundance at each site, an estimate of total combined annual reproductive effort (i.e., total number of nesting females) for all sites is presented. To convert from number of nests to number of nesting females, a bracketed figure of 3-5 nests per female was used. Where the estimate is derived from total number of tracks (crawls), a conversion factor of 1.8 tracks per nest is used (based on Mortimer and Bresson 1999). The application of these conversion factors is based on the assumptions that the mean number of egg clutches/female/season differ insignificantly through time, and that efforts to monitor nesting activity are consistent through time.

As with any assessment based on long term data, there is a level of uncertainty relating to the final results of this report. It should be noted that a major caveat of using the annual number of nesting females to assess population trends is that this data type provides information for the proportion of the adult females that nest in any given year, not the total adult female population. This limitation is heightened by the inter-annual variability in magnitude of nesting, and the potential that the proportion of a population's adult female cohort nesting each year may oscillate over decadal or longer time frames (Limpus and Nichols 1988, Miller 1997).

To characterize the quality of data used to estimate current abundance, this report uses a letter grading system (A, B; Tables 1-3). An 'A' is given to those data sources that are either in peer-reviewed published literature or are based on unpublished data collected by highly dependable experts and a 'B' is used when data come from personal communications or other sources for which the data precision is not fully verifiable, or when the estimate is imprecise. It should be noted that the grade given for confidence in data is independent of the time duration for which the estimate is based. In other words, a letter grade of 'A' is given for peer-reviewed data, even if it represents only a single nesting season.

In addition to mean annual reproductive effort for these sites, we estimate the change in reproductive effort based on published values of former versus current nesting levels. To this extent, this report does not present robust modeling exercises, but rather provides a summary of the empirical data available for each nesting concentration. This evaluation focuses on current abundance and population trends, including both recent population trends (within the past 20 years) and historic trends (when the current population size is compared to that of 20 to 100 years ago). Summaries of both recent and historic trends are given in Tables 1-4, where the symbols ▲, ▼, and ▬ are used to indicate if a population is increasing, declining, or stable, respectively. The symbol '?' is used when data are insufficient to make a trend determination or the most 'recent' values are not current (10 years or older).

Table 1. Estimates of current (or most recent) abundance for hawksbill nesting rookeries in the Atlantic Ocean with data confidence grades (G). See page 13 for explanation of data confidence grades. See Figure 1 for location of rookeries. Population trends, both recent (Rec T) within the past 20 years and historic (His T) comparing current nesting female abundance with that during a period >20 to 100 years ago are indicated. Data types include: AF = annual nesting females; AN = annual nests; AT = annual tracks; ▲ = increasing population; ▼= decreasing population; ▬ = stable population; ? = unknown trend. Additional information about trend data is presented in the text for each geographic location. Information derived largely from review by Mortimer and Donnelly (in review).

Location	Data	Years	Number of nesting ♀ /season	G	Rec T	His T	Reference
ATLANTIC: INSULAR CARIBBEAN							
1. Antigua (Jumby Bay)	AF	2002-2005	52	A	▲	?	Parish and Goodman 2006; McIntosh *et al.* 2003; Stapleton and Stapleton 2004, 2006
2. Antigua/ Barbuda (outside Jumby Bay)	AN	1999	50-75	B	▼	▼	Fuller *et al.* 1992, Meylan 1999
3. Bahamas	AN	2001-2005	100-333	B	?	▼	K. Bjorndal, University of Florida, in litt. to J. Mortimer, ICS, 2006
4. Barbados	AF	2003-2005	483	A	▲	?	Beggs *et al.* in press; J. Horrocks and B. Krueger, UWI, unpubl. data
5. Bonaire	AT	2006	3-19	B	?	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, Caribbean Conservation Corporation (CCC), 2007
6. British Virgin Islands	AN	2005	no estimate	B	▼	▼	McGowan *et al.* in review
7. Cuba (Doce Leguas Cays)	AN	2002	400-833	B	?	▼	Cuban Turtle Group, in litt. to A. Abreu-Grobois, Unidad Academica Mazatlan, 2002
8. Dominican Republic	AT	2006	50-407	B	▼	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007
9. French West Indies (Guadeloupean Archipelago)	AN	2003-2005	40-66	B	?	▼	Chevalier *et al.* 2003, 2005
10. French West Indies (Martinique)	AN	2006	50-100	B	?	▼	La Gazette de Karets 2006
11. Jamaica	AN	1991-1996	200-275	B	?	▼	R. Kerr, Duke University, pers. comm. to A. Meylan, Florida Fish and Wildlife Conservation Commission, 2001
12. Grenada	AT	2006	6-37	B	?	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007
13. Puerto Rico (Culebra, Caja de Muertos, Humacao)	AN	2001-2005	51-85	A	▲	?	R.P. van Dam and C.E. Diez, Chelonia, Inc., unpubl. data; C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer, ICS, 2006
14. Puerto Rico (Mona Island)	AN	2001-2005	199-332	A	▲	?	R.P. van Dam and C.E. Diez, Chelonia, Inc., unpubl. data; C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer, ICS, 2006
15. St. Kitts	AT	2006	6-37	B	▼	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007
16. Trinidad and Tobago (N. coast Trinidad)	AN	2000-2004	150	A	?	?	Livingstone 2006
17. U.S. Virgin Islands (Buck Island Reef NM)	AF	2001-2006	56	A	▲	?	Z. Hillis-Starr, National Park Service, unpubl. data, in litt. to J. Mortimer, ICS, 2006
18. U.S. Virgin Islands (sites outside Buck Island Reef NM)	AT	2006	30-222	B	?	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007

Table 1 (continued).

ATLANTIC: WESTERN CARIBBEAN MAINLAND							
19. Belize (Manatee Bar, Sapodilla Cays, South Water Cay)	AT	2006	8-56	B	▼	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007
20. Colombia (Isla Fuerte)	AT	2006	19-93	B	▼	▼	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007
21. Colombia (San Andres Archipelago)	AN	2006	no estimate	B	▼	▼	Carr *et al.* 1982, Cordoba *et al.* 1998
22. Costa Rica (Tortuguero National Park)	AF	2005	~10	A	▼	▼	CCC, unpubl. data
23. Costa Rica (Cahuita and Erlin)	AT	2006	6-37	B	?	?	WIDECAST unpubl. data from W. Dow, WIDECAST, in litt. to M. Donnelly, CCC, 2007
24. Honduras (Bay Islands)		1982-1987	<10	A	?	▼	Cruz and Espinal 1987 as cited in Meylan 1999
25. Mexico (Entire Yucatan Peninsula: Campeche, Yucatan, and Quitana Roo)	AN	2001-2006	534-891	A	▲	?	Abreu-Grobois *et al.* 2005; A. Abreu-Grobois, Unidad Academica Mazatlan (UAM), in litt. to J. Mortimer, ICS, 2007[1]
26. Nicaragua (El Cocal)	AN	2000	15-25	A	▼	▼	Lagueux and Campbell 2005
27. Nicaragua (Pearl Cays)	AN	2000-2006	30-52	A	?	▼	Lagueux *et al.* 2003; C. Campbell, Wildlife Conservation Society (WCS), pers. comm. to J. Mortimer, ICS, 2007
28. Panama (Bastimentos Island National Marine Park)	AN	2003-2005	27-45	A	▲	▼	Meylan *et al.* 2006
29. Panama (Chiriqui Beach)	AN	2003-2005	84-150	A	▲	▼	Meylan *et al.* 2006
30. Venezuela (Los Roques and Paria region)	AN	2006	32-53	A	?	▼	H. Guada, Centro de Investigación y Conservación de Tortugas Marinas (CICTMAR), in litt. to J. Mortimer, ICS, 2006
ATLANTIC: SOUTH WESTERN							
31. Brazil	AN	2005	350-585	A	▲	▼	Marcovaldi 2005
ATLANTIC: EASTERN							
32. Equatorial Guinea (Bioko)	AF	1996-1998	7	A	▼	▼	Tomás *et al.* 2000
33. Sao Tomé and Principe	AN	1998-2001	14-27	A	▼	▼	J. Fretey (IUCN France) and A. Formia, Universita di Firenze, in litt. to J. Mortimer, ICS, 2001; J.-F. Dontaine, in litt. to J. Mortimer, ICS, 2001
TOTAL			**3,072-5,603**				

[1] Based on unpublished data collected in: a) Yucatan and Quintana Roo by: Pronatura Península de Yucatán, SEMARNAT, CONANP, Secretaría de Ecología de Yucatán; and b) Campeche by: Conanp-APFFLT, SEMAR V Zona Naval, Secretaria de Ecologia Gob. del Estado, Enlaces con tu Entorno AC, Marea Azul AC, Desarrollo Ecologico Cd. del Carmen AC, Quelonios AC, UNACAR, Universidad Autónoma de Campeche, H. Ayuntamiento del Carmen, Pronatura PPY, Profepa.

Table 2. Estimates of current abundance for hawksbill nesting rookeries in the Indian Ocean with data confidence grades (G). See page 13 for explanation of data confidence grades. See Figure 2 for location of rookeries. Population trends, both recent (Rec T) within the past 20 years and historic (Hist T) comparing current nesting female abundance with that during a period >20 to 100 years ago are indicated. Data types include: AF = annual nesting females; AN = annual nests; AT = annual tracks; ▲ = increasing population; ▼= decreasing population; ▬ = stable population; ? = unknown trend. Additional information about trend data is presented in the text for each geographic location. Information derived largely from review by Mortimer and Donnelly (in review).

Location	**Data**	**Years**	**Number of nesting ♀ /season**	**G**	**Rec T**	**His T**	**Reference**
INDIAN OCEAN: SOUTH WESTERN							
34. Comoro Islands	AF	1996	25-50	A	?	▼	Ben Mojadji *et al.* 1996
35. France Iles Eparses (Europa, Tromelin, Juan de Nova, Glorieuses)	AN	2006	20-45	A	?	?	Gravier-Bonnet *et al.* 2006; J. Bourjea and S. Ciccione, CEDTM, in litt. to J. Mortimer, ICS, 2006
36. Kenya	AN	2004	<10	A	?	▼	Okemwa *et al.* 2004
37. Madagascar	AF	2001	~1,000	B	▼	▼	A. Cooke, Resolve Consulting, in litt. to J. Mortimer, ICS, 2001
38. Mauritius (including St. Brandon)	AF	1996	<50	A	?	▼	Mangar and Chapman 1996
39. Mayotte	AF	2006	10-50	B	?	▼	M. Quillard and S. Ciccione, CEDTM, in litt. to J. Mortimer, ICS, 2006; J. Bourjea, IFREMER, in litt to J. Mortimer, ICS, 2006
40. Mozambique	AF	2006	<10	A	?	▼	A. Costa, WWF-Mozambique, in litt. to J. Mortimer, ICS, 2006; J. Garnier, Maluane Conservation, in litt. to J. Mortimer, ICS, 2007; I. Marques da Silva, Zoological Society London, in litt. to J. Mortimer, ICS, 2007
41. Seychelles (all 22 Inner Islands)	AF	2000-2003	625	A	▼	▼	Mortimer 2004, 2006
42. Seychelles (Outer Islands)	AN	2000-2006	800	A	?	▼	J. Mortimer unpubl. data
43. Tanzania	AF	1996	<50	B	▼	▼	Howell and Mbindo 1996
INDIAN OCEAN: NORTH WESTERN							
44. Bahrain		2006	no estimate		?	?	
45. Egypt	AF	2006	50-100	A	?	▼	J.D. Miller, American University Cairo (AUC), in litt. to J. Mortimer, ICS, 2006
46. Eritrea		1996	no estimate	B	?	?	Hillman and Gebremariam 1996
47. Iran	AF	1970s	500-1,000	B	?	?	Ross and Barwani 1982
48. Kuwait	AF	1989	<20	B	?	?	Groombridge and Luxmoore 1989
49. Oman	AF	1990s	600-800	A	▬	?	Salm *et al.* 1993, Baldwin and Al-Kiyumi 1997
50. Qatar	AN	2005	>100	A	▬	?	Pilcher 2006
51. Saudi Arabia (Arabian Gulf)	AF	1990s	175-265	A	?	?	Pilcher 1999; J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006
52. Saudi Arabia (Red Sea)	AN	2005	100-200	A	?	?	J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006
53. Somalia		2006	no estimate		?	?	
54. Sudan	AN	1970s	300-350	B	?	?	Moore and Balzarotti 1977, Hirth and Abdel Latif 1980
55. United Arab Emirates	AF	2006	100-200	B	?	?	J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006
56. Yemen	AF	1960s-1970s	~500?	B	?	?	Ross and Barwani 1982

Table 2 (continued).

INDIAN OCEAN: CENTRAL and EASTERN							
57. Australia (Western Australia)	AF	2002	~2,000	B	?	?	Limpus 1997, 2002
58. British Indian Ocean Territory (Chagos Islands)	AF	1996	300-700	A	?	▼	Mortimer and Day 1999
59. India (Andaman and Nicobar)	AF	1990s	~250	B	?	▼	Andrews *et al.* 2006
60. Malaysia (Melaka)	AN	2005	50-85	A	?	▼	Malaysian Department of Fisheries Statistics
61. Maldives	AN	1988-1995	460-767	B	▼	▼	Zahir and Hafiz 1997
62. Myanmar	AF	1989	<5	B	?	▼	Groombridge and Luxmoore 1989
63. Sri Lanka (south coast)	AN	2006	~10	A	?	▼	T. Kapurusinghe, Turtle Conservation Project (TCP), pers. comm. to J. Mortimer, ICS, 2006
64. Thailand (Andaman Sea)	AF	2006	<10	A	▼	▼	M. Aureggi, NAUCRATES, in litt. to J. Mortimer, ICS, 2006
TOTAL			**<8,130 - 10, 052**				

Table 3. Estimates of current abundance for hawksbill nesting rookeries in the Pacific Ocean with data confidence grades (G). See page 13 for explanation of data confidence grades. See Figure 2 for location of rookeries. Population trends, both recent (Rec T) within the past 20 years and historic (His T) comparing current nesting female abundance with that during a period >20 to 100 years ago are indicated. Data types include: AF = annual nesting females; AN = annual nests; AT = annual tracks; ▲ = increasing population; ▼ = decreasing population; ▬ = stable population; ? = unknown trend. Additional information about trend data is presented in the text for each geographic location. Information derived largely from review by Mortimer and Donnelly (in review).

Location	Data	Years	Number of nesting ♀ /season	G	Rec T	His T	Reference
PACIFIC OCEAN: WESTERN							
65. Australia (Torres Strait-Northern Great Barrier Reef)	AF	2004	~4,000	A	▼	?	Limpus 2004
66. Australia (Northeastern Arnhem Land)	AF	2004	~2,500	A	?	?	Limpus 2004
67. Indonesia (entire country)	AN	2006	1,362-3,026	A B	▼	▼	J. Schulz in litt. to K. Bjorndal, University of Florida, 1995; Suganuma *et al.* 1999; H. Suganuma, ELNA, in litt. to J. Mortimer, ICS, 2006
68. Japan		1980s	rare	B	▼	▼	Groombridge and Luxmoore 1989
69. Malaysia (East) Sabah Turtle Islands	AN	1997-2005	69-116	A	▬	?	Sabah Parks unpubl. data; P. Basinthal, Sabah Parks, in litt. to J. Mortimer, ICS, 2006
70. Malaysia (West): Terengganu	AN	1992-2000	4-6	A	▼	▼	Liew 2002
71. Papua New Guinea	AF	2004	~500-1000	B	▼	▼	Wilson *et al.* 2004; B. Krueger, UWI, in litt. to J. Mortimer, ICS, 2007
72. Philippines	AF	1980s	<500	B	▼	▼	Groombridge and Luxmoore 1989
73. Thailand (Gulf of Thailand)	AN	1990-2005	~20	A	▼	▼	Charuchinda and Monanunsap 1998; M. Charuchinda, Thailand Department of Marine and Coastal Resources, unpubl. data; M. Aureggi, NAUCRATES, in litt. to J. Mortimer, ICS, 2006
74. Vietnam	AF	1980s	100	B	▼	▼	Groombridge and Luxmoore 1989
PACIFIC OCEAN: CENTRAL							
75. American Samoa and Western Samoa	AF	1991	<10-30	B	▼	▼	Tuato'o-Bartley *et al.* 1993; Grant *et al.* 1997; G. Balazs, NMFS, in litt. to J. Mortimer, ICS, 2007
76. Fiji	AN	2006	100-200	A	▼	▼	Batibasaga 2002
77. Guam	AF	2003	<5-10	B	▼	▼	G. Davis, NMFS, in litt. to J. Mortimer, ICS, 2007; G. Balazs, NMFS, in litt. to J. Mortimer, ICS, 2007
78. Hawaii	AF	2006	5-10	B	▲	▼	G. Balazs, NMFS, in litt. to J. Mortimer, ICS, 2007
79. Micronesia	AF	1998	~300	B	▼	▼	NMFS and FWS 1998
80. Palau Republic	AF	1998	20-50	A	?	▼	NMFS and FWS 1998
81. Solomon Islands	AN	2004	200-300	B	▼	▼	Ramohia and Pita 1996, Wilson *et al.* 2004
82. Vanuatu	AF	2004	>300	B	?	▼	Wilson *et al.* 2004; K. MacKay, University of the South Pacific (USP), pers. comm. to J. Mortimer, ICS, 2007
PACIFIC OCEAN: EASTERN							
83. Mexico (Baja California)	AF	2003	<15	A	?	▼	Seminoff *et al.* 2003b; J. Nichols unpubl. data
TOTAL			**10,010 - 12,483**				

Table 4. Summary of recent trends (within the past 20 years) and historic trends (during a period of >20 to 100 years) for each of the 83 sites for which data are available. Key to trend symbols: ▲ = increasing population; ▼= decreasing population; ▬ = stable population; ? = unknown trend.

Ocean Basin	Number of Sites								
	Total Sites	Recent Trends (within past 20 years)				Historic Trends (during a period of >20 to 100 years)			
		▲	▬	▼	?	▲	▬	▼	?
Atlantic	33	9	0	11	13	0	0	25	8
Indian	31	0	2	5	24	0	0	17	14
Pacific	19	1	1	13	4	0	0	16	3
Total	**83**	**10**	**3**	**29**	**41**	**0**	**0**	**58**	**25**

Based on the mean annual reproductive effort reported in Tables 1-3, an estimated total of 21,212 to 28,138 hawksbills nest each year among the 83 sites included in this evaluation. This is a rough estimate of total reproductive output since not all sites have been surveyed and some data are for single years. Nevertheless, it provides a good starting point with which to estimate annual global nesting effort since most of the major nesting concentrations are included in this analysis.

Tables 1-3 present information about population trends for each of 83 hawksbill nesting sites. Population trends are assessed over two time frames: "Recent" trends apparent within the past 20 years and "Historic" trends apparent over a period of >20 to 100 years. For each of the two time frames, each site was assigned one of the following four categories: increasing, stable, decreasing, or trend unknown. Based on the data available, recent trends could be assessed for 42 of the 83 sites, and historic trends for 58 of the 83 sites.

Summary data are provided in Table 4. Among the 58 sites for which historic trends could be assessed, all 58 (100%) showed a decline during the long-term period of >20 to 100 years. Among those 42 sites for which recent trend data are available, the picture is somewhat more optimistic with 10 (24%) increasing, 3 (7%) stable, and 29 (69%) decreasing.

Quantitative continuous data over periods of approximately 20 or more years are available for only 11 sites in the world. In the Atlantic, these include Antigua (Jumby Bay), Barbados, Puerto Rico (Mona Island), U.S. Virgin Islands (Buck Island Reef National Monument), Mexico (Yucatan Peninsula), and Costa Rica (Tortuguero National Park). In the Indo-Pacific, these include Seychelles (four nature reserves in the inner islands), Australia (Milman Island), Malaysia (Sabah Turtle Islands), Malaysia (Terengganu), and Thailand (Ko Khram). Among these 11 sites, 6 (55%) are increasing, 4 (36%) are decreasing, and 1 (9%) is stable. Unfortunately, these data are not representative of the global picture. The fact that turtles are legally protected at most of these 11 sites and/or are monitored continuously provides a degree of protection to both turtles and their habitats that is not enjoyed by most nesting populations worldwide (Mortimer and Donnelly in review). More long term quantitative studies are needed at unprotected sites.

With respect to regional trends (Table 4), some regions are doing better than others based on available trend data. Although greatly depleted from historical levels, nesting populations in the Atlantic in general are doing better than in the Indo-Pacific. In the Atlantic, more population increases have been recorded in the Insular Caribbean than along the Western Caribbean Mainland or the Eastern Atlantic. In general, hawksbills are doing better in the Indian Ocean (especially the South Western and North Western Indian Ocean) than in the Pacific Ocean. In fact, the situation for hawksbills in the Pacific Ocean is particularly dire, despite the fact that it still has more nesting hawksbills than in either the Atlantic or Indian Oceans.

Atlantic Ocean: Insular Caribbean

There are eight nesting concentrations of particular interest in the Insular Caribbean, including Antigua/Barbuda (especially Jumby Bay), Bahamas, Barbados, Cuba (Doce Leguas Cays), Jamaica, Puerto Rico (especially Mona Island), Trinidad and Tobago, and U.S. Virgin Islands (especially Buck Island Reef National Monument). Of these, the rookeries that are being regularly monitored (Jumby Bay, Barbados, Mona Island, and Buck Island Reef National Monument) are increasing; while at the other sites the few recent data that exist indicate a less optimistic status (especially Bahamas, Jamaica, Trinidad (east coast) and Tobago, and U.S. Virgin Islands outside of Buck Island Reef National Monument).

At Antigua/Barbuda, some 36 nesting beaches have been documented (Fuller *et al*. 1992) of which only one (Jumby Bay) has been monitored (Richardson *et al*. 2006). Although the population at Jumby Bay has increased by 79% during the past 19 years (Richardson *et al.* 2006;

Parish and Goodman 2006; McIntosh *et al.* 2003; Stapleton and Stapleton 2004, 2006), there is no evidence of similar increases anywhere else in Antigua (J. Richardson, University of Georgia, personal communication to J. Mortimer, ICS, 2007).

The Bahamas was historically a major source of tortoiseshell for the European market, and by the 1890s some 4,186 kg were exported annually (equivalent to more than 3,122 turtles). If half came from nesting females, an average of 1,561 nesting females would have been taken annually (Northcroft 1900 as cited in McClenachan *et al.* 2006). Despite high Japanese demand for shell, exports declined by 82% from the 1890s to 1979 (Export Statistics listed in Commonwealth of Bahamas, Colonial Reports, 1932-1964; Seminoff and Bjorndal, unpublished summary). Today an estimated 100-333 females nest annually on the 700 islands and cays that comprise the Bahamas (K. Bjorndal, University of Florida, in litt. to J. Mortimer, ICS, 2006).

In Barbados, hawksbills have been monitored since the mid-1980s and a moratorium on take has been in place since 1998. Estimated numbers of nesting females have increased by more than 700%. Based on 2003-2005 data, an estimated 483 females nest per year (Beggs *et al*. in press; J. Horrocks and B. Krueger, UWI, unpublished data). Nesting habitat is however largely unprotected and coincides with areas that are heavily developed for tourism or are designated for tourism development.

For Cuba (Doce Leguas Cays), historical records indicate that thousands of nesting females were captured annually during the 19th and 20th centuries (Ballou 1888 as cited in McClenachan *et al.* 2006; McClenachan *et al.* 2006). In 1936, a closed season was introduced, and in 1961 the government prohibited egg collection and disturbance of nesting females, suggesting concern about sustainability (Carrillo *et al.* 1999). Annual legal foraging ground exploitation of 5,000 turtles was reduced to 3,000 in 1993, 1,000 in 1994, and 500 from 1995 onwards (Carrillo *et al.* 1999). The impact of current exploitation (500/year) and current nesting trends are unknown, but the number of nesting females is suspected to be declining in some areas (Carrillo *et al.* 1999; Moncada *et al.* 1999), with small increases at other sites (Cuban Turtle Group to A. Abreu-Grobois, Unidad Academica Mazatlan (UAM), 2002).

In Jamaica, nesting surveys conducted from 1991-1996 indicated 200-275 females nesting per year (R. Kerr, Duke University, personal communication to A. Meylan, Florida Fish and Wildlife Conservation Commission,2001). No recent information is available.

The most significant hawksbill nesting in Puerto Rico occurs on Mona Island, which is located in the middle of the Mona Passage between

Hispaniola and the mainland of Puerto Rico. Nesting also occurs on Culebra Island, Vieques Island, and some mainland beaches. Nesting populations of Puerto Rico appeared to be in decline until the early 1990s, but all have increased during the periods they were surveyed: Mona Island (1974-2005), +539%; Caja de Muertos (1995-2003), +23%; Culebra Island (1993-2005), +190%; and Humacao (1987-2004), +930%. Mona Island now hosts some 199-332 nesting females annually, and the other sites combined host 51-85 nesting females annually (R.P. van Dam and C.E. Diez, Chelonia, Inc., unpublished data; C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer, ICS, 2006).

Trinidad and Tobago support important hawksbill rookeries, but only the north coast of Trinidad was surveyed recently (in 2000-2004) and some 150 females were reported nesting annually (Livingstone 2006). Similarly significant nesting is reported for the east coast of Trinidad and nearby Tobago but annual nesting numbers have not yet been determined (Livingstone 2006).

The most significant nesting in the U.S. Virgin Islands occurs at Buck Island Reef National Monument, a small, uninhabited island about 2.4 km north of the northeast coast of St. Croix. Nesting also occurs on other beaches in St. Croix and on St. John and St. Thomas. The U.S. Virgin Islands have a long history of tortoiseshell trade (Schmidt 1916). At Buck Island Reef National Monument, protection has been in force since 1988, and during that time hawksbill nesting has increased by +143% to 56 nesting females annually, with apparent spill over to beaches on adjacent St. Croix (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer, ICS, 2006). However, similar increases have not been recorded at St. John, perhaps due to the proximity of the legal turtle harvest in the British Virgin Islands (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer, ICS, 2006).

Other nesting populations, for which estimates are available, occur at Bonaire (WIDECAST unpublished data), British Virgin Islands (Mc Gowen *et al.* in review), Dominican Republic (Ottenwalder 1981, 1987, as cited in Meylan 1999)), French West Indies including the Guadaloupean Archipelago (Chevalier *et al.* 2003, 2005) and Martinique (La Gazette des Karets 2006), Grenada (WIDECAST unpublished data), and St. Kitts (WIDECAST unpublished data). Serious efforts to conserve nesting hawksbills are particularly apparent in the French West Indies (Chevalier *et al.* 2003, 2005; La Gazette des Karets 2006).

Regional Issues Affecting Trends: The centuries-old historic trade in tortoiseshell greatly impacted hawksbill populations in the Insular Caribbean. During 1950-1992 alone, Cuba exported the equivalent of 106,948 turtles (170,047 kg shell) to Japan. Increases in nesting hawksbills in the region coincide with the decline of international trade in hawksbill shell (Milliken and Tokunaga 1987, Japanese Trade Statistics), and in particular with the 90% reduction in the annual take of large hawksbills from Cuban waters during the same period (i.e., down from 5,000 large hawksbills annually during 1970-1992 to fewer than 500 annually since 1995) (Carrillo *et al.* 1999). Overall, this reduction spared more than 50,000 large hawksbills in the last 12 years.

Atlantic Ocean: Western Caribbean Mainland

The most important hawksbill rookery in the Western Caribbean Mainland region nests along the coastline of the Mexican Yucatan Peninsula. That population was in decline until 1978 when local and regional protection was implemented; and during 1985 to 1999 numbers of nesting hawksbills increased dramatically (Garduno-Andrade *et al.* 1999). But, during 1999-2004 nesting numbers declined by 63% in 5 years, reaching its lowest point in 2004 (Abreu-Grobois *et al.* 2005). Since 2004, nesting numbers have increased (unpublished data collected in (a) Yucatan and Quintana Roo by Pronatura Península de Yucatán, SEMARNAT, CONANP, Secretaría de Ecología de Yucatán, and (b) Campeche by Conanp-APFFLT, SEMAR V Zona Naval, Secretaria de Ecologia Gob. del Estado, Enlaces con tu Entorno AC, Marea Azul AC, Desarrollo Ecologico Cd. del Carmen AC, Quelonios AC, UNACAR, Universidad Autónoma de Campeche, H. Ayuntamiento del Carmen, Pronatura PPY, Profepa.).

Playa Chiriqui, Panama, may once have been the most significant rookery in the region, but during the past 50 years it has declined by more than 95% (Carr 1956, Carr *et al*. 1982, Meylan and Donnelly 1999). Recently it gained a degree of protected status as a Damani-Guariviara Wetland, but threats from poaching and predators (especially dogs) are difficult to address on this mainland beach where some 84-140 females nest annually (Meylan *et al.* 2006). Meanwhile, at Bastimentos Island Marine National Park, which has been protected since 1988, nesting populations have tripled (to 27-45 females/year) in response to the protection of nesting females from exploitation (Meylan *et al.* 2006).

Other historically significant, but now much reduced, hawksbill rookeries include those at Belize, Colombia (San Andres Archipelago), and Honduras (Bay Islands). Belize supported a valuable tortoiseshell industry in the early 1900s (Smith *et al.* 1992 cited in Meylan 1999), but now has only about 10-50 nesting females (WIDECAST unpublished data). The rookeries of Colombia's San Andres Archipelago were an important source of tortoiseshell in the 1930s (Parsons 1972), but by 1981 were almost extirpated (Carr *et al.* 1982); no current population estimates are available. Colombia's Isla Fuerte may host 20-100 females per year (WIDECAST unpublished data). The Honduran Bay Islands were a major hawksbill rookery in the 16th and 17th centuries (McClenachan *et al.* 2006), but 20th century declines have been significant (Carr *et al.* 1982, Meylan 1999), and today fewer than 10 females per year are estimated to nest (Aronne 2000a, 2000b).

In Costa Rica, hawksbills nest in the Tortuguero National Park and at Cahuita and Erlin in small numbers, where, respectively, fewer than 10 females and an estimated 6-37 females now nest annually. Despite decades of protection in the Tortuguero National Park, nesting numbers have declined by 80% since the 1950s (Troëng *et al.* 2005).

In Nicaragua, the hawksbill population of El Cocal has declined by more than 75% (to only 15-25 females/year) since the 1970s (Lagueux and Campbell 2005). At the Pearl Cays rookery (30-52 females/year), although efforts to protect nesting females and eggs have been successful through community awareness programs, coastal development by foreign nationals poses an extreme threat to nesting habitat (Lagueux *et al.* 2003).

In Venezuela (Los Roques and Paria region), hawksbill populations (now approximately 32-53 females/year) are much reduced, primarily due to massive exploitation for shell in the 1960s and 1970s, and more recently to illegal take, destruction of foraging and nesting habitats, and incidental capture in fishing gear (H. Guada, Centro de Investigación y Conservación de Tortugas Marinas (CICTMAR), in litt. to J. Mortimer, ICS, 2006).

Regional Issues Affecting Trends: The centuries-old historic trade in tortoiseshell greatly impacted hawksbill populations in the Western Caribbean Mainland. During 1950-1992, Panama alone exported the equivalent of 152,070 turtles (203,774 kg shell) to Japan. Mexican researchers suspect the more recent declines in the Yucatan population may be due to extraction at low levels and/or impacts on marine habitats (Abreu-Grobois *et al.* 2005). Throughout the region, hawksbills are still killed for meat, eggs, and shell; and their foraging and nesting habitat is being destroyed by unregulated coastal development.

Atlantic Ocean: South Western

In Brazil, an estimated 350-585 hawksbills now nest annually (N. Marcovaldi, Projeto TAMAR, in litt. to J. Mortimer, ICS, 2006). This represents a decline of about 80% during the past 105 years due to a combination of directed take of females and eggs, manufacture of shell ornaments, incidental capture in fishing gear, and habitat destruction before 1982. Nesting once extended from north Rio de Janeiro State to the Ceará State (N. Marcovaldi, Projeto TAMAR, in litt. to J. Mortimer, ICS, 2001), but is today restricted primarily to northern Bahia and Sergipe (approximately 1,300 nests annually), Rio Grande do Norte near Pipa (approximately 450 nests in 2002-2003), and only scattered nesting elsewhere (Marcovaldi 2005). Since protection in 1982, the decline in the nesting population has stopped; studies from 1990 to 2003 on the remnant population in Northern Bahia show increasing trends in nest numbers although the numbers fluctuate from year to year (Marcovaldi 2005). Hybridization of hawksbills with other sea turtle species may be a threat (Lara-Ruiz *et al.* 2006).

Atlantic Ocean: Eastern

Hawksbill populations along the west coast of Africa have suffered significant declines due to intense exploitation for eggs and shell. Two areas of interest in the eastern Atlantic Ocean include Bioko Islands (Equatorial Guinea) and São Tomé and Principe. At Bioko, fewer than 10 females nest annually (Tomás *et al.* 2000) and their numbers are in decline (J. Fretey, IUCN France, and A. Formia, Universita di Firenze, in litt. to J. Mortimer, ICS, 2001). In São Tomé and Principe, only about 14-27 females nest annually, and exploitation of about 80% of the females and eggs occurs (J.-F. Dontaine, Conservation et utilisation rationnelle des Ecosystèmes Forestiers d'Afrique Centrale, in litt. to J. Mortimer, ICS, 2001; J. Fretey, IUCN France, and A. Formia, Universita di Firenze, in litt. to J. Mortimer, ICS, 2001; J. Fretey, IUCN France, in litt. to J. Mortimer, ICS, 2002).

Recent surveys in Liberia have also documented low numbers of hawksbills nesting. Between July 2005 and July 2006, a community based project organized by Save My Future Foundation (SAMFU) recorded 37 hawksbill nests along 15 km of coastline in Borgor Point, Rivercess County, Liberia. Much of the remaining 579 km of Liberian coastline remains unsurveyed, suggesting the potential for greater numbers of undocumented hawksbill nesting, although any nests located outside the Borgor Point survey areas are likely collected for local consumption (SAMFU 2006).

Indian Ocean: South Western

In the South Western Indian Ocean, virtually all sites were greatly impacted by the centuries-long trade in tortoiseshell. The most important hawksbill nesting populations remaining occur in the Seychelles and in Madagascar.

In the Seychelles, hawksbills nest throughout the entire country, but predominantly on the 22 inner islands (including the granitic islands) and in the Amirantes group (Mortimer 1984). Shell export intensified in the 19th and 20th centuries, and prior to the 1960s most of it was used for export to Europe (Mortimer 1984). From the mid-1960s through the mid-1990s, most shell was exported to Japan, with the remainder used for the local curio trade. During that same period, except at protected sites, most females were killed prior to laying eggs (Mortimer 1984, Mortimer and Collie 1998). In 1994, Seychelles passed legislation protecting all turtles and prohibiting all trade in turtle products (Mortimer and Collie 1998, Mortimer 2000); that same year, all domestic tortoiseshell trade ceased (Mortimer 1999). Surveys conducted in the early 1980s (Mortimer 1984) and in the early 2000s demonstrate the following population trends for the 22 inner islands of Seychelles: at 2 islands well protected since the early 1970s, hawksbill numbers increased by 389% (from 44 to 215 females); at 7 islands with intermediate levels of protection since 1979, hawksbill numbers declined by 21% (from 240 to 190 females); and at 13 islands that had no protection prior to 1994, hawksbill numbers declined by 59% (from 536 to 220 females) (Mortimer 2006). Turtle conservation programs are continually expanding in the Seychelles, so future increases in the nesting populations can be expected. Currently, the most serious threat to hawksbills is destruction of nesting habitat from inadequate regulation of coastal development (Mortimer 2004). In the outer islands of the Seychelles, an estimated 800 females nest annually. Unpublished data suggest a similar pattern as in the inner islands, with increases at protected sites and declines at unprotected sites (J. Mortimer, ICS, unpublished data).

Madagascar exported hawksbill shell as early as the 15th century (Frazier 1980). From the mid-19th century to 1920, exports were equivalent to about 4,054 to 5,405 turtles. Petit (1930 as cited in Hughes 1973) reported drastic population declines after World War I, and exports dropped to an estimated 1,351 turtles by the mid-20th century and to an estimated 270 turtles by 1973 (Hughes 1973). Sale of worked shell to tourists continues (Meylan and Donnelly 1999). Nesting turtles in surveyed areas appear to be in decline with exploitation for meat, eggs, and shell (Rakotonirina and Cooke 1994, Metcalf *et al.* 2007). Turtles are often entangled in nets (Metcalf *et al.* 2007), and trawling along the northwest and west coasts of Madagascar is believed to be a threat (Randrianmiarana *et al.* 1998).

At some sites in the South Western Indian Ocean, nesting hawksbills occur only in small numbers and no evidence exists that they were ever abundant: Comoro Islands, 25-50 females/year (Ben Mohadji *et al.* 1996) and France (Iles Eparses), 20-45 females/year (J. Bourjea, IFREMER, and S. Ciccione, CEDTM, in litt. to J. Mortimer, ICS, 2006).

But other sites have probably suffered significant declines, due in large part to the historic trade in tortoiseshell, but also to destruction of nesting habitat, exploitation for meat and eggs, and entanglement in fishing gear: Mauritius, now <50 females/year (Mangar and Chapman 1996); Mayotte, now estimated at 10-50 females/year, but inadequately surveyed (Groombridge and Luxmoore 1989; M. Quillard and S. Ciccione, CEDTM, in litt. to J. Mortimer, ICS, 2006; J. Bourjea, IFREMER, in litt. to J. Mortimer, ICS, 2006); Kenya, now <10 females/year (Okemwa *et al.* 2004); Tanzania, now <50 females/year (Howell and Mbindo 1996); and Mozambique, now <10 females/year (A. Costa, World Wildlife Fund (WWF)-Mozambique, in litt. to J. Mortimer, ICS, 2006; J. Garnier, Maluane Conservation, in litt. to J. Mortimer, ICS, 2007; I. Marquas da Silva, Projeto TAMAR, in litt. to J. Mortimer, ICS, 2007).

Indian Ocean: North Western

The fact that hawksbills in the North Western Indian Ocean were only minimally involved with the Japanese tortoiseshell trade since at least 1950 probably explains their current relative abundance. Nevertheless, the species faces significant threats from entanglement in fishing gear, habitat degradation associated with oil production, exploitation for meat and eggs, and coastal development. Much of this region has not yet been properly surveyed, nor have current trends been documented.

The most important hawksbill populations in the North Western Indian Ocean are found in Iran (mostly along the Arabian/Persian Gulf coast) and in Oman. Saudi Arabia hosts important hawksbill rookeries on two coasts, along the Arabian/Persian Gulf and along the Red Sea. Elsewhere along the Gulf, relatively recent data are available for Kuwait, Qatar, and United Arab Emirates, but data are lacking for Bahrain. Along the Red Sea, recent data are available for Egypt, but only old data (1960s-1970s) are available for Sudan. Almost no data exist for Eritrea and Somalia. The most recent data available for Yemen is from the 1960s and 1970s.

Iran may host as many as 500 to 1,000 females/year, but the area is poorly surveyed. Available data indicate the Shitvar, Lavan, Hormuz, Larak, Queshm, and Jabrin islands and adjacent mainland beaches host significant, but poorly surveyed nesting populations (Kinunen and Walczak 1971; Ross and Barwani 1982; Valavi 1999; J. Mortimer, ICS, personal observation, 2001; Mobaraki 2003; Mobaraki and Elmi 2005). Populations are threatened by egg harvest, especially on the mainland (H. Rostamian, Department of Environment of Bushehr Province, Iran, unpublished data); incidental capture in fishing gear (J. Mortimer, ICS, personal observation, 2001; Mobaraki and Elmi 2005); foraging habitat degradation due to coral bleaching events (Sheppard and Loughland 2002, Sheppard 2006), and oil spills (Miller 1989). Current population trends are unknown.

In Oman, approximately 600-800 females nest annually, primarily on the coast of the Gulf of Oman (Salm *et al.* 1993, Baldwin and Al-Kiyumi 1997), including 250-350 at the protected Dimaniyat Islands and 100 at Masirah Island (Ross and Barwani 1982, Ross 1981). Monitoring at Dimaniyat Islands indicates stable nesting numbers (A. Al-Kiyumi, Nature Conservation Oman, personal communication to N. Pilcher, Marine Research Foundation, 2006), but unsustainable egg harvest has been reported at Bar al Hikman (Salm 1991 as cited in Baldwin and Al Kiyumi 1997). Harvest of eggs is believed to be minor at Masirah and the Dimaniyat Islands (R. Baldwin, Environmental Society of Oman, personal communication, 2007). On mainland beaches, foxes destroy 62-82% of eggs, and 10-15% of eggs are laid below the high tide line (Salm 1991 as cited in Baldwin and Al Kiyumi 1997). Other problems include rainwater runoff, gill nets, tourist activities, and vehicular traffic (Baldwin and Al-Kiyumi 1997, Rees and Papathanasopoulou 2006).

Saudi Arabia hosts important hawksbill rookeries on two coasts. Along the Arabian Gulf, approximately 175-265 females nest annually. Estimates by island based on Pilcher (1999) and J.D. Miller (AUC, in litt. to J. Mortimer, ICS, 2006) are Jana, 100-150; Karan, <50; Jurayd, 10-15; and Kurayn, <50. Population trends are unknown. Saudi nationals do not eat turtle eggs or meat, but foreigners on fishing boats do (Pilcher 1999). Gill nets entangle hatchlings leaving the beach (Pilcher 1999) and turtles in the water (Miller 1989). The most serious threat is destruction of nesting and foraging habitats. Tar, oil slicks, and debris on shore entrap hatchlings and prevent nesting (Miller 1989, Pilcher 1999). Spilled oil and dispersants threaten marine ecosystems (Miller 1989). Coral bleaching events in 1998 and 2000 destroyed much coral reef in the Arabian Gulf (Sheppard and Loughland 2002, Sheppard 2006).

Along Saudi Arabia's Red Sea coastline, 100-200 females nest annually (J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006). Low density nesting occurs at numerous sites from the islands of the Farasan Archipelago to Tiran Island at the Gulf of Aqaba (Miller 1989). Population trends are unknown, but the major threats identified by Miller (1989; J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006) include egg harvest, fisheries related mortality (especially from trawlers), and habitat destruction caused by cement dust that lands on the beach and solidifies.

Kuwait reportedly hosts fewer than 20 females/year (Groombridge and Luxmoore 1989), while both Qatar and the United Arab Emirates host significant numbers of nesting females, more than 100 females/year in Qatar (Pilcher 2006) and 100-200 females/year in the United Arab Emirates (J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006). Several countries in the immediate area have banned trawling, including Bahrain, Kuwait, and Qatar (N. Pilcher, Marine Research Foundation, in litt. to J. Mortimer, ICS, 2007).

For Egypt on the Red Sea, the recent estimate of 50-100 females annually (J.D. Miller, AUC, *in litt.* to J. Mortimer, ICS, 2006) is lower than the 200-500 reported by Frazier and Salas (1984). Egypt is a historically important source and consumer of shell (Parsons 1972). Threats include destruction of habitat from oil pollution, underwater explosions related to seismic oil exploration (Frazier and Salas 1984), and coastal development and near shore reef habitat destruction (J.D. Miller, AUC, in litt. to J. Mortimer, ICS, 2006).

Neighboring Sudan has not been surveyed since the 1970s when a total of 300-350 females/year nested on the islands of the Suakin Archipelago (Moore and Balzarotti 1977, Hirth and Abdel Latif 1980) and islands off Mohammed Qol (Moore and Balzarotti 1977). Sudanese hawksbills were formerly intensively exploited for the tortoiseshell trade (Groombridge and Luxmoore 1989), and later killed in large numbers for meat in the late 19th century at the opening of the Suez Canal (Moore and Balzarotti 1977). Subsistence harvest was reported in the 1970s (Frazier 1980). The current situation is unknown.

Eritrea has never been properly surveyed. The sparse coastal human population indicates that neither subsistence take nor coastal development is likely to pose a threat (Hillman and Gebremariam 1996). However, fisheries related mortality (especially from trawlers and shark nets) may be a serious problem with an estimated 0.61 turtles (47% are hawksbills) caught per hour trawled in Eritrean waters (Gebremariam *et al.* 1998).

For Somalia, nesting is reported in the northeast and southwest regions, but no nesting estimates are available (Abdulrizak Osman Ali, Ocean Training Promotion, personal communication to J. Mortimer, ICS, 2000). Bajun on the south coast harvested tortoiseshell for generations, which they sold to Europe in the 1970s, and formerly to Zanzibar at approximately 100 kg/year, except for 5,099 kg exported in 1976 (Frazier 1980). Population trends are unknown.

For Yemen, approximately 500 nesting females/year are estimated based on data from the 1960s and 1970s. Nesting is reported for Socotra, Abd al Kuri, Jabal Aziz, and Perim, and at low coral islands 3-30 km offshore (Hirth 1968 as cited in Ross and Barwani 1982; Groombridge and Luxmoore 1989). Meat and eggs were eaten by fishermen (Frazier 1980). Population trends are unknown.

Indian Ocean: Central and Eastern

Currently, the most important hawksbill nesting populations in the Central and Eastern Indian Ocean are those that occur in Australia (Western Australia), Maldives, British Indian Ocean Territory (Chagos Islands), and India (Andaman and Nicobar Islands). Except for those of Australia, all the hawksbill rookeries of the Central and Eastern Indian Ocean have declined significantly. Populations of Malaysia (Melaka), Myanmar, Sri Lanka, and Thailand (Andaman Sea) can be considered remnant populations.

The Western Australian hawksbill population is the largest in the Indian Ocean (Limpus 1997, 2002). Nesting distribution has been mapped, but population sizes are poorly quantified (Limpus 2002). Much of the nesting occurs within areas of the greatest industrial development, including brightly lit oil/gas facilities on islands and at sea. Altered light horizons may reduce nesting activity and increase hatchling predation at sea. No monitoring of expanding human populations, new holiday huts on nesting islands, and associated habitat destruction, as well as increased boat strikes and other disturbances, has been conducted (Limpus 2002). Migrations are not documented; hawksbills leaving Australian waters may be subject to intense mortality in unprotected waters (as is the case for eastern Australian populations) (Limpus 2002). Population trends are unknown.

Maldives hosts an estimated 460-767 females/year based on data collected in the 1980s (Frazier *et al.* 2000) and during 1988-1995 (Zahir and Hafiz 1997). The long history of tortoiseshell export combined with hunting for eggs and meat has had tremendous impact (Frazier 1980). In the early 1980s, Maldives was considered one of the most important areas for hawksbills in the Indian Ocean, but exploitation has been identified as the probable cause for depletion (Groombridge 1982). A continued decline is likely because: a) no protected nesting areas exist in Maldives, and b) no regulations of egg harvest occurred until 2006 when 11 islands began protection measures (H. Zahir, Marine Research Centre Maldives, in litt. to J. Mortimer, ICS, 2006).

The British Indian Ocean Territory (BIOT; Chagos Islands) hosts an estimated 300-700 females/year (Mortimer and Day 1999). The islands were inhabited from the 1780s until 1972 when a United States/United Kingdom military base was established at Diego Garcia. Historical records show "significant export" of tortoiseshell (Parsons 1972), but during the 20th century (1904-1929) annual harvest was less than 200 animals/year (Frazier 1980). BIOT turtles are now protected by law (Mortimer and Day 1999), but enforcement is difficult in the outer islands (J. Mortimer, ICS, unpublished data). Erosion of nesting beaches is a serious long-term problem, especially in the outer islands (Mortimer and Day 1999; J. Mortimer, ICS, unpublished data), perhaps due to sea level rise and coral reef mortality (Sheppard 2002). Hawksbill numbers have declined significantly since the late 18th century, but current population trends are unknown.

India (Andaman and Nicobar Islands) has an estimated 250 females/year based on incomplete surveys conducted in 1992 (Andrews *et al.* 2006). Threats include sand mining, egg predation by dogs and pigs, incidental capture in active and discarded gill nets, and poaching of nesting females and foraging turtles by settlers (Andrews *et al.* 2006). The data indicate a population in decline.

Malaysia (Melaka State) hosts the most important hawksbill rookery remaining in Peninsular Malaysia. Prior to 1990 when the Malaysia Department of Fisheries established a hatchery, people consumed most of the eggs (Mortimer *et al.* 1993). The Melaka coastline is now undergoing intensive coastal development and massive land reclamation (Min Min Lau, WWF-Malaysia, personal communication to J. Mortimer, ICS, 2006; J. Mortimer, ICS, personal observation, 2003). Few eggs hatch outside the hatchery, and the numbers of eggs incubated per year during 1991-2005 have remained stable, averaging approximately 250 egg clutches/year (Malaysia Department of Fisheries, unpublished data); however, this apparent stability may reflect increased efforts to protect eggs despite a possible decline in nesting (Min Min Lau, WWF-Malaysia, personal communication to J. Mortimer, ICS, 2006). Current threats include destruction of nesting habitat and entanglement in fishing nets (Min Min Lau, WWF-Malaysia, personal communication to J. Mortimer, ICS, 2006). The evidence indicates a population in decline.

Myanmar hosts a remnant population of fewer than 5 females/year (based on data from Maxwell 1911 as cited in Groombridge and Luxmoore 1989). No recent data are available.

Sri Lanka is believed to host only about 10 females/year (T. Kapurusinghe, Turtle Protection Project (TCP), in litt. to J. Mortimer, ICS, 2006). From December 2006 to March 2007, TCP protected 20 hawksbill nests; additional nests may occur in unsurveyed areas of Sri Lanka (L. Ekanayake, TCP, in litt. to J. Mortimer, ICS, 2007). In the 1840s, nesting hawksbills were so abundant along the south coast that the Government sold individuals the right to capture them, and a flourishing local artisanal trade developed (Deraniyagala 1939). Legislation protecting turtles and eggs was enacted in 1972, but ignored (Salm 1981 as cited in Groombridge and Luxmoore 1989). Heavy exploitation continues. Virtually no eggs survive outside hatcheries, except under in situ protection conducted by TCP (Kapurusinghe 2000). Many hatcheries are poorly managed. This is a remnant population in decline.

Thailand (Andaman Sea coast) now hosts fewer than 10 hawksbill females/year (M. Aureggi, NAUCRATES, in litt. to J. Mortimer, ICS, 2006). In Thailand, exploitation for turtle meat and eggs was unregulated until the 1947 Fisheries Act, which prohibited killing of turtles and established an egg concession system requiring protection of 10-15% of eggs (Mortimer 1988). By the 1980s, egg concessions were abandoned at most sites due to disturbance from massive coastal development and tourism, but several National Parks were established (Mortimer 1988). Major threats include poaching of eggs and turtles by Moken ("sea gypsy") people, and fisheries related mortality (Mortimer 1988; M. Aureggi, NAUCRATES, in litt. to J. Mortimer, ICS, 2006). In the 1980s, small numbers of hawksbills nested at Sulin and Similan islands, Phang Nga Province, and at Tarutao National Park in Satun Province (Ginsberg and Congdon 1981 as cited in Mortimer 1988, Mortimer 1988). Hawksbill nesting is now reported only at Ko Surin National Park, where eggs collected by sea gypsies are sold to park officers for incubation; however, hatching success is poor (M. Aureggi, NAUCRATES, in litt. to J. Mortimer, ICS, 2006). This is a depleted population in decline.

Pacific Ocean: Western

Hawksbill populations throughout most of the Western Pacific (with the exception of Australia) plummeted during the 20th century. This decline was enhanced by both past and current exploitation of hawksbills for the tortoiseshell trade, continued take for meat, incidental capture in fisheries, and destruction of nesting habitat by unregulated coastal development. Because this region was historically one of the world's most famous hawksbill breeding and foraging areas, its declining and depleted hawksbill populations represent a significant global loss. The most important populations in the Western Pacific Ocean are those found in Australia and in Indonesia.

The Australian Torres Strait-Northern Great Barrier Reef (GBR) population comprises an estimated 4,000 females/year (Limpus 2004). Within Torres Strait and western Cape York Peninsula, half of all nesting is outside protected habitat (Limpus 2004). On the inner shelf of the Northern GBR, most rookeries are within National Parks, but these nesting females are harvested on foraging grounds in adjacent countries, particularly Solomon Islands (Limpus 1997, 2004). From about 1850 into the 1930s, a ton of tortoiseshell was exported annually from Torres Strait (i.e., an annual harvest of more than 1,000 adult hawksbills) (Limpus 2004); however, since 1968 hawksbills have been protected in Queensland. The Milman Island index population, surveyed since 1990, is declining at a rate of 3% annually (Limpus 1997; Limpus and Miller 2000; K. Dobbs, GBR Marine Park Authority, in litt. to J. Mortimer, ICS, 2001). If trends continue, the projected rate of decline for the Torres Strait-Northern GBR population would be greater than 90% by the year 2020 (i.e., in less than one hawksbill generation) (Limpus 2004).

The Australian Northeastern Arnhem Land population comprises an estimated 2,500 females/year (Limpus 2004). Most hawksbill rookeries of Arnhem Land are outside National Parks or other habitat managed for conservation purposes (Limpus 2004). Populations are not regularly surveyed, and population trends are not known.

What is now Indonesia may at one time have hosted more nesting hawksbills than any other country in the world. In the mid-1980s, Schulz (1987) estimated 21,000-28,000 hawksbill egg clutches laid annually in Indonesia (equivalent to 4,200-9,333 nesting females/year). But by then, the hawksbill populations were already depleted. Parsons (1972) described the "shoal waters of the East Indian archipelago [to] have been the most productive of all the world's seas in tortoise shell." Dammerman (1929) reported much hunting to produce the shell equivalent of 160,700 hawksbills exported to Japan, Singapore, and the Netherlands during 1918-1927. However, even in those early years Dammerman (1929) was particularly concerned about the impact of the intensive egg collection, which he considered to be the greatest danger to the species' survival. Sixty years later, J. Schulz (in litt. to K. Bjorndal, University of Florida, 1995) reported: "Almost every egg is taken in virtually every nesting place in Indonesia, however small or far-off it may be" and fishermen complained that hawksbills had become rare with large sizes seldom caught. The situation has not improved since the mid-1980s. For 14 sites in Indonesia, Table 5 presents data on egg clutch production during the mid-1980s and compares it to data collected in recent years (sites #1-14). The total estimated annual number of egg clutches produced at these 14 sites in the 1980s was 8,113; and the total estimated annual number of egg clutches produced at the same sites in recent years is 2,630. This represents a decline of 68% in just two decades. For an additional three sites, only recent data on egg clutch production are available, and these data are also presented in Table 5 (sites #a, b, c). In addition, for each of the 17 sites information on current levels of protection are indicated by "yes" or "no" along with the average numbers of egg clutches protected in recent years. Of the annual total of 3,126 egg clutches produced in recent years, only about 598 were protected annually. In other words, only about 19% of all egg clutches laid at the 17 sites in recent years has been protected.

In the mid-1980s, the total egg clutch production from the 14 sites described in Table 5 (8,113) would have accounted for approximately 33% of total egg clutch production for Indonesia estimated by Schulz (if we use the mid-point (24,500) of his bracketed estimate of 21,000-28,000). If we assume that the data from the 14 sites in Table 5 represent population trends throughout the country, then egg clutch production throughout the country would also have declined by 68% during the past two decades. If so, estimated current production would be 6,808-9,077 egg clutches annually, equivalent to 1,362-3,026 females nesting annually.

Table 5. Hawksbill nesting activity and population trends at 14 sites (sites #1-14) in Indonesia showing available *Past* and *Recent* estimates of egg clutch production and current protected status. For an additional 3 sites (sites # a-c), only *Recent* estimates and current protected status are presented. All values are based on annual means. For each site, Current Protected Status is indicated by "yes" or "no" (i.e., egg protection) and the numbers of nests protected annually. The following information is derived largely from review by Mortimer and Donnelly (in review).

Province		**Past Estimate (clutches/year)**		**Recent Estimate (clutches/year)**		**Currently Protected?**		**Citation (Past)**	**Citation (Recent)**
Site #	**Nesting Site**	**Years**	**Mean**	**Years**	**Mean**	**Yes/ No**	**Nest/ /year**		
Bangka-Belitung Province									
1	Langkuas Islands	1980s	100	1995-1997	<50	No		Groombridge and Luxmoore 1989	Suganuma *et al*. 1999
2	Lima Islands	1980s	300	1995-1997	300	No		Schulz 1987, Groombridge and Luxmoore 1989	Suganuma *et al*. 1999
3	Momperang and Pesemut Islands (in vicinity Belitung)	1980s	3,250	2000-2005	350	Yes	270	Schulz 1987, Suganuma *et al*. 1999	H. Suganuma, ELNA, unpubl. data, in litt. to J. Mortimer, ICS, 2006 (www.elna.or.jp)
a	Kimar Island			2000-2005	~230	No			H. Suganuma, ELNA, in litt. to J. Mortimer, ICS, 2006
4	Tiga Islands	1980s	350	1995-1997	150	No		Groombridge and Luxmoore 1989	Suganuma *et al*. 1999
DKI Jakarta Province									
5	Seribu Islands National Park	1980s	500	since 1995	150	Yes	50	Groombridge and Luxmoore 1989	Suganuma 2005, H. Suganuma, ELNA, in litt. to J. Mortimer, ICS, 6 Oct 2006
Irian Jaya Barat Province									
b	Jamursba-Medi region			1999-2005	21	Yes	21		H. Suganuma, ELNA, in litt. to J. Mortimer, ICS, 2006
Jawa Tengah Province									
6	Karimunjawa	1980s	300	since 1995	100	No		Groombridge and Luxmoore 1989, Salm 1984	Suganuma *et al*. 1999 Suganuma 2005
Jawa Timur Province									
7	Alas Purwo National Park	1983-1989	7.6	1997-2002	8.7	Yes	9	Alas Purwo National Park, unpubl. data; K. Putra, pers. comm. to J. Mortimer, ICS, 2006	Alas Purwo National Park, unpubl. data; K. Putra, Conservation International, pers. comm. to J. Mortimer, ICS, 2006
8	Meru Betiri National Park	1980-1989	14.8	1995	<3	Yes	<3	Noor *et al*. 1997	Noor *et al*. 1997

Table 5. Continued.

Kalimantan Barat Province									
9	Paloh (4 beaches)	1980s	250	1990-1995	450-478	No		Schulz 1987	H. Suganuma, ELNA, in litt. to J. Mortimer, ICS, 2006; Suganuma 2005
Kalimantan Selatan Province									
10	Kalimantan Selatan Province	1980s	1,000	since 1995	400	No		Groombridge and Luxmoore 1989	Suganuma 2005
Lampung Province									
c	Segama Besar and Segama Kecil			2001-2005	245	Yes			H. Suganuma, ELNA. in litt. to J. Mortimer, ICS, 2006
Riau Province									
11	Anambas Islands	1980s	800	2002	300	No		Schulz 1987	Akil *et al*. 2004
12	Natuna Besar Islands	1980s	200	2002	50	No		Schulz 1987	Akil *et al*. 2004
13	Tambelan Islands	1980s	1,000	2003	300	No		Schulz 1987	Suganuma *et al*. 1999, Akil *et al*. 2004
Sulawesi Selatan Province									
14	Spermonde (Panambungan)	1980s	40	1995-1997	4	No		Schulz 1984	Suganuma *et al*. 1999
TOTAL			**8,113**		**2,630**				

Papua New Guinea has not been recently surveyed, but low density nesting occurs throughout the country, suggesting a possible nesting population of approximately 500-1,000 females/year (Wilson *et al*. 2004, B. Krueger, WWI, in litt. To J. Mortimer, ICS, 2007). Spring (1982) reported nesting in East Sepik Province on the mainland and islands, in West Sepik Province on islands, on Long Island and mainland beaches of Madang Province, and on islands of Central Province. The only recent surveys conducted were at Long Island in Madang Province (Wilson *et al*. 2004). Current status and population trends are unknown.

The Philippines has not been surveyed since the 1970s. Mindanao coast and the Sulu district of southern Philippines are historic sources of shell (Parsons 1972). According to Seale (1917), outlying islands of the Sulu Archipelago were famous for their hawksbills; in 1917, almost all of the 8,000 kg of shell collected each year were exported to Japan. Hawksbills abounded in most areas during the 20th century, but were reduced by 1980 due to heavy exploitation (de Celis 1982). Populations have declined due to exploitation for shell, meat, and eggs (Alcala 1980 as cited in Groombridge and Luxmoore 1989, de Celis 1982, Groombridge and Luxmoore 1989, Palma 1997). In 1980, Alcala reported that virtually every nesting turtle was killed in the Central

Visayas, and believed the same occurred throughout the Philippines (Meylan and Donnelly 1999).

East Malaysia hosts the Sabah Turtle Islands where an estimated 69-116 females nest annually. Eggs were being overexploited prior to 1965 when protection began at Turtle Islands Park (de Silva 1982). There is concern that incubation of all eggs in hatcheries since 1965 has feminized offspring (Mortimer 1991c). During 2006, severe erosion of nesting beach habitat at Gulisaan Island posed a threat to the nesting population (P. Basinthal, Sabah Parks, in litt. to J. Mortimer, ICS, 2006).

On the east coast of Peninsular Malaysia, hawksbills nest primarily in the states of Terengganu, Pahang, and Johor. In the late 1970s, several hundred hawksbill nests were produced annually in Terengganu at Pulau Redang (island), Tanjung Galiga on the mainland, and Tioman Island off the Pahang-Johor border. In West Malaysia, in Terengganu State, only an estimated 4-6 females now nest annually. Eggs have been taken since the early 20th century (Siow and Moll 1982), and overexploitation has caused a significant decline (Liew 2002). Surveys conducted in 1990 estimated 100-200 egg clutches laid annually in Johor (Mortimer 1991b), and fewer than 100 in Pahang (Mortimer 1991a), with nesting levels at both sites reported by local inhabitants to be much lower than in previous years. Local informants attributed declines to overexploitation of eggs, capture of turtles in commercial fishing gear (especially trawl nets), and destruction of nesting beach by coastal development (Mortimer 1991a, 1991b). No recent data are available from Johor and Pahang.

The west coast of Thailand (Gulf of Thailand) now hosts about 20 nesting females/year. Ko Khram is Thailand's most important hawksbill nesting site, controlled and protected by the Royal Thai Navy since the 1950s. During the 1980s, most of the eggs laid at Ko Khram and nearby islands were sold to Navy Officers, the remainder incubated in a hatchery, and all hatchlings headstarted at Ko Man Nai (Mortimer 1988). Other threats include mortality from heavy trawl activity and poaching of nesting females (Polunin 1977 as cited in Mortimer 1988, Mortimer 1988), and disturbance from bright lights and noise from a jetty built in the 1970s (Polunin 1977 as cited in Mortimer 1988). There has been a serious decline in nesting activity since the 1950s, including a recorded decline of 43% during 1973-2005 and an estimated decline of 75% during 1956-2005 (Polunin and Nuitja 1982; Charuchinda and Monanunsap 1998; M. Charuchinda, Thailand Department of Marine and Coastal Resources, unpublished data). Nesting at other sites in the Gulf of Thailand is now insignificant (Charuchinda and Monanunsap 1998). These populations are considered depleted and declining.

Vietnam hosts approximately 100 nesting females/year. The population is depleted and probably in decline. Sixty-five years ago hawksbills were common along the coast of Vietnam (Bourret 1941 as cited in Groombridge and Luxmoore 1989). Egg harvest at Cochin China reduced hawksbill populations by 1923 (Le Poulain 1941 as cited in Groombridge and Luxmoore 1989). Despite declines in the nesting population, Vietnam still has "a strong continuing local tortoiseshell industry" (Le Dien and Broad 1995; N. Pilcher, in litt to J. Mortimer, ICS, 2002) and international export trade.

Japan hosts a remnant population of nesting hawksbills off the southern main islands of Japan in Ryukyu Archipelago and Ogasawara Islands. It has been considered in danger of extirpation since 1985 (Groombridge and Luxmoore 1989). Hawksbills are still hunted on the foraging grounds in Japan (TRAFFIC East Asia-Japan 2000).

Regional Issues of Concern: During the past several years, illegal Asian fishing boats from China and Vietnam have been intercepted in Indonesian waters (Turtle Foundation 2007) and Malaysian waters (E.H. Chan, University Malaysia Terengganu, in litt. to J. Mortimer, ICS, 2007), each with cargos of hundreds of large hawksbill turtles prepared as stuffed specimens. There is evidence that many of these turtles are caught in drift nets (E.H. Chan, University Malaysia Terengganu, in litt. to J. Mortimer, ICS, 2007). Such illegal activities pose a serious threat to the survival of the already greatly depleted hawksbill populations of the Western Pacific region.

Pacific Ocean: Central

In the Central Pacific Ocean, hawksbill nesting populations were already depleted prior to contact with European cultures (Diamond 2005). The most concentrated hawksbill nesting that remains is that of the Arnavon Islands in the Solomon Islands with about 100-200 females nesting annually.

The Solomon Islands have an estimated 200-300 nesting females/year. The estimated number of nests/year is based on Wilson *et al*. (2004), except where otherwise noted: Arnavon Islands and adjacent sites (500-600) (Ramohia and Pita 1996); Shortlands (100-200), Marovo (50), Ramos (50), Santa Cruz (50-200), and Russell (50-100). In the second half of the 20th century, nesting numbers declined throughout the Solomon Islands (Groombridge and Luxmoore 1989) to approximately 500 nesting females/year. From 1988 to 1997, Limpus (1997) estimated population declines of more than 50%. Current subsistence harvest is unsustainable (Pita and Broderick 2005). In communities adjacent to Arnavon Community Marine Conservation Area (ACMCA), approximately 825 hawksbills of all sizes are slaughtered each year (Pita and Broderick 2005). Of captured hawksbills tagged and released by Broderick in adjacent communities, 30% were recaptured, and half of those were subsequently slaughtered (Pita and Broderick 2005).

Vanuatu is believed to have more than 300 females nesting/year. Nesting is scattered throughout the country, especially at: a) Banks/Torres; b) Malekula; c) Epi, Green; and d) Aneityum (Wilson *et al*. 2004). Hawksbills are subject to heavy exploitation at some sites (i.e., Malekula) while elsewhere there is little or no pressure (Wilson *et al*. 2004); but recently they are less exploited in many areas (especially foraging populations) (K. MacKay, USP, personal communication to J. Mortimer, ICS, 2007) due to public awareness programs (Petro 2002). There are a number of unsurveyed nesting beaches, but surveys in 2006-2007 have identified two beaches: Moso Island (Efate) with over 100 nests, and Bamboo Bay (Malakula) with over 200 nests. Feral dog predation is a problem in some areas (K. MacKay, USP, personal communication to J. Mortimer, ICS, 2007).

Fiji has about 100-200 nesting females/year (Batibasaga 2003), but hawksbills have been heavily exploited for more than 100 years (Troëng 1996). In latter half of the 20th century, there was intense local exploitation of eggs and adults for food and a major shell carving industry (Groombridge and Luxmoore 1989). A decline of 50% in 20 years was reported at Namena Lai Lai, a major hawksbill rookery hosting 30-40 females/year (K. MacKay, USP, personal communication to J. Mortimer, ICS, 2007). Domestic tourist trade in tortoiseshell curios and whole carapaces continues (Laveti and MacKay in preparation) with suggestions of an underground export trade via Asian fishing boats.

Micronesia with its thousands of islands and atolls probably supports about 300 females annually (NMFS and FWS 1998). Palau Republic has the largest nesting population remaining in Micronesia with about 20-50 females/year (NMFS and FWS 1998). However, the population in Micronesia is exploited for meat, eggs, and shell for local consumption (Meylan and Donnelly 1999), and is considered depleted and declining.

In American Samoa and Western Samoa, fewer than 30 females are estimated to nest annually (Tuato'o-Bartley *et al.* 1993; Grant *et al.* 1997; G. Balazs, NMFS, in litt. to J. Mortimer, ICS, 2007). In Guam, only about 5-10 females are estimated to nest annually (G. Davis, NMFS, in litt. to J. Mortimer, ICS, 2007; G. Balazs, NMFS, in litt. to J. Mortimer, ICS, 2007).

In the U.S. Pacific, about 5-10 females nest annually in Hawaii, and there are indications that the population is increasing (G. Balazs, NMFS, personal communication to J. Mortimer, ICS, 2007).

Pacific: Eastern

Mexico hosts remnant populations of hawksbills with fewer than 15 females estimated as nesting each year. There are low nesting numbers in Jalisco, Nayarit, and Tres Marias Islands (Seminoff *et al*. 2003b). Once found abundantly along the eastern Pacific coast, hawksbills are now very rare (Cliffton *et al*. 1982, Seminoff *et al*. 2003b). Baja California should be a priority for regional recovery efforts (Seminoff *et al*. 2003b).

2.3.1.2.2. Demography

The primary demographic features of hawksbill turtles that are relevant for interpreting population abundance and long term trends include age-to-maturity (often via growth studies), reproductive longevity, reproductive output (i.e., egg production, clutch frequency, internesting interval), and annual survivorship. A brief description of these features is given below.

Most hawksbills exhibit slow growth rates, which vary substantially within and among populations. Those measured in the Indo-Pacific averaged between 1 and 3 cm/year (Chaloupka and Limpus 1997, Mortimer *et al*. 2002, Mortimer *et al*. 2003, Whiting 2000). In the Caribbean, rates were higher with 2 to 4 cm/year being typical (Boulon 1994, Diez and van Dam 2002, León and Diez 1999), but averaging more than 5 cm/year at certain other sites (Diez and van Dam 2002, León and Diez 1999). Differences in growth rates are likely due to differences in diet quality, duration of foraging season (Chaloupka *et al*. 2004), and possibly density of turtles in foraging areas (Bjorndal *et al*. 2000). Additionally growth rates in sea turtles vary with size and age. Chaloupka and Limpus (1997) recorded immature female hawksbills growing at about 0.5 cm/year faster than immature males at all recorded sizes.

At most sites studied, hawksbill growth rates tended to be non-monotonic, rising rapidly from recruitment to a maximum growth rate before declining to negligible growth approaching sexual maturity (Chaloupka and Limpus 1997, Diez and van Dam 2002, Mortimer *et al*. 2003).

Consistent with slow growth, age-to-maturity for hawksbills is long, taking 20 to 40 years (Chaloupka and Musick 1997). Estimates based on mark recapture studies indicate that in the Caribbean and Western Atlantic, hawksbills may mature in 20 or more years (Boulon 1983, 1994; Diez and van Dam 2002). Age-to-maturity in the Indo-Pacific requires a minimum of 30-35 years (Limpus 1992; Mortimer *et al*. 2002, 2003). In northeastern Australia, first breeding is estimated at 31-36 years for females and 38 years for males (Limpus and Miller 2000).

Data on reproductive longevity in hawksbills are limited, but are becoming available with increasing numbers of intensively monitored, long-term projects on protected beaches. During the last decade, numerous individual Caribbean hawksbills have been recorded actively nesting over a period of 14-22 years (C.E. Diez, Chelonia Inc., in litt. to J. Mortimer, ICS, 2006; Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer, ICS, 2006; Parrish and Goodman 2006). In the Indo-Pacific, Mortimer and Bresson (1999) and Limpus (1992) have reported nesting over 17-20 years, comparable to other Chelonid turtles that range from 20 to 30 years (Carr *et al*. 1978, FitzSimmons *et al*. 1995).

Considering that mean remigration intervals range from 2 to 5 years, these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her natural life. Based on the reasonable means of 3-5 nests/season (Richardson *et al.* 1999, Mortimer and Bresson 1999) and 130 eggs/nest (Witzell 1983), a female may lay 9 to 55 egg clutches, or about 1,170-7,190 eggs, during her lifetime [note that figures for the Arabian/Persian Gulf would be significantly less (Witzell 1983, Pilcher 1999)]. These are rough estimates, but they nonetheless provide a basis for characterizing reproductive effort in hawksbill turtles.

Survivorship has been quantified for adult hawksbill females at a protected nesting beach (Jumby Bay, Antigua) (Kendall and Bjorkland 2001), and studies of survivorship are underway at several foraging sites around the world, including Barbados (B. Krueger, UWI, unpublished data), and northwestern Brazil (A. Grossman, Projeto TAMAR, unpublished data).

2.3.1.2.3. Demographic trends

One aspect relating to hawksbill demography that may become a problem is the likelihood of increasing bias in the sex ratio of hawksbill turtle populations due to two factors: global climate change and imperfect egg hatchery strategies. Global warming is unequivocal (IPCC 2007a) and may result in significant changes in hatchling sex ratios. The fact that hawksbill turtles exhibit temperature-dependent sex determination (reviewed by Wibbels 2003) suggests that there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos). Other problems include deforestation and associated removal of shade (Kamel and Mrosovsky 2006) and high incubation temperatures in poorly located egg hatcheries of nesting beach conservation programs. For example, artificially high incubation temperatures are resulting in nearly 100% female sex among hatchlings at the Sabah Turtle Island hatcheries in Malaysia (Tiwol and Cabanban 2000).

2.3.1.3 Genetics and genetic variation:

The genetic substructure of the hawksbill regional subpopulations shows distinctive mitochondrial DNA properties (Broderick *et al.* 1994, Bass *et al.* 1996). The analyses support a natal homing model for recruitment of breeding females. They showed reproductive populations to be effectively isolated over ecological time scales (Bass *et al*. 1996). The fact that sea turtles exhibit fidelity to their natal beaches suggests that if subpopulations become extirpated they may not be replenished by the recruitment of turtles from other nesting rookeries over ecological time frames; and because each nesting subpopulation is genetically discrete, the loss of even one rookery represents a decline in genetic diversity and resilience of the species (Bass *et al*. 1996).

Substantial efforts have been made to determine the nesting population origins of hawksbills assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting beach origins commonly mix in these areas (Bowen *et al*. 1996, Broderick and Moritz 1996, Mortimer and Broderick 1999). Bowen *et al*. (2007) demonstrated that the origins of juveniles found on foraging areas correlates with both nesting population size and geographical distance from the nesting areas, and is also influenced by ocean currents. Genetic studies and flipper tag returns have indicated transoceanic movements of juvenile hawksbills (Bellini *et al*. 2000, Bowen *et al*. 2007, Grossman *et al*. 2007).

These studies demonstrate that significant harvests at one site can impact multiple other sites (e.g., harvest at a nesting beach can impact multiple feeding grounds, and harvest at a feeding ground can impact multiple nesting sites) (Mortimer *et al*. 2007), thus reinforcing the need for regional cooperation.

2.3.1.4 Taxonomic classification:

Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Order: Testudines
Family: Cheloniidae
Genus: *Eretmochelys*

Species: *imbricata*
Common name: Hawksbill sea turtle

2.3.1.5 Spatial distribution and trends in spatial distribution or historic range:

2.3.1.5.1. Spatial distribution:

The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic Ocean, Indian Ocean, and Pacific Ocean. Their movements within the marine environment are not fully understood, but it is believed that hawksbills inhabit coastal waters of more than 108 countries (Groombridge and Luxmoore 1989).

Nesting occurs in at least 70 countries, although much of it now occurs only at low densities. The primary nesting rookeries (i.e., sites with ≥ 100 nesting females per year) are listed below in alphabetical order by ocean basin; a question mark (?) indicates sites where estimates are very approximate:

a) Atlantic Ocean: Antigua/Barbuda, Bahamas, Barbados, Brazil, Cuba (Doce Leguas Cays), Dominican Republic(?), Jamaica(?), Mexico (Yucatan Peninsula), Panama, Puerto Rico (Mona Island), Trinidad and Tobago, and U.S. Virgin Islands(?);
b) Indian Ocean: Australia (Western Australia), British Indian Ocean Territory (Chagos Islands), India, Madagascar, Maldives, Seychelles, Iran, Oman, Qatar, Saudi Arabia (Arabian Gulf), Saudi Arabia (Red Sea), Sudan(?), United Arab Emirates, and Yemen; and
c) Pacific Ocean: Australia (Torres Strait-Northern Great Barrier Reef), Australia (Northeastern Arnhem Land), Fiji, Indonesia, Malaysia (Sabah Turtle Islands), Papua New Guinea, Phillippines, Solomon Islands, Vanuatu, and Vietnam(?).

2.3.1.5.2. Trends in spatial distribution or historic range:

The present distribution of the breeding sites has been largely affected by historical patterns of human exploitation. In general, the most significant rookeries left today are at sites that have not been permanently inhabited by humans or have not been heavily exploited until recently (Groombridge and Luxmoore 1989).

Several sites that formerly held large breeding colonies are known to have been lost once inhabited by humans (e.g., extensive sections of the Brazilian coastline (N. Marcovaldi, Projeto TAMAR, personal communication to J. Mortimer, ICS, 2006; Frazier 1980; Mangar and

Chapman 1996). More common than total extirpation, however, is for hawksbill populations to be reduced to extremely low levels (i.e., less than 10 nesting females per year). Known examples of such near extirpations include the following sites listed in alphabetical order by ocean basin:

a) Atlantic Ocean: Bonaire, Costa Rica (Tortuguero National Park), Equatorial Guinea (Bioko), and Honduras (Bay Islands);
b) Indian Ocean: Kenya, Mozambique, Myanmar, Sri Lanka, and Thailand (Andaman Sea coast); and
c) Pacific Ocean: Japan and Malaysia (Terengganu State).

2.3.1.6 Habitat or ecosystem conditions:

Hawksbills nest on insular and mainland sandy beaches throughout the tropics and subtropics. They rely on ecologically healthy beaches, with intact dune structure, native vegetation, and natural beach temperatures for nesting (Ackerman 1997). Coastal areas denuded of vegetation (Kamel and Mrosovsky 2006) or with coastal construction can impact thermal regimes on beaches and thus affect the incubation and resulting sex ratio of hatchling turtles.

Hawksbills are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (review by Witzell 1983). Available data indicate that newly emerged hatchlings enter the sea and are carried by offshore currents into major gyre systems where they remain until reaching a carapace length of approximately 20 to 30 cm. At that point, they recruit into a neritic developmental foraging habitat that may comprise coral reefs or other hard bottom habitats, sea grass, algal beds, or mangrove bays and creeks (review by Musick and Limpus 1997) or mud flats (R. von Brandis, Tshwane University of Technology, unpublished data). Once sexually mature, they undertake breeding migrations between foraging grounds and breeding areas at intervals of several years (Witzell 1983, Dobbs *et al*. 1999, Mortimer and Bresson 1999). Much remains to be learned about how oceanograpic features affect juvenile survival, adult migration, internesting duration, and prey availability.

In their neritic developmental foraging habitat, hawksbills rely on a variety of food items. At most sites documented in the Caribbean, they feed primarily on sponge (Meylan 1988, van Dam and Diez 1997b) or other types of invertebrates (review by Bjorndal 1997). They are apparently more omnivorous in the Indo-Pacific, and at some sites algae features prominently in their diets. In northwestern Australia, for example, Whiting (2000) found the hawksbill diet to be dominated by algae (45.5%) and sponge (43.9%).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The determination to list a species under the ESA is based on the best scientific and commercial data regarding five listing factors (see below). Subsequent 5-year reviews must also make determinations about the listing status based, in part, on these same factors.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

There are increasing impacts to the nesting and marine environment that affect hawksbills. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Lutcavage *et al*. 1997, Bouchard *et al*. 1998). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to nesting females, and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman 1997; Witherington *et al*. 2003, 2007). In addition, coastal development is usually accompanied by artificial lighting. The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991). In many countries, coastal development and artificial lighting are responsible for substantial hatchling mortality. Although legislation controlling these impacts does exist (Lutcavage *et al*. 1997), a majority of countries do not have regulations in place.

Tropical coastlines are rapidly being developed for tourism, which often leads to destruction of hawksbill nesting habitat (Mortimer and Donnelly in review). Because hawksbills prefer to nest under vegetation (Mortimer 1982, Horrocks and Scott 1991), they are particularly impacted by beachfront development and clearing of dune vegetation (Mortimer and Donnelly in review). Daytime nesting hawksbills in the Western Indian Ocean are especially sensitive to disturbance from human activity on the coast and in internesting habitat (Mortimer 2004). In other parts of the world, such as the Middle East and Western Australia, gas and oil refineries seriously disrupt nesting habitat (Miller 1989, Limpus 2002, Mortimer and Donnelly in review).

Considering that coastal development and beach armoring are detrimental to hawksbill nesting behavior (Lutcavage *et al*. 1997), the pending human population expansion is reason for major concern. This concern is underscored by the fact that over the next few decades the human population is expected to grow by more than 3 billion people (about 50%). By the year 2025, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2001) forecasts that population growth and migration will result in a situation in which 75% of the world human population will live within 60 km of the sea. Such a migration undoubtedly will change a coastal landscape that, in many areas, is already suffering from human impacts. The problems associated with development in these zones will progressively become a greater challenge for conservation efforts, particularly in the developing world where wildlife conservation is often secondary to other national needs.

In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour *et al*. 1999, Lee Long *et al*. 2000, Waycott *et al*. 2005). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson 2000). Climate change has led to massive coral bleaching events with permanent consequences for local habitats (Sheppard 2006, Mortimer and Donnelly in review).

The vast depletion of hawksbills in coastal coral reef foraging areas has likely resulted in widespread habitat modifications. In their role as spongivores, hawksbills support healthy reefs by controlling sponges, which would otherwise outcompete reef-building corals for space (Hill 1998, Leon and Bjorndal 2002, Bjorndal and Jackson 2003). Like other species of sea turtles, hawksbills contribute to marine and coastal food webs and transport nutrients within the oceans (Bouchard and Bjorndal 2000).

Thus, with most hawksbill populations substantially depleted relative to historic levels, it is likely that today's coastal marine and terrestrial systems are dramatically modified (Jackson *et al*. 2001).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Hawksbills, like all sea turtle species, are vulnerable to anthropogenic impacts during all life-stages: from eggs to adults. Four of the greatest threats to hawksbills result from harvest for commercial and subsistence use. These include the tortoiseshell trade, egg exploitation, exploitation of females on nesting beaches, and directed hunting of hawksbills in foraging areas.

Tortoiseshell Trade

Recent and historical tortoiseshell trade statistics are key to understanding the enormous and enduring effect that trade has had on hawksbill populations around the world (Mortimer and Donnelly in review). Within the last 100 years, millions of hawksbills have been killed for the tortoiseshell markets of Europe, the United States, and Asia. The global plight of the hawksbill in the latter half of the 20th century has been recognized by the inclusion of the species in the most threatened category of the IUCN's Red List since its creation in 1968 and the listing of all hawksbill populations on Appendix I of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, since 1977. Nevertheless, trade continued at exceptionally high levels for years as major trading countries acceded to CITES and Japan, the world's largest consumer of bekko (tortoiseshell), continued to import shell under a CITES reservation (exception) until 1993. During 1950-1992, Japan's bekko imports were the equivalent of 1,329,044 large turtles (1,408,787 kg). Conservatively estimating that 30% of the turtles taken for the trade were nesting females, nearly 400,000 adult female hawksbills were killed for the Japanese market in those years, a time frame that approximates a single hawksbill generation (Milliken and Tokunaga 1987, Groombridge and Luxmoore 1989, Meylan and Donnelly 1999, Mortimer and Donnelly in review). Significant domestic trade in hawksbill products continues to be a major problem in many countries and, despite international prohibitions and the lessening of the volume in the last decade, trade remains an ongoing and pervasive threat in the Americas and Southeast Asia (Fleming 2001, Chacon 2002, TRAFFIC-Southeast Asia 2004, van Dijk and Shepherd 2004, Bräutigam and Eckert 2006, Reuter and Allan 2006).

Egg Exploitation

One of the most detrimental human threats to hawksbill turtles is the intentional and intensive exploitation of eggs from nesting beaches. As each nesting season passes and populations continue to suffer from egg take, they will progressively lose the juvenile cohorts that would have recruited from the post-hatchling phase (Mortimer 1995). Present nesting populations may appear hardy, but without recruitment into the juvenile population and a well-balanced distribution of turtles among all cohorts, populations are more vulnerable to decline (Crouse *et al*. 1987, Frazer 1992).

Egg exploitation has impacted hawksbill populations throughout the world, but has been especially detrimental in Asia. In some countries, very few eggs hatch outside protected hatcheries (Mortimer and

Donnelly in review), particularly in Indonesia, Thailand, Malaysia, and Sri Lanka.

Egg exploitation is an ongoing major problem at the following sites listed below in alphabetical order by ocean basin; a question mark (?) indicates sites where recent documentation is weak:

a) Atlantic Ocean: Antigua/Barbuda, Bahamas, Belize(?), Bonaire(?), British Virgin Islands, Colombia, Dominican Republic(?), Equatorial Guinea, Honduras(?), Jamaica(?), Grenada(?), Nicaragua, Panama, São Tomé and Principe, St. Kitts(?), Trinidad and Tobago (?), and Venezuela(?);
b) Indian Ocean: Australia, Iran, Kenya, Madagascar, Malaysia, Maldives, Mauritius, Mayotte, Mozambique, Myanmar, Saudi Arabia, Sri Lanka, Tanzania, Thailand, and Yemen; and
c) Pacific Ocean: American Samoa, Australia, Fiji, Guam, Indonesia, Malaysia, Palau Republic, Papua New Guinea, Philippines, Solomon Islands, Thailand, Vanuatu, and Vietnam.

Take of Nesting Females

The killing of nesting females continues to threaten the stability of hawksbill subpopulations in many areas. This affects nesting populations by reducing both adult abundance and the population's potential for annual egg production. The killing of nesting female hawksbills is an ongoing problem at the following sites listed below in alphabetical order by ocean basin; a question mark (?) indicates sites where recent documentation is weak:

a) Atlantic Ocean: Antigua/Barbuda(?), Bahamas, Belize(?), Bonaire(?), British Virgin Islands, Colombia, Dominican Republic, Equatorial Guinea, Honduras(?), Jamaica(?), Grenada(?), Nicaragua, Panama, São Tomé and Principe, St. Kitts(?), Trinidad and Tobago, and Venezuela;
b) Indian Ocean: Australia, Kenya, Madagascar, Maldives(?), Mauritius, Mayotte, Mozambique, Saudi Arabia(?), Seychelles, Sri Lanka(?), Tanzania, Thailand, and Yemen; and
c) Pacific Ocean: American Samoa, Australia, Fiji, Guam, Indonesia, Malaysia, Palau Republic, Papua New Guinea, Philippines, Solomon Islands, Thailand, Vanuatu, and Vietnam.

Hunting of Turtles in Foraging Habitats

Although subpopulations may be protected at nesting beaches, their large-scale in-water movements often cross jurisdictional boundaries and traverse areas where protection is absent. Although adult mortality in foraging habitats results in more quickly observable abundance changes on the nesting beach, the mortality of immature turtles in marine habitats may be as great a threat to the stability of hawksbill populations. This life-stage is the most valuable in terms of recovery and stabilization of sea turtle populations due to the fact that not only have large juveniles already survived many mortality factors, thus having a high reproductive value, but also there are typically more juveniles than adults in a population (Crouse *et al*. 1987, Ogren 1989). Therefore, relatively small changes in the survival rate of this life-stage impact a large segment of the population (Crouse 1999). As with the delayed feedback from egg harvest, the hawksbill turtles' slow maturation delays the observable effects of juvenile harvests, and they may not manifest as a decline in nesting females for decades. However, once there is a crash in the adult nesting population as a result of such impacts, the nesting population may be substantially more difficult to recover compared to a population with a thriving sub-adult population (Mortimer 1991d).

Hunting of hawksbills on foraging grounds is an ongoing problem at the following sites listed below in alphabetical order by ocean basin; a question mark (?) indicates sites where recent documentation is weak:

a) Atlantic Ocean: Antigua/Barbuda(?), Bahamas, Belize(?), Bonaire(?), British Virgin Islands, Colombia, Dominican Republic, Equatorial Guinea, Honduras(?), Jamaica(?), Grenada(?), Nicaragua, Panama, São Tomé and Principe, St. Kitts(?), Trinidad and Tobago, and Venezuela;
b) Indian Ocean: Australia, Kenya, Madagascar, Maldives(?), Mauritius, Mayotte, Mozambique, Saudi Arabia(?), Seychelles, Sri Lanka(?), Tanzania, Thailand, and Yemen; and
c) Pacific Ocean: American Samoa, Australia, Fiji, Guam, Indonesia, Malaysia, Palau Republic, Papua New Guinea, Philippines, Solomon Islands, Thailand, Vanuatu, and Vietnam.

2.3.2.3 Disease or predation:

Fibropapillomatosis has been reported in all sea turtle species, including the hawksbill. This disease is characterized by the presence of internal and external tumors (fibropapillomas) that may grow large enough to hamper swimming, vision, feeding, and potential escape from predators (Herbst 1994). Fortunately, the frequency of fibropapillomatosis in hawksbills is relatively low and is not presently a major source of concern for this species.

Predators of hawksbill eggs include feral pigs (Diez *et al*. 1998), mongoose (Nellis and Small 1983), raccoons and coatimundis (Smith 1991), dogs (Lagueux *et al*. 2003, Meylan *et al.* 2006), ghost crabs

(Hitchins *et al*. 2004, Wood 1986), and monitor lizards, ants, and fly larvae (Chan and Liew 1999). Natural predation on hatchling hawksbills by birds and fish is also undoubtedly high, although documented cases are scarce (Witzell 1983). Juvenile and adult hawksbills are also taken by carnivorous fish (Witzell 1983).

At Playa Chiriqui, Panama, the most significant hawksbill nesting beach in the region, threats from predators (especially dogs) have proven difficult to address (Meylan *et al.* 2006). In the Andaman and Nicobar Islands in India, egg predation by feral dogs and pigs is a major concern at several beaches (Andrews *et al.* 2006). Feral dog predation is also a problem in some areas in Vanuatu (K. MacKay, USP, personal communication to J. Mortimer, ICS, 2007). Within the U.S. Caribbean, feral pig predation was formerly a major threat to the survival of hawksbill nests laid on Mona Island, Puerto Rico, with 44 to 100% of all hawksbill nests deposited outside fenced areas from 1985 to 1987 destroyed (Kontos 1985, 1987, 1988). However, the installation of protective fencing to exclude feral pigs from Mona Island nesting beaches has significantly reduced this threat (R. van Dam, Chelonia, Inc., personal communication, 2007). In the U.S. Virgin Islands, mongooses were destroying up to 55 percent of all nests on Buck Island Reef National Monument until they were eradicated in 1987 (Small 1982).

Overall, disease and predation are believed to be relatively minor threats to the hawksbill.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The conservation and recovery of sea turtles is facilitated by a number of regulatory instruments at international, regional, national, and local levels. As a result of these designations and agreements, many of the intentional impacts directed at sea turtles have been lessened: harvest of eggs and adults has been slowed at several nesting areas through nesting beach conservation efforts and an increasing number of community-based initiatives are in place to slow the take of turtles in foraging areas. Moreover, there is now a more internationally concerted effort to reduce sea turtle interactions and mortality in artisanal and industrial fishing practices.

Despite these advances, human impacts continue throughout the world. The lack of comprehensive and effective monitoring and bycatch reduction efforts in many pelagic and near-shore fisheries operations still allows substantial direct and indirect mortality, and the uncontrolled development of coastal and marine habitats threatens to destroy the supporting ecosystems of long-lived hawksbill turtles. Although several international agreements provide legal protection for sea turtles, additional multi-lateral efforts are needed to ensure they are sufficiently implemented and/or strengthened, and key non-signatory parties need to be encouraged to accede.

Considering the worldwide distribution of hawksbills, virtually every legal instrument that targets or impacts sea turtles is almost certain to cover hawksbills. A summary of the main regulatory instruments from throughout the world that relate to hawksbill turtle management is provided below. The pros and cons of many of these were recently evaluated by Hykle (2002) and Tiwari (2002), and a summary of these findings is given when appropriate.

United States Magnuson-Stevens Conservation and Management Act

The recently-amended U.S. Magnuson-Stevens Fishery Conservation and Management Act (MSA), implemented by NMFS, mandates environmentally responsible fishing practices within U.S. fisheries. Section 301 of the MSA establishes National Standards to be addressed in management plans. Any regulations promulgated to implement such plans, including conservation and management measures, shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch. Section 301 by itself does not require specific measures. However, mandatory bycatch reduction measures can be incorporated into management plans for specific fisheries, as has happened with the U.S. pelagic longline fisheries in the Atlantic and Pacific oceans. Section 316 requires the establishment of a bycatch reduction engineering program to develop "technological devices and other conservation engineering changes designed to minimize bycatch, seabird interactions, bycatch mortality, and post-release mortality in Federally managed fisheries."

FAO Technical Consultation on Sea Turtle-Fishery Interactions

While not a true international instrument for conservation, the Food and Agriculture Organization of the United Nations' (FAO) technical consultation on sea turtle-fishery interactions was groundbreaking in that it solidified the commitment of this international body to reduce sea turtle bycatch in marine fisheries operations. Recommendations from the technical consultation were endorsed by the FAO Committee on Fisheries (COFI) and called for the immediate implementation by member nations and Regional Fishery Management Organizations (RFMOs) of guidelines to reduce sea turtle mortality in fishing operations, developed as part of the technical consultation. Compliance with these guidelines is voluntary.

Indian Ocean – South-East Asian Marine Turtle Memorandum of Understanding (IOSEA)

This MOU puts in place a framework through which States of the Indian Ocean and South-East Asian region, as well as other concerned States, can work together to conserve and replenish depleted marine turtle populations for which they share responsibility. This collaboration is achieved through the collective implementation of an associated Conservation and Management Plan. Currently, there are 26 signatory states. The United States became a signatory in 2001. Numerous accomplishments have been made under the auspices of this MOU (for detailed information, visit the IOSEA website at http://www.ioseaturtles.org).

Memorandum of Understanding on ASEAN Sea Turtle Conservation and Protection

The objectives of this MOU, initiated by the Association of South East Asian Nations (ASEAN), are to promote the protection, conservation, replenishing, and recovery of sea turtles and their habitats based on the best available scientific evidence, taking into account the environmental, socio-economic and cultural characteristics of the Parties. It currently has nine signatory states in the South East Asian Region. Additional information is available at http://www.aseansec.org/6185.htm.

Memorandum of Agreement between the Government of the Republic of the Philippines and the Government of Malaysia on the Establishment of the Turtle Island Heritage Protected Area

Signed in 1996, this bilateral MOA paved the way for the Turtle Islands Heritage Protected Area (TIHPA), which protects very important concentrations of nesting green turtles and hawksbills. Additional information is available at http://www.oneocean.org/ambassadors/track_a_turtle/tihpa/index.html.

Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa.

This MOU was concluded under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and became effective in 1999. It aims at safeguarding six marine turtle species - including the hawksbill - that are estimated to have rapidly declined in numbers during recent years due to excessive exploitation (both direct and incidental) and the degradation of essential habitats. However, despite this agreement, killing of adult turtles and harvesting of eggs remains rampant in many areas along the Atlantic African coast.

Additional information is available at http://www.cms.int/species/africa_turtle/AFRICAturtle_bkgd.htm.

Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC)

This Convention is one of only a handful of international treaties dedicated exclusively to sea turtles, setting standards for the conservation of these endangered animals and their habitats with a large emphasis on bycatch reduction. It is the only binding multi-national agreement for sea turtles and is open to all countries in North, Central, and South America, and the Caribbean. It currently has 12 signatory countries, with the United States being a signatory in 1999. Additional information is available at http://www.iacseaturtle.org.

Convention on the Conservation of Migratory Species of Wild Animals

This Convention, also known as the Bonn Convention or CMS, is an international treaty that focuses on the conservation of migratory species and their habitats. As of January 2007, the Convention had 101 member states, including parties from Africa, Central and South America, Asia, Europe, and Oceania. While the Convention has successfully brought together about half the countries of the world with a direct interest in sea turtles, it has yet to realize its full potential (Hykle 2002). Its membership does not include a number of key countries, including Brazil, Canada, China, Indonesia, Japan, Mexico, Oman, and the United States. Additional information is available at http://www.cms.int.

Convention on Biological Diversity (CBD)

The primary objectives of this international treaty are 1) the conservation of biological diversity, 2) the sustainable use of its components, and 3) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. This Convention has been in force since 1993 and currently has 190 Parties. While the Convention provides a framework within which broad conservation objectives may be pursued, it does not specifically address sea turtle conservation (Hykle 2002). Additional information is available at http://www.cbd.int.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Known as CITES, this Convention was designed to regulate international trade in a wide range of wild animals and plants. CITES was implemented in 1975 and currently includes 169 Parties. CITES has been of critical importance in ending the legal international trade in hawksbill shell. Nevertheless, it does not limit legal and illegal harvest within countries, nor does it regulate intra-country commerce of sea turtle products (Hykle 2002).

In 1975, in recognition of its endangered status, the hawksbill was included on Appendices I (Atlantic population) and II (Pacific population) of CITES when the Convention came into force. By 1977, the entire species was moved to Appendix I to prohibit all international trade. Nevertheless, the global trade continued for a number of years, in large part driven by Japanese demand. At the end of 1992, Japanese imports ceased, but the industry continues to operate with stockpiled material. Although the tortoiseshell trade continues to threaten hawksbills in numerous places, overall volume is substantially reduced. Thirty years after CITES came into force, the ban on international trade demonstrates its value over time in protecting hawksbills. Above all, nesting increases in the Caribbean coincide with the enormous reduction in hawksbill fishing in Cuban waters (Mortimer and Donnelly in review). Additional information is available at http://www.cites.org.

Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean

This Protocol is under the auspices of the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution. It has been in force since 1999 and includes general provisions to protect sea turtles and their habitats within the Mediterranean Sea. The Protocol requires Parties to protect, preserve, and manage threatened or endangered species, establish protected areas, and coordinate bilateral or multilateral conservation efforts (Hykle 2002). In the framework of this Convention, to which all Mediterranean countries are parties, the Action Plan for the Conservation of Mediterranean Marine Turtles has been in effect since 1989. Additional information is available at http://www.rac-spa.org.

Convention on the Conservation of European Wildlife and Natural Habitats

Also known as the Bern Convention, the goals of this instrument are to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the cooperation of several States, and to promote such co-operation. The Convention was enacted in 1982 and currently includes 45 European and African States and the European Union. According to Hykle (2002), while the Convention's "innovative approach to holding States to account for their implementation of the Convention is laudable, and has certainly drawn attention to issues of species and habitat protection, its efficacy in relation to particular marine turtle cases that have been deliberated for many years is debatable." Additional information is available at http://www.coe.int/t/e/cultural_co-operation/environment/nature_and_biological_diversity/Nature_protection.

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region

Also called the Cartagena Convention, this instrument has been in place since 1986 and currently has 21 signatory states. Under this Convention, the component that may relate to hawksbill turtles is the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) that has been in place since 2000. The goals of this protocol are to encourage Parties "to take all appropriate measures to protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species, in the Convention area." All six sea turtle species in the Wider Caribbean are listed in Annex II of the protocol, which prohibits (a) the taking, possession or killing (including, to the extent possible, the incidental taking, possession or killing) or commercial trade in such species, their eggs, parts or products, and (b) to the extent possible, the disturbance of such species, particularly during breeding, incubation, estivation, migration, and other periods of biological stress. Hykle (2002) believes that in view of the limited participation of Caribbean States in the aforementioned Convention on the Conservation of Migratory Species of Wild Animals, the provisions of the SPAW Protocol provide the legal support for domestic conservation measures that might otherwise not have been afforded. Additional information is available at http://www.cep.unep.org/law/cartnut.html.

Convention for the Protection of the Natural Resources and Environment of the South Pacific Region

This Convention has been in force since 1990 and currently includes 12 Parties. The purpose of the Convention is to protect the marine environment and coastal zones of the South-East Pacific within the 200-mile area of maritime sovereignty and jurisdiction of the Parties, and beyond that area, the high seas up to a distance within which pollution of the high seas may affect that area. Additional information is available at http://ekh.unep.org/?q=node/684.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Hybridization has been documented in Brazil between hawksbills and loggerheads and hawksbills and olive ridleys (Lara-Ruiz *et al*. 2006) and in Florida between hawksbills and loggerheads (Meylan and Redlow 2006). Bass *et al*. (1996) and Bowen *et al*. (2007) reported other hawksbill hybrids. Hawksbill and green turtle hybridization has also been reported in the Eastern Pacific (Seminoff *et al* 2003a).

Hybridization of hawksbills with other species of sea turtles is especially problematic at certain sites where hawksbill numbers are particularly low (Mortimer and Donnelly in review).

There are also several manmade factors that affect hawksbill turtles in foraging areas and on nesting beaches. Two of these are truly global phenomena: climate change and fisheries bycatch.

Impacts from climate change, especially due to global warming, are likely to become more apparent in future years (IPCC 2007a). The global mean temperature has risen 0.76ºC over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These changes include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b) and damage to coral reefs (Sheppard 2006).

As global temperatures continue to increase, so will sand temperatures, which in turn will alter the thermal regime of incubating nests and alter natural sex ratios within hatchling cohorts (e.g., Glen and Mrosovsky 2004). Because hawksbill turtles exhibit temperature-dependent sex determination (reviewed by Wibbels 2003), there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos). The effects of global warming are difficult to predict, but may be exacerbated on developed nesting beaches where shoreline armoring and construction has denuded natural vegetation. The pending sea level rise from global warming is also a potential problem, particularly for areas with low-lying beaches where sand depth is a limiting factor, as the sea will inundate nesting sites and decrease available nesting habitat (Daniels *et al*. 1993, Fish *et al*. 2005, Baker *et al*. 2006). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al*. 2006, Baker *et al*. 2006). Likewise, the damage to coral reefs caused by global warming (Sheppard 2006) threatens to impact hawksbill foraging populations at the global level.

Fisheries bycatch in artisanal and industrial fishing gear is also a major impact. Although other species such as leatherback turtles and loggerhead turtles have received most of the attention relative to sea turtle bycatch, hawksbill turtles are also susceptible, particularly in nearshore artisanal fisheries gear. These fisheries practices include drift-netting, long-lining, set-netting, and trawl fisheries, and their adverse impacts on sea turtles have been documented in marine environments throughout the world (National Research Council 1990, Lutcavage *et al*. 1997, Epperly 2003). Hawksbills are particularly susceptible to entanglement in gill nets and to capture on fishing hooks of artisanal fishers (Mortimer 1998). The majority of the world's 17 major fisheries zones is either considered depleted or are in early stages of collapse (Pauly *et al*. 2005). Unfortunately, rather than elicit a closure of fisheries, declines in catch rate are often greeted with new fisheries and expanding fleets (Pauly *et al*. 2005). Without effective management practices, such expansion likely will result in increased mortality of all sea turtle species.

In addition, there are numerous localized impacts to hawksbill turtles. Increasing incidence of exposure to heavy metals and other contaminants in the marine environment is of concern. Contaminants such as PCBs, mercury, copper, and other metals have been found in tissues of sea turtles from numerous areas (Presti *et al*. 1999, Miao *et al*. 2001, Al Rawahy *et al*. 2006, Lewis 2006). Although their explicit effects on hawksbills have yet to be determined, such exposure may lead to immunosuppression or other hormonal imbalances (J. Keller, National Institute of Standards and Technology, personal communication to Jeff Seminoff, NMFS, 2006). Many of these agents also diminish the health of coastal marine ecosystems which may, in turn, adversely affect hawksbills.

Additional factors affecting hawksbill turtles, albeit perhaps not as globally impacting as those mentioned above, include the ingestion of and entanglement in marine debris that can reduce food intake and digestive capacity (Bugoni *et al*. 2001, Meylan and Redlow 2006), and the interaction with oil spills (Yender and Mearns 2003). There is evidence that oil pollution has a greater impact on hawksbills than on other species of turtle (Meylan and Redlow 2006). In some parts of the world, especially in the Middle East, oil pollution poses a major problem for hawksbills (Mortimer and Donnelly in review). In addition, sea turtle interaction with oils spills may lead to immunosuppression and other chronic health issues (Sindermann *et al*. 1982).

In addition to climate change and sea-level rise, natural impacts on hawksbill turtles may include the effects of aperiodic hurricanes and catastrophic environmental events such as tsunamis. In general, these events are episodic and, although they may affect hawksbill hatchling production, the results are generally localized to a small area (but see Hamann *et al*. 2006) and they rarely result in whole-scale losses over multiple nesting seasons (Hamann *et al.* 2006). The negative effects of hurricanes on low-lying and/or developed shorelines may be longer-lasting and a greater threat overall.

2.4 Synthesis

By examining both recent and historic information available for 83 nesting sites distributed among 10 ocean regions around the world, both "Recent" nesting abundance trends (within the past 20 years) and "Historic" nesting trends were determined insofar as possible. Historic trends were determined for 58 of the 83 sites, and all 58 (100%) showed a decrease in nesting abundance over time. Recent trends determined for 42 sites were more optimistic, with 10 (24%) increasing, 3 (7%) stable, and 29 (69%) in decline. The nesting sites included both large and small rookeries and are believed to be representative of the overall trends for their respective regions.

Quantitative continuous data over periods of approximately 20 or more years are available for only 11 sites in the world. In the Atlantic these include Antigua (Jumby Bay), Barbados, Puerto Rico (Mona Island), U.S. Virgin Islands (Buck Island Reef National Monument), Mexico (Yucatan Peninsula), and Costa Rica (Tortuguero National Park). In the Indo-Pacific, these include Seychelles (four nature reserves in the inner islands), Australia (Milman Island), Malaysia (Sabah Turtle Islands), Malaysia (Terengganu), and Thailand (Ko Khram). Among these 11 sites, 6 (55%) are increasing, 4 (36%) are decreasing, and 1 (9%) is stable. Unfortunately, these data are not representative of the global picture. The fact that most of these 11 sites are being monitored continuously provides a degree of protection to both turtles and their habitats not enjoyed by most nesting populations worldwide. More long term quantitative studies are needed at unprotected sites to provide an accurate picture of global population trends.

Recent and historic tortoiseshell trade statistics are fundamental to understanding the enormous and enduring effect that trade has had on hawksbill populations around the world. Within the last 100 years, millions of hawksbills have been killed for the tortoiseshell markets of Europe, the United States, and Asia. In addition, hawksbill populations are also threatened by the problems of habitat destruction, directed take for meat and eggs, and incidental capture in fishing gear. Threats to nesting and marine habitats continue to affect critically endangered hawksbill turtle populations. Pending human population expansion into coastal areas is a cause for major concern. Fisheries bycatch, especially in artisanal nets but also in industrial fishing gear, is also a major impact. These fisheries practices include drift-netting, long-lining, set-netting, pound netting, and trawl fisheries, and their adverse impacts on sea turtles have been documented in marine environments throughout the world. In addition, increasing incidence of exposure to heavy metals and other contaminants in the marine environment is of concern in some areas. Hybridization of hawksbills with other species of sea turtles is problematic at certain sites where hawksbill numbers are particularly low. Additional factors affecting hawksbill turtles include the ingestion of and entanglement in marine debris that can reduce food intake and digestive capacity, and the interaction with oil spills. See Table 6 for a comparison of 10 ocean regions in terms of the relative impact of habitat issues, categories of directed take, bycatch, and hybridization on hawksbill populations.

With respect to regional trends, some regions are doing better than others based on available trend data. Although greatly depleted from historical levels, nesting populations in the Atlantic are doing better, in general, than in the Indo-Pacific. In the Atlantic, insular Caribbean populations are generally faring better than those found along the western Caribbean mainland or the eastern Atlantic. Population increases observed at sites in the insular Caribbean coincide with the decline of international trade in hawksbill shell. In contrast, although more hawksbill turtles remain in the Indo-Pacific than in the Atlantic, recent trends in nesting numbers indicate that many Indo-Pacific populations are doing relatively poorly.

Table 6. Comparison of 10 ocean regions in terms of the relative impact of negative factors on hawksbill populations. The factors assessed include: habitat issues, categories of directed take, bycatch, and hybridization. For each impact, each ocean region is scored on the following scale: 4 = Extreme, 3 = Serious, 2 = Moderate, 1 = Low, and ? = Uncertain. Points are assigned accordingly and totals calculated in the following grid. Shading indicates where the impact is "3 Serious" or "4 Extreme." This system of rating is meant to evaluate the overall (average) situation in a region. The circumstances of individual countries may vary greatly within a region.

Impacts	Atlantic Ocean				Indian Ocean			Pacific Ocean		
	Insular Caribbean	Western Caribbean Mainland	South Western	Eastern	South Western	North Western	Central and Eastern	Western	Central	Eastern
Habitat Issues:										
Coastal Development: Residential and Tourism	3	3	3?	3?	3	1-2	3	3	2	2
Disturbance and Pollution Related to Oil/Gas Facilities	1	1	1	1	1	3	2	2	1	1
Marine Pollution	2	2	2	2	2	3-4	2	3	1?	1?
SUBTOTAL POINTS	6	6	6	6	6	7-9	7	8	4	4
Directed Take:										
Historic Tortoiseshell Trade	3	4	2	3	4	3	3	4	2	3
Current Tortoiseshell Trade	2	3	1	3-4	2	1	2	3	2	1
Egg Exploitation	2	3	2	3	2	2	3	4	3	1?
Take of Nesting Females	2	2	1?	3	3	1	1	3	3	1?
Hunting of Foraging Animals	2	2	1	2?	3	1	2	3	3	1?
SUBTOTAL POINTS	11	14	7	14.5	14	8	11	17	13	7
Fisheries Bycatch SUBTOTAL POINTS	2	2	2?	2?	2	2	2	3-4	2	2
Hybridization SUBTOTAL POINTS	?	?	3	?	?	?	?	?	?	3
TOTAL POINTS	**19**	**22**	**18**	**22.5**	**22**	**18**	**20**	**28.5**	**19**	**16**

3.0 RESULTS

3.1 Recommended Classification:

Based on the best available information, we do not believe the hawksbill turtle should be delisted or reclassified. However, we have information that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the hawksbill turtle. See Section 4.0, for additional information.

3.2 New Recovery Priority Number: No change.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

We have preliminary information that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the hawksbill. Since the species' listing, a substantial amount of information has become available on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies). The Services have not yet fully assembled or analyzed this new information; however, at a minimum, these data appear to indicate a possible separation of populations by ocean basins. To determine the application of the DPS policy to the hawksbill, the Services intend to fully assemble and analyze this new information in accordance with the DPS policy. See Section 2.3 for new information since the last 5-year review.

The current "Recovery Plan for the Hawksbill Turtle (*Eretmochelys imbricata*) in the U.S. Caribbean, Atlantic and Gulf of Mexico" was signed in 1993 and the "Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*)" was signed in 1998. The recovery criteria contained in the plans, while not strictly adhering to all elements of the 2004 NMFS Interim Recovery Planning Guidance, are a viable measure of the species status. The species biology and population status information can be updated; however, the recovery actions identified in the plans are appropriate and properly prioritized. While some additional recovery actions can no doubt be identified, the Services believe that the current plans remain a valid conservation planning tool. The recovery plans should be re-examined over the next 5-10 year horizon, particularly if the DPS analysis results in restructuring of the current listing, to update the plan to conform to the 2004 NMFS Interim Recovery Planning Guidance. In the near-term, additional information and data are particularly needed on genetic relationships among nesting populations, impacts of fisheries (particularly trawl and longline fisheries) on population status, foraging areas and identification of threats at foraging areas, and long-term population trends.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Hawksbill Sea Turtle*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review: No change

Review Conducted By:

Barbara Schroeder, Therese Conant (National Marine Fisheries Service)
Sandy MacPherson, Earl Possardt, Kelly Bibb (U.S. Fish and Wildlife Service)

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve ____________________ Date 8/17/07
David L. Hankla

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve ____________________ Date 8/23/07

Cooperating Regional Director, Fish and Wildlife Service

X Concur ____ Do Not Concur

Signature ____________________ Date 8/22/07

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW of *Hawksbill Sea Turtle*

Current Classification: Endangered

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Barbara Schroeder, Therese Conant (National Marine Fisheries Service)
Sandy MacPherson, Earl Possardt, Kelly Bibb (U.S. Fish and Wildlife Service)

REGIONAL OFFICE APPROVAL: The draft document was reviewed by the appropriate Regional Offices and Science Centers.

HEADQUARTERS APPROVAL:
Director, Office of Protected Resources, NOAA Fisheries

AUG 2 3 2007

Approve: ______________________ Date: __________
James H. Lecky

Assistant Administrator, NOAA Fisheries

__✓__ Concur _____ Do Not Concur

Signature______________________ Date 8/23/07

Samuel D. Rauch, III
Deputy Assistant Administrator
for Regulatory Programs

APPENDIX

Summary of peer review for the 5-year review of *Hawksbill Sea Turtle* (*Eretmochelys imbricata*)

A. Peer Review Method: See B. below.

B. Peer Review Charge: On June 22, 2007, the following letter and Guidance for Peer Reviewers of Five-Year Status Reviews were sent via e-mail to potential reviewers requesting comments on the 5-year review. Requests were sent to Dr. Anne Meylan (Florida Fish and Wildlife Conservation Commission), Carlos Diez (Puerto Rico Department of Natural and Environmental Resources), Dr. Julia Horrocks (University of the West Indies), Robert van Dam (Chelonia, Inc.), and Eduardo Cuevas (Pronatura Peninsula de Yucatan, A.C.).

We request your assistance in serving as a peer reviewer of the U.S. Fish and Wildlife Service and National Marine Fisheries Service's (Services) 5-year status review of the hawksbill sea turtle (Eretmochelys imbricata). The 5-year review is required by section 4(c)(2) of the United States Endangered Species Act of 1973, as amended (Act). A 5-year review is a periodic process conducted to ensure the listing classification of a species as threatened or endangered on the Federal List of Endangered and Threatened Wildlife and Plants is accurate. The initiation of the 5-year review for the hawksbill turtle was announced in the Federal Register on April 21, 2005, and the public comment period closed on July 20, 2005. Public comments have been incorporated into the status review.

The enclosed draft of the status review has been prepared by the Services pursuant to the Act. In keeping with directives for maintaining a high level of scientific integrity in the official documents our agencies produce, we are seeking your assistance as a peer reviewer for this draft. Guidance for peer reviewers is enclosed with this letter. If you are able to assist us, we request your comments be received on or before July 20, 2007. Please send your comments to Sandy MacPherson at the address on this letter. You may fax your comments to Sandy MacPherson at 904-232-2404 or send comments by e-mail to Sandy_MacPherson@fws.gov.

We appreciate your assistance in helping to ensure our decisions continue to be based on the best available science. If you have any questions or need additional information, please contact Sandy MacPherson at 904-232-2580, extension 110. Thank you for your assistance.

Sincerely yours,

David L. Hankla
Field Supervisor
Jacksonville Ecological Services Field Office

Enclosures

Guidance for Peer Reviewers of Five-Year Status Reviews

U.S. Fish and Wildlife Service, North Florida Ecological Services Office

February 7, 2007

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with Service policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data that appears not to have been used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., Endangered, Threatened) of the species.

4. Provide written comments on:
- *Validity of any models, data, or analyses used or relied on in the review.*
- *Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.*
- *Oversights, omissions, and inconsistencies.*
- *Reasonableness of judgments made from the scientific evidence.*
- *Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.*
- *Strengths and limitation of the overall product.*

5. Keep in mind the requirement that we must use the best available scientific data in determining the species' status. This does not mean we must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents, and portions may be incorporated verbatim into our final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance, the peer review process, or other aspects of the Service's recovery planning process should be referred to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, at 904-232-2580, extension 110, email: Sandy_MacPherson@fws.gov.

C. Summary of Peer Review Comments/Report:

A summary of peer review comments from the five respondents is provided below. The complete set of comments is available at the Jacksonville Ecological Services Field Office, U.S. Fish and Wildlife Service, 6620 Southpoint Drive South, Suite 310, Jacksonville, Florida, 32216.

Eduardo Cuevas, Pronatura Peninsula de Yucatan. A.C., Merida, Yucatan, Mexico: Mr. Cuevas felt that the biological information summarized in the document was appropriate. He indicated that scientific uncertainties in the document could have been more explicitly mentioned to provide a framework for the document and the information presented in it.

Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico: Mr. Diez noted that the document did not focus on the status of the hawksbill turtle in the U.S. and its territories. He provided information on other hawksbill nesting sites in Puerto Rico in addition to those included in the document. He also indicated a need to include information on hawksbill feeding ground aggregations as a means of assessing population status.

Dr. Julia Horrocks, University of the West Indies, Bridgetown, St. Michael, Barbados: Dr. Horrocks provided several edits, but overall felt that the document provided an impressive compilation of the global status of hawksbill populations, particularly the nesting segment. She did express some concerns about the historical trend being assessed over a time period of >20 to 100 years ago. She felt that it might have been more appropriate for historical trends to compare the present to 50 to 100 years ago. Dr. Horrocks also felt that the document did not sufficiently emphasize that there is little documentation on hawksbill foraging population status. She felt that the impact of other factors (e.g., nesting habitat deterioration and loss), in addition to trade issues, on population status must not be underestimated.

Dr. Anne Meylan, Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL: Dr. Meylan provided several edits, but felt that the document provided a thorough and up-to-date analysis of the status of the hawksbill. She also stated that the calculations used for estimates of abundance were appropriate and encompassed worldwide variability in key parameters. Dr. Meylan was concerned about the use of unpublished sources of information. She suggested that the document would be strengthened by the elimination of non-essential information that is based solely on this type of reference, and by archival of copies of all unpublished or difficult-to-find material.

Dr. Robert van Dam, Chelonia, Inc., San Juan, Puerto Rico: Dr. van Dam felt that the document adequately addressed global hawksbill nesting populations. However, he noted that the document did not contain any progress information relative to the Recovery Criteria identified in the recovery plans for U.S. hawksbill populations. He also commented that the document focused heavily on the Indo-Pacific hawksbill populations even though these populations are the most geographically removed from the United States and its territories. He noted that the document did not include the implementation of fencing exclosures to reduce egg predation by feral pigs on Mona Island, Puerto Rico. He also stated that no mention was made of in-water surveys of immature hawksbills on their foraging grounds, which could shed light on future abundance of the species.

D. Response to Peer Review:

Eduardo Cuevas, Pronatura Peninsula de Yucatan. A.C., Merida, Yucatan, Mexico: Data confidence grades are provided in Tables 1-3 to address the scientific uncertainties of the nesting data.

Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico: The Services are required to conduct reviews every 5 years on species listed under the ESA to determine whether their current classification remains valid. The hawksbill turtle is listed as endangered globally throughout its range and thus the 5-year review must be conducted on the entire listed entity. We included additional information on hawksbill nesting in Puerto Rico and the U.S. Virgin Islands. Although Mr. Diez indicated a need to include information on hawksbill feeding ground aggregations as a means of assessing population status, he did not reference any specific information, and we are unaware of any trends analyses of in-water hawksbill turtle assemblages.

Dr. Julia Horrocks, University of the West Indies, Bridgetown, St. Michael, Barbados: Dr. Horrocks' suggested edits were incorporated. However, we continued to assess the historical trend over a time period of >20 to 100 years ago as it was based on the best available information. Text was added to clearly state that there is little comprehensive documentation on the status of hawksbill foraging populations.

Dr. Anne Meylan, Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL: Dr. Meylan’s suggested edits were incorporated. We agree that unpublished data are less desirable than peer-reviewed and published data, and we have replaced or deleted citations where published references or references with more rigorous peer review were available. However in many cases the unpublished data were the best available information, and those references were not deleted. The Services have copies of all cited references, these are available at the Jacksonville Ecological Services Field Office, U.S. Fish and Wildlife Service, 6620 Southpoint Drive South, Suite 310, Jacksonville, Florida, 32216.

Dr. Robert van Dam, Chelonia, Inc., San Juan, Puerto Rico: Information relative to progress and accomplishments has been added to Section 2.2. The Services are required to conduct reviews every 5 years on species listed under the ESA to determine whether their current classification remains valid. The hawksbill turtle is listed as endangered globally throughout its range and thus the 5-year review must be conducted on the entire listed entity. Information on the importance of protective fencing in excluding feral pigs from nesting beaches on Mona Island, Puerto Rico, has also been added. Although Dr. van Dam indicated a need to include information on in-water surveys of immature hawksbills on their foraging grounds, he did not reference any specific information, and we are unaware of any trends analyses of in-water hawksbill turtle assemblages.