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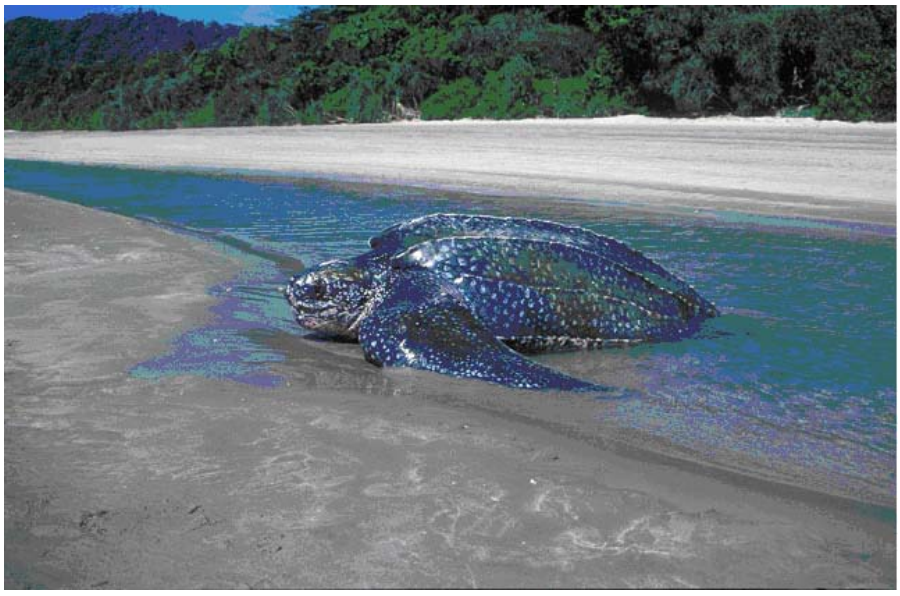
Assessment of the conservation status of the Leatherback turtle in the Indian Ocean and South East Asia, including consideration of the impacts of the December 2004 tsunami on turtles and turtle habitats

DRAFT of February 2006



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Preface

The IOSEA Marine Turtle MoU puts in place a framework through which States of the Indian Ocean and South-East Asia region, as well as other concerned States, can work together to conserve and replenish depleted marine turtle populations for which they share responsibility. A seven-member Advisory Committee has been appointed by the Signatory States to provide advice in relation to the implementation of the MoU's associated Conservation and Management Plan.

During the Third Meeting of the Signatory States in March 2005, concern was raised about the impacts of the December 2004 tsunami on turtle populations and habitats, including Leatherback turtles in the Indian Ocean. This species attracted particular attention in light of its restricted numbers and nesting areas, which are present in two of the most affected countries: India (Andaman and Nicobar Islands) and Sri Lanka.

Accordingly, the Meeting requested that the Advisory Committee provide an assessment of the tsunami's impacts on turtles and turtle habitats, giving priority to the completion of an assessment of the conservation status of Leatherback turtles. In view of the fact that a relatively small number of countries were severely impacted by the tsunami, the Advisory Committee has elected to give more emphasis to the Leatherback assessment, and to nest the tsunami impact assessment within that presentation.

To undertake the assessment, marine turtle experts in each of the countries in the IOSEA region (including non Signatory States) were contacted and asked to complete a short survey regarding leatherback turtles in their country. The survey covered legislative aspects, nesting populations, foraging populations and the tsunami impacts. Completed surveys were then edited for content, by the compilers, and in some cases additional information was added. The final edited surveys on leatherback turtles are presented in the document as country reports, and the tsunami results are presented in section 2.

Table of contents

Acknowledgements 3
Contributing authors 4
Preface 6
Table of contents 7
Leatherback turtle synthesis 8
Introduction 11
Status of leatherback turtles in Australia 18
Status of leatherback turtles in Bahrain 25
Status of leatherback turtles in Bangladesh 27
Status of leatherback turtles in Brunei – Darussalam 33
Status of leatherback turtles in Cambodia 34
Status of leatherback turtles in China 35
Status of Leatherback turtles in the Comores 40
Status of leatherback turtles in Djibouti 41
Status of leatherback turtles in Eritrea 44
Status of leatherback turtles in the French Territories of West Indian Ocean 48
Status of Leatherback turtles in India 50
Status of leatherback turtles in Indonesia 56
Status of leatherback turtles in Iran 69
Status of leatherback turtles in Iraq 72
Status of leatherback turtles in Japan 74
Status of leatherback turtles in Jordon 76
Status of leatherback turtles in Kenya 78
Status of leatherback turtles in Korea 80
Status of leatherback turtles in Korea 81
Status of leatherback turtles in Kuwait 82
Status of leatherback turtles in Madagascar 84
Status of leatherback turtles in Malaysia 85
Status of Leatherback turtles in Maldives 91
Status of leatherback turtles in Mauritius 94
Status of leatherback turtles in Mozambique 95
Status of leatherback turtles in Myanmar 102
Status of leatherback turtles in Oman 103
Status of leatherback turtles in Pakistan 106
Status of the leatherback turtle in Papua New Guinea 110
Status of the leatherback turtle in the Philippines 116
Status of leatherback turtles in Qatar 117
Status of leatherback turtles in Saudi Arabia 119
Status of Leatherback turtles in Seychelles 123
Status of the leatherback turtle in Singapore 127
Status of leatherback turtles in Somalia 129
Status of Leatherback turtles in Sri Lanka 132
Status of leatherback turtles in South Africa 141
Status of leatherback turtles in Sudan 147
Status of leatherback turtles in Thailand 150
Status of leatherback turtles in Timor Leste 156
Status of leatherback turtles in Tanzania 157
Status of leatherback turtles in United Arab Emirates 159
Status of leatherback turtles in British Indian Ocean Territory (B.I.O.T.) 161
Status of leatherback turtles in Vietnam 164
Status of leatherback turtles in Yemen 172
Tsunami impacts on marine turtles 175

Leatherback turtle synthesis

Nesting areas
This study has confirmed that there are four main areas of leatherback turtle nesting in the Indian Ocean and South East Asian region. These probably represent separate large-scale management units.

1. Southwest Indian Ocean - South Africa and Mozambique
The population nesting in South Africa has rarely averaged more than 100 females nesting annually within the index beach (56km of the 200km beach). Data from the index beach shows a rise from 10 to 20 nesting females per year in the 1960s, and up to approximately 100 nesting females per year in the 1990s, but in the last four years it has declined to approximately 20 to 40 nesting females per year visiting the index beach per year. The study in South Africa is one of the longest, continuous studies of leatherback turtle nesting in the world. The numbers nesting in Mozambique are not well documented, but based on data presented in this report from 1994 to 2004 it is likely that approximately 10 females nest per year in southern Mozambique (see Mozambique and South Africa sections). In addition, there does not appear to be an increase in the number of leatherback turtles nesting per year in southern Mozambique to offset the decline in South Africa.

2. Bay of Bengal and north-eastern Indian Ocean - Sri Lanka, Andaman & Nicobar Islands (India), Thailand and Sumatra – Jave and other islands of southern Indonesia and Arnhem Land (Australia)
There are few continuous long term data sets at any of these locations. Data from recent years, presented in this report, indicate that the nesting population in Sri Lanka might be in the order of 100 to 200 females per year (based on one year of data), for the Andaman and Nicobar Islands it is approximately 400 to 600 females per year and in Thailand fewer than 10 nests (that is probably not more than 3 or 4 females) are laid per year. An interesting pattern is emerging from two geographically close rookeries in Java. At Meru Betiri the number of leatherback turtles nesting each year has declined from approximately 20 females per year in the early 1980s down to less than five females per year in the early 2000s. In contrast, at a neighbouring beach, Alas Perwo, the very small nesting population may have doubled over the same time period (from approximately 500 eggs laid per year (1 or 2 females) up to 1000 eggs laid per year). Sightings of nesting in Arnhem Land (northern Australia) are irregular but the area has been incompletely surveyed.

3. Southwestern South China Sea – Malaysia, Viet Nam and other minor nesting out to Japan
The Malaysian rookeries have undergone a well-documented decline from approximately 5000 nests per year in the 1960s down to less than 10 nests per year in the 2000s. This is one of the best-studied, most dramatic examples of decline in a nesting population of marine turtles. While there are no detailed data from Viet Nam, community surveys reveal that the population has declined from an estimated 500 females per year (equivalent to thousands of nests per year) prior to the 1960s down to less than 10 nests per year in recent years.

4. Western Pacific – Indonesia (northwest Papua), Papua New Guinea, eastern Australia
The leatherback turtles nesting along the north coast of New Guinea (Indonesia and Papua New Guinea) are from the same genetic population as females nesting in the Solomon Islands. There are few long term data for either location (see Indonesian and Papua New Guinea sections). Data from recent surveys at both locations indicates that the total nesting population is approximately 1000 females per year. Surveys along the Papua coast are incomplete. The small eastern Australian population identified in the 1970s is approaching extinction, no nests have been recorded in eastern Australia since 1996, and track sightings in northern Australia are irregular.

Foraging grounds and migratory corridors (non breeding areas)
This study has confirmed that there are few data on the foraging grounds and migratory corridors of leatherback turtles in the IOSEA region. The data presented in this report indicates that leatherback turtles have been reported from the waters of 32 of the 44 nations in the Indian Ocean and South East Asian region. However, in most of the countries that have no records of leatherback turtles, the main fisheries are shallow water artisanal fisheries, and there have, in most cases, been few efforts made to collect fisheries based bycatch information.

The use of satellite telemetry to track post-nesting leatherback turtles has revealed that turtles from nesting beaches within the IOSEA region use the southern Atlantic, Southern and Pacific Oceans (northern and southern). In particular, migration data from post nesting females in South Africa show that the leatherback turtles migrated south into the southern ocean, and in one case over into the southern Atlantic Ocean. In addition, post nesting leatherback turtles tracked with satellite telemetry from West Papua swam northwards into the northern Pacific Ocean whereas those tracked from Papua New Guinea migrated into the southern Pacific Ocean. Aside from these data, and those collected from tag recoveries from Peninisla Malaysia there is little known about the "as sea" components of leatherback turtle life history in the IOSEA region.

Gaps in the basic biological information

*Population genetics (*Assessments of marine turtle population genetics are used to determine distinct breeding populations).

There are wide gaps in our understanding of leatherback turtle population genetic profiling within the IOSEA region. To address this gap, and determine the genetic structure of leatherback turtle populations the following rookeries need to be sampled and compared to each other, as well as to published genotypes from Malaysia, Indonesian West Papua and South Africa;

- Australia (northern and eastern)
- Andaman and Nicobar Islands
- Mozambique
- Sri Lanka
- Sumatra
- Java
- Thailand
- Viet Nam

Knowledge of these genotypes will facilitate identification of the origon (by breeding area) of leatherback turtles being captured throughout their dispersed foraging and migratory distribution of the IOSEA region.

Life history attributes

A. Nesting populations

There are substantial gaps in our knowledge of life history attributes for several of the leatherback turtle nesting sites in the IOSEA region. The specific gaps vary between locations, and details can be found by referring to sections on India, Indonesia, Malaysia, Mozambique, Papua New Guinea, Sri Lanka, South Africa, Thailand and Viet Nam. Data on life history attributes are necessary for the development of accurate population models. It is preferential that life history parameters be collected from at least one rookery per management unit. The gaps in life history attributes include;

- The number of clutches per female per year/nesting season
- The number of years between breeding seasons
- The rate of recruitment into the breeding population
- Nest success and hatchling recruitment
- Internesting areas

B. Non nesting beach aspects

Within the IOSEA region there are substantial gaps in our knowledge of leatherback turtle foraging areas, habitat use (oceanic and coastal), internesting area habitats, diet, growth, age and survivorship. While there have been substantial tracking and foraging area studies in eastern Pacific and western Atlantic leatherback turtle populations, few data exist for the Indian Ocean region, with the exception of the South Africa and Papua area region.

Gaps in management

Bycatch and fisheries mortality

Leatherback turtle fisheries bycatch was reported to occur at varying levels of intensity in 25 of the 44 nations in the IOSEA region, not recorded in 13 nations and undetermined in 6. This bycatch has not been quantified in most countries, and fewer bycatch data exist for the high seas fisheries. There are also gaps in the ecological, social and economical aspects of marine turtle bycatch. Bycatch and fisheries based mortality needs to be addressed, by Fisheries and/or Government organizations, which will take a coordinated international effort similar to those undertaken in the Atlantic and Pacific Ocean fisheries.

Egg take
The direct take of leatherback turtle eggs occurs in each of the leatherback turtle breeding areas to varying degrees (encompasses both legal and illegal take). However in most cases the level of exploitation in relation to the size of the population and the socio-economic and cultural factors related to the use of eggs are unknown. Improved knowledge of these factors will enable the level of exploitation to be assessed for sustainability and managed accordingly. All efforts must be made not to repeat what has happened at Rantau Abang.

Hatchling production
Aside from data collected from the hatchery programme in Malaysia, there have been no detailed assessments of the hatchling production at any of the rookeries in the IOSEA region. Without these data it is impossible to conduct meaningful population assessments and design management strategies. While natural (in situ) incubation is the preferred management option for egg incubation, hatcheries are used as a management tool in XX nations (plus some of the commercial hatcheries in Sri Lanka occasionally incubate leatherback turtle eggs).

Rising beach temperatures associated with climate change can be expected to negatively impact on population sex ratio and incubation success of leatherback turtle eggs. No adequate monitoring appears to be in place in any of the IOSEA countries to guide rookery management in response to climate change.

Standard monitoring
Monitoring of several of the rookeries in the IOSEA region has been initiated relatively recently. There is a need for managers in each location to develop standard monitoring protocols that remain consistent year to year, and complements existing projects. Mostly importantly, if whole season monitoring is not possible at all rookeries, index beaches and standard monitoring periods need to be determined and used annually. It is also preferable that tagging projects double tag turtles (PIT and flipper) to minimize problems of tag loss. The introduction of standard practices will substantially improve the ability to use the data effectively in the future.

Additional issues for leatherback turtles in the IOSEA region.
Direct harvest of turtles
A traditional harvest of leatherback turtles occurs in the Kei Islands of Indonesia. While research addressing social, economical and cultural aspects of this harvest are underway (see Indonesian section), gaps exist with regard to understanding biological aspects of the harvest (size, age class, sex and maturity). The combination of biological, social, economic and cultural data can be assessed to determine ecological sustainability and help to manage any trade-offs (social, economical, cultural or ecological) that may occur as a result of management.

Predation of eggs
Depredation of eggs by pigs and dogs presents a problem in at least several locations (Andman and Nicobar Islands Papua New Guinea and Indonesian West Papua). Turtle conservation groups in these regions would benefit from assistance in management of the problem e.g. by predator removal or nest protection programs.

Leatherback turtles nesting in South Africa
The leatherback turtle nesting population in South Africa and Mozambique was rising and has recently undergone a marked decline in annual nesting numbers (based on data from the South African index beach). In addition, an increase in the proportion of recruits (identified as first time nesting turtles) to the size of the nesting population has occured. Therefore, close attention should be paid to the assessment of current and future nesting leatherback turtle data so that management and remediation actions can be quickly instated if needed.

Incomplete nesting distribution data
There are gaps in our knowledge of the distribution and size of current and/or historical leatherback turtle rookeries along the Indian Ocean southern margin of Indonesian (Sumatra, Java and out to the east) and the islands on northern Indonesian Papua and southeastern Philippines. These data could be collected from a combination of ground based and aerial surveys in each of the respective areas.

Introduction

The leatherback turtle, *Dermochelys coriacea*, is the only surviving species of the Family Dermochelyidae. This ancient turtle family probably had it origins more than 60 millions years ago in the early Cretaceous (Gaffney 1991). This is the largest living turtle (up to 916kg. Morgan 1989) and it has the greatest geographical distribution for any reptile. Its habitat range extends from tropical nesting beaches to marine foraging areas spread from the tropics to cool temperate waters, with some individuals even foraging in sub-polar waters (Goff and Lien 1988). It is the deepest diving turtle, having been record down to depths of 315m (possibly to depths exceeding 1000m) during dives up to 37minutes in duration (Eckert et al. 1989).

While leatherback turtles share many features of their biology with the hard-shelled turtles, Family Cheloniidae, leatherback turtles also are characterised by a number of unique features. The leatherback turtle can be regarded as a warm-blooded reptile. They can maintain a core body temperature well above that of the surrounding waters (Frair et al. 1972, Standora et al. 1984). To maintain these elevated temperatures they must be able to generate endogenous heat via utilisation of thermogenic brown fat tissue (Eckert 1992). Additional heat would be derived from normal metabolism during muscular activity. Reduction in heat loss is facilitated by this turtle's thick insulating sub-epithelial fat deposits (blubber), its large body size and hence its low surface area to volume ratio and the counter-current heat exchange system utilising a bundle of veins and arteries at the base of each flipper to reduce heat loss via blood flow to the flippers (Greer et al. 1973). With these adaptations, the leatherback turtle is able to remain functional in the very cold waters that it encounters during deep dives and during migrations to high latitudes. This species also has a number of skeletal features within its limb bones that are unique among living reptiles but which it shares with other marine diving animals including cetaceans and sirenians and the extinct ichthyosaurs and plesiosaurs (Rhodin et al. 1981, 1996). The diet of leatherback turtles consists primarily of large planktonic invertebrates such as jellyfish and tunicates.

The Indian Ocean – South-east Asian region can be regarded in many ways as a birth place for modern turtle biology and conservation management, particularly for the leatherback turtle.

In the northern Indian Ocean during the early 1900s, Sri Lanka, then a British Colony known as Ceylon, was recognised as a significant area for leatherback turtles (Smith 1931). It was from Ceylon that Deraniyagala published numerous scientific papers commencing with his description of the nesting biology of leatherback turtles and his first paper on leatherback turtle embryology (Deraniyagala 1930, 1932). His detailed descriptions of marine turtle taxonomy, behaviour, embryology and morphology (Deraniyagala 1939) remain essential reading for any serious student of leatherback turtle biology. In his later career, Deraniyagala (1953) enhanced these studies with publication of his well illustrated "Atlas" of the reptiles of Ceylon. Although Smith (1931) reported declining occurrences for these turtles, no significant conservation actions for the Sri Lankan leatherback turtles appear to have been initiated as a consequence of the scientific studies of the 1930s. While various proposals have been made for improving leatherback turtle conservation in Sri Lanka (de Silva 1996), it was not until the late 1990s that concerted efforts to improve the conservation outlook for leatherback turtles under threat from egg harvest and coastal development in southern Sri Lanka were revitalised by the proactive involvement of community groups (Kapurusinghe 2000).

Concerns regarding the long term survival of marine turtle populations subject to intense egg harvest in Sarawak (Harrison 1947) led to the invention of the stainless steel (monel metal) flipper tag (Harrison 1956a,b, 1958). This tag facilitated detailed studies of marine turtle reproductive biology and the formulation of hatchery-based management projects in Sarawak, now a State within Malaysia, for the green turtle (*Chelonia mydas*) (Harrison 1951, 1952, 1954, 1955, 1956a,b,c, 1958, 1959, 1961, 1962a,b; Hendrickson 1958).

The "discovery" by the scientific community of the leatherback turtle nesting population at Terengganu in Peninsula Malaysia in the 1950s (Tweedie 1953), was closely followed by scientific investigations that parallelled those under way in Sarawak. These studies raised concerns for the sustainability of the existing intense egg harvest from this leatherback turtle population (Hendrickson and Albert 1957, 1961; Hendrickson 1961). A hatchery based conservation project was initiated (Wyatt-Smith 1960,

Hendrickson 1962, Anon 1963, Balasingam 1965, 1969, Wycherley 1969, Tho 1974, Kiew 1975, Siow 1978, Leong and Siow 1980a,b, Siow and Moll 1982, Siow 1987) and investigation of leatherback reproductive biology and ecology commenced (Hendrickson and Winterflood 1961, Hendrickson and Balasingham 1966, Balasingam 1967). Subsequent tagging studies provided the first detailed descriptions of the reproductive biology and breeding migrations for this species (Balasingam and Tho 1972, Chua 1988, Chua and Furtado 1988). The egg harvest was progressively reduced and an increasing proportion of eggs retained for hatchery incubation as the nesting population continued to decline during the 1980s and 1990s (Chan 1986a, Salleh et al. 1987, Chan 1988a, Aikanathan 1989, Chan and Liew 1989a, Aikanathan and Mortimer 1990, Limpus 1993). In response to the declining nesting population and corresponding decreasing incubation success of the eggs in the hatcheries, additional research addressing embryology, incubation success and hatchling biology was initiated (Chan 1985, 1986b, Chan et al. 1985. Chan 1988b, 1989, Chan and Solomon 1989, Chan 1993). At the same time, increased emphasis was given to understanding leatherback turtle internesting biology (Eckert et al. 1991, Chan et al. 1988, Chan et al. 1991, Chan and Liew 1995) and to introducing conservation measures within the interesting habitat (Chan and Liew 1989b, 1995).

Although Loveridge and Williams (1957), in their taxonomic review of African turtles, record leatherback turtles from Cape Province of South Africa, they make no reference to the Natal–Mozambique breeding population. In response to local concerns for the depleted leatherback and loggerhead turtle nesting populations of north-eastern Natal, the Natal Parks Board commenced long term research and monitoring of these nesting populations in the early 1960s (Bass and McAllister 1964). The ongoing studies of this leatherback breeding population (Hughes et al. 1967, Hughes and Mentis 1967, Hughes 1969, 1971a,b, Hughes and Brent 1972, Hughes 1974a,b, 1989, Hughes and Bartholomew 1998) have provided leadership in increasing our understanding of leatherback turtle biology and conservation.

In Indonesia, leatherback turtle distribution had been poorly documented (de Rooij 1915) but by the 1970s marine turtle specialists were aware of leatherback turtle nesting along the northern New Guinea coast (Pritchard 1979). As the conservation movement in Indonesia became more informed regarding marine turtles within their country, it became apparent that a very large leatherback turtle population was nesting in north-eastern New Guinea (Anon 1981). In addition, a nation wide survey by IUCN-WWF staff identified that leatherback turtle nesting was wide spread throughout Indonesia (Salm 1984): southern Sumatra, southern Java, many of the other islands bordering the Indian Ocean as well as the Vogelkop area of north-western Irian Jaya (now known as Papua).

WWF Indonesia has had two decades of participation in developing and implementing conservation actions in the Vogelkop area, beginning with Bhaskar's intensive population surveys in 1984 – 1985. This work has been complemented by additional studies by other Indonesian teams (Yamasaki 1991, Nababan and Jacob 1996) and visiting international teams (Starbird and Suarez 1994). Loss of eggs through pig predation, erosion and egg harvest were identified as significant issues for this population and conservation efforts have focused on nesting census and increasing hatchling production. Few additional studies (Maturbongs et al. 1993, Maturbongs 1995, 1996) of leatherback turtles within its more broadly dispersed nesting range within Indonesia have occurred since the country-wide survey in the early 1980s (Salm 1984). The localized traditional leatherback turtle harvest in the Kei Islands of eastern Indonesia has been highlighted (Starbird and Suarez 1994, Suarez and Starbird 1996, Suarez 2000) and offers some insights into the poorly understood oceanic life of the species.

The significant leatherback nesting population of the Andaman Sea and eastern Bay of Bengal started to gain recognition during the latter part of the 1900s (Polunin 1975, Phasuk 1983). However, it was not until the surveys commenced by Baskar in the early 1990s that the significance of the Andaman and Nicobar Islands leatherback nesting population was appreciated (Bhaskar 1993, Tiwari 1994, Andrews 2000). This leatherback population is now identified as under threat (Andrews 2000) and plans were developed to address some of the conservation problems for the area (Choudhury et al. 2000). The 1990s also saw a breakdown of language barriers in the region. Actions by Thailand, Myanmar and Bangladesh agencies and NGO groups in conservation of the depleted and small nesting population along the Andaman coast of mainland Asia are now recognised (Chantraspornsyl 1996, 2000, Islam 2000). Egg harvest and egg depredation has been a significant threat to leatherback turtles along this coastal region.

Except for localised egg harvests, the leatherback turtle has not had any prominent role in trade in marine turtle (Mack et al. 1979). In response to the recognised threat to the populations arising from the over harvest of eggs for local consumption, South Africa and Malaysia developed two independent management regimes for leatherback turtles commencing in the 1960s:

- **Natal, South Africa**: The management responses included a long term moratorium on the harvest of eggs by the indigenous community, protection of over 200km of nesting habitat as National Park and habitat protection in the immediately adjacent waters, maintenance of a darkness zone along these hundreds of kilometres of coast, and control of public access to the nesting habitat by night.
- **Terengganu, Malaysia**: The management response in the initial phases included the protection of a few percent of eggs in hatcheries while maintaining the "traditional" harvest of the majority of the eggs. No management was put in place to protect the nesting habitat from the encroachment of coastal development and associated change of light horizons. In the late 1970s, the majority of the Rantau Abang nesting beach was declared a turtle sanctuary but its role was primarily to minimise public disturbance of the turtles nesting in the area designated for egg harvest. Through the 1980s and into early 1990s, the percentage of eggs laid taken into protected incubation in hatcheries was progressively increased to 100% of leatherback turtle eggs laid throughout the State.

Both these models were initially designed at a time when the global understanding of marine turtle biology and population dynamics was limited and both were designed on the basis of what was at the time to be considered good turtle conservation management practice. The results of these two long term management experiments are summarised in the population census graphs within the respective national reports (see Malaysia and South African sections of this report).

The South African model with regional protection of the turtles, their eggs and breeding habitat over decades has worked. It halted the decline of the species in Natal, increased the size of the nesting population and ensured a controlled but financially viable tourist industry around these turtles.

The Malaysian model with its initial emphasis on maintaining a large egg harvest has clearly failed in maintaining a viable leatherback turtle population as well as having failed to ensure a long term sustainable egg harvest. At the same time, the leatherback turtle tourist industry which had been a significant international dollar earner for the State also collapsed.

As the 20th Century drew to a close, the new genetic research tools were applied to the region's leatherback turtle breeding populations. The region was found to support several discrete breeding populations or stocks. The leatherbacks that breed in South Africa, peninsula Malaysia and northern New Guinea are genetically different to each other and to the leatherback turtle nesting populations from other ocean basins (Figure 1) (Dutton et al. 1999). Unfortunately, samples from the leatherbacks that breed in Sri Lanka, Andaman and Nicobar Islands and from the widely dispersed low density nesting that occurs along southern Indonesia (Sumatra, Java, Bali) and across to northern Australia were not available for inclusion in these genetic analyses.

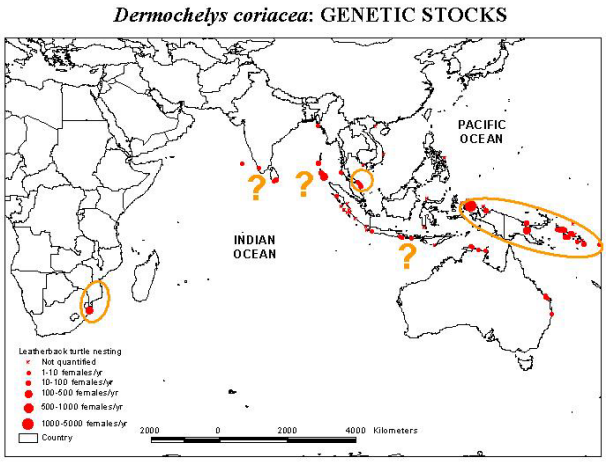

Figure 1. Nesting distribution of leatherback turtles in the Indian Ocean – Australasian region showing identified independent genetic stocks for the species (After Dutton et al. 1999). ? denotes that the nesting population has not be genetically identified.

As the scientific community was coming to the understanding that widely separated breeding assemblages of leatherback turtles around the world were independent stocks/management units, other studies were aggregating the long term census data from many of these stocks and identifying that leatherback turtles were under threat (Spotila et al. 1996). Pritchard (1996) advised some caution in too broad a generalization of the global conservation problem, particularly within the Indian Ocean. However, Pritchard (1996) clearly recognized the major population decline of the Malaysian leatherback turtle population and stressed that excessive egg harvest would be a significant threat for any population. These two studies collectively highlight the general paucity of data on the biology of leatherback turtles with respect to a number do key issues that are critical to developing sound conservation management for the species – particularly in the IOSEA Turtle MoU region:

- Imprecise understanding of key population dynamics parameters including population age structure, age at first breeding, breeding life expectancy, annual survivorship values for any at-sea age class.
- Incomplete mapping of the nesting distribution throughout the Andaman Sea and across southern Indonesia, Timor Leste to northern Australia; across northern New Guinea and Southern Philippines and in Mozambique.
- Paucity of precise census data by which the population trends within the respective stocks can be assessed.
- Paucity of precise mortality data especially from the fisheries that catch leatherback turtles, especially the wide spread long-line, trawl and inshore gill-net fisheries.

It is against this background that we have moved into the 21st century and the IOSEA Marine Turtle Conservation MoU signatory States take up the challenge to care for leatherback turtles for future generations within the region. This report aims to (1) provide a current assessment of the distribution, abundance and threats to leatherback turtles in the IOSEA region and (2) report on the impacts that the December 2004 tsunami had on regional marine turtles, their habitats, and conservation programs.

To undertake the assessment, marine turtle experts in each of the countries in the IOSEA region (including non Signatory States) were contacted and asked to complete a short survey regarding leatherback turtles in their country. The survey covered legislative aspects, nesting populations, foraging populations and the tsunami impacts. Completed surveys were then edited for content, by the compilers, and in some cases additional information was added. The final edited surveys on leatherback turtles are presented in the document as country reports, and the tsunami results are presented in section 2.

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Status of leatherback turtles in Australia

By Colin Limpus

1. The legal protection status for leatherback turtles

In Australia, wildlife management is the responsibility of both the Federal and State and Territory Governments, each with their respective management agencies and associated legislation (Table 1).

Leatherback turtles are protected species nationally as a vulnerable, migratory, marine species. They are also listed as protected species with each State and Territory with varying levels of concern – from vulnerable to critically endangered, depending on the State (Table 1).

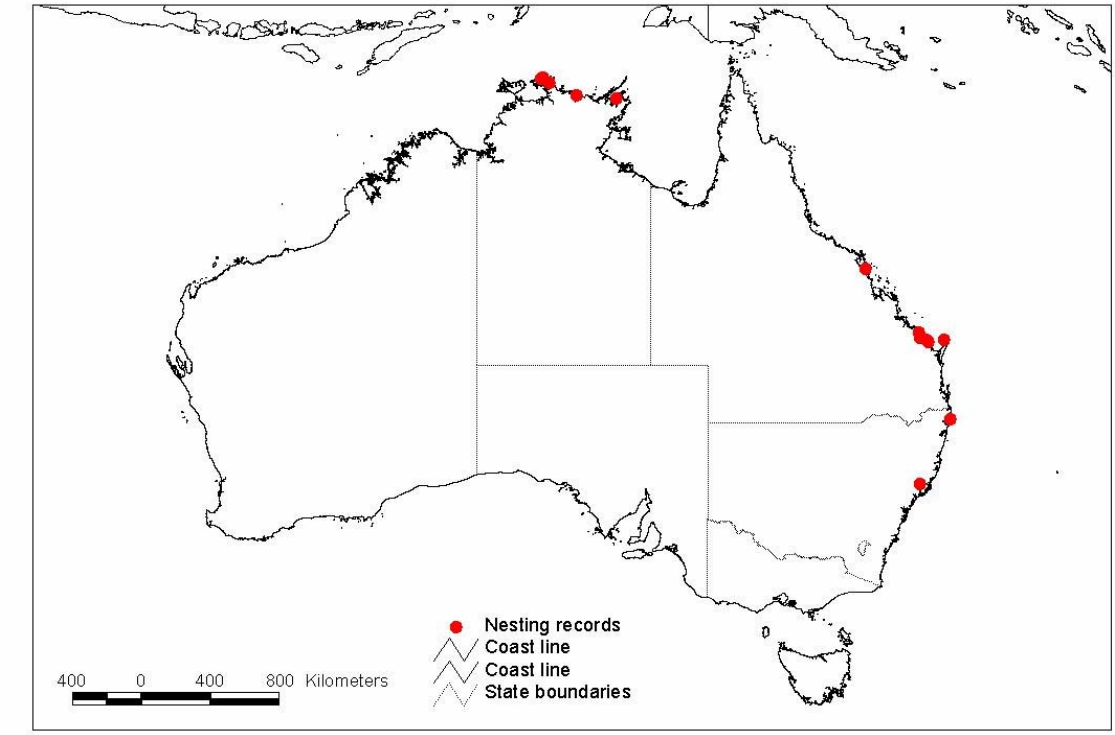

Figure 1. Distribution of confirmed *Dermochelys coriacea* nesting records in Australia.

Table 1. Summary of the legally defined conservation status of *Dermochelys coriacea* for Australia and the Federal and State-Territory agencies responsible for the administration of this legislation.

	Status	**Legal basis**	**Management Agency**
International obligations			
Convention for the Conservation of Migratory Species of Wild Animals (CMS)	Appendix I & II	Australia is a signatory state.	Department of the Environment & Heritage, John Gorton Building, King Edward Terrace Parkes ACT 2600, GPO Box 787, Canberra ACT 2601
Convention for International Trade in Endangered Species (CITES)	Appendix 1	Australia is a signatory state.	
Legislation			
Australia including Aust'n Territories	Vulnerable Migratory species Marine species	*Commonwealth Environment Protection and Biodiversity Conservation Act 1999*	Department of the Environment & Heritage (see above)
Tasmania	Vulnerable	*Threatened Species Protection Act 1995*	Tasmanian Parks and Wildlife Service, GPO Box 1751, Hobart, TAS 7001, Australia.
Victoria	Critically endangered	*Advisory list of Threatened Vertebrate Fauna in Victoria 2003*	Environment Protection Authority Victoria, GPO Box 439QQ, Melbourne, Victoria, 3001, Australia.
New South Wales	Vulnerable	*Threatened Species Conservation Act 1995*	NSW Department of Environment and Conservation Incorporating Environment Protection Agency, PO Box A290, Sydney South, NSW 1232, Australia.
Queensland	Endangered	*Nature Conservation Act 1992*	Environmental Protection Agency, Queensland Parks and Wildlife Service, PO Box 15155, City East, QLD 4002, Australia.
Northern Territory	Vulnerable	*Territory Parks and Wildlife Conservation Act 2000*	Environment Protection Agency Northern Territory, Office of Environment and Heritage, GPO Box 1680 Level 2, Darwin, NT 0801, Australia.
Western Australia	Rare or likely to become extinct	*Wildlife Conservation Act 1950*	Department of Conservation and Land Management, Government of Western Australia, Locked Bag 104, Bentley Delivery Centre, WA 6983, Australia.
South Australia	Vulnerable	*National Parks and Wildlife Act 1972*	Environment Protection Authority South Australia, GPO Box 2607, Adelaide, SA 5001, Australia.

2. Nesting populations

2.1 Overview

There is no historical evidence of a large nesting population of leatherback turtles in Australia. Nesting by the species here was first reported in 1974 (Limpus 1974). Nesting has been reported for low numbers of turtles annually from two areas of Australia (Figure 1).

- Eastern Australia: While there have been isolated reports of leatherback turtle nesting from Mackay in Central eastern Queensland south to Newcastle in central New South Wales, most nesting occurs on about 40km of coastline on the Wreck Rock and Rules Beaches in south Queensland (Limpus and McLachlan 1994). When "discovered" in the 1970s during systematic studies of other marine turtle species, about three female leatherback turtles nested annually in south Queensland. Of course people had been familiar with leatherback turtles visiting these beaches for decades before. Nesting numbers have declined. No leatherback nesting has been recorded in eastern Australia since 1996.
- Northern Arnhem Land: While there have been isolated reports of leatherback turtles from many beaches across northern Arnhem Land and the adjacent islands since the 1970s, most report of their nesting have been from the Coburg Peninsula (Limpus and McLachlan 1994). There is no reliable estimate of the size of this presumably small nesting population but nesting here continues to be recorded (Rod Kennett pers. comm.).

There have been no confirmed records of leatherback turtle nesting in Western Australia.

2.2 Genetic studies on nesting populations

No population genetics studies for leatherback turtles from Australia have been reported.

2.3) Seasonality of leatherback turtle nesting

Nesting in southeast Queensland occurs during December-February.
Leatherback turtle tracks were recorded during December to January at Danger Point near Coburg Peninsula in the Northern Territory (Rod Kennett Pers. Comm.).

2.4) Biological parametres

Biological data from the nesting turtles are only available from eastern Australia and has been summarised by Limpus and McLachlan (1994) and Limpus et al. (1984) for Queensland and Tarvey (1993) for New South Wales (see Table 2).

Table 2. Summary of the biological data for leatherback turtles in Australia

Category of data	Average & Standard deviation	Range	Sample size
Size of nesting females	CCL = 162 ± 6.8	150.5-174.5	11
Number of eggs per clutch	Qld: 86.1 ± 15.7	64-121	16
	NSW: 97.7	94-104	3
Clutches per season	-	Up to 4	
Re-nesting interval (days)	9.17 ± 0.75	9-11	6
Number of years between breeding seasons (years)	Not recorded		
Size of eggs (cm)	5.33 ± 0.11	5.11-5.63	130
Size of hatchlings (cm)	Qld: 5.88 ± 0.29	5.14-6.52	39
	NSW: 6.10	5.73-6.53	39
Incubation success (%)	Qld: 15.3 ± 17.6%	0-39	7
	NSW: 40.3	0-78	3

2.5) Pivotal temperature studies

There have been no studies of hatchling sex ratio reported and the pivotal temperature for the population has not been defined.

2.6) Migration records

There are no reports of migration from the Australian rookeries.

2.7) Protection of nesting beaches
Eastern Australia: None of the main nesting area occurs within protected area. The adjacent interesting habitat occurs within the Great Barrier Reef Marine Park.

Northern Territory: None of the nesting sites are within designated protected areas, however they are in some of the most remote parts of coastal Australia; so they are pristine in nature and not likely to suffer any major degradation.

It is not known whether any state agencies are planning to protect any of the leatherback turtle nesting sites.

2.8) Use of hatcheries to protect leatherback turtle nests
Hatcheries are not used

2.9) Threats to leatherback turtles (foraging and nesting)
Limpus (in press) has reviewed the impacts of human impacts on leatherback turtles in Australia. This review is summarised in Table 3.

2.10) Impacts of coastal development and/or sand mining on leatherback turtle nesting
None

2.11) Major threats to leatherback turtles
Entanglement in float lines used in lobster and crab fisheries.

2.12) Activities underway to improve the conservation of nesting populations of marine turtles
Annual fox baiting is conducted along Wreck Rock beaches to reduce predation of turtle eggs.

2.13) Other biological studies conducted on leatherback turtles
The embryology of leatherback turtles has been described (Miller 1985).

3. Foraging populations

3.1) Overview
Leatherback turtle are most frequently encountered in the waters of southern Australia (Tasmania, Victoria, South Australia and Western Australia) and along the mid-eastern Australian Coast (SE Queensland) (Figure 2). Inshore movements to feed on jellyfish in shallow coastal waters during mid-year have been recorded from northwestern Queensland.

There has been only one tag recovery reported from an Australian foraging area: A female tagged while nesting in Java, Indonesia was recaptured from north-western Western Australia.

In eastern Australia, the bycatch of leatherback turtles that are entangled as they swim past the drumline hooks set within the Queensland Shark Control Program are released alive. These data provide an index of the occurrence of leatherback turtles in those waters. The most comprehensive dataset for this leatherback turtle bycatch was recorded at Point Lookout, south Queensland from 1984 to the present (Figure 3). These data are consistent with a decline of leatherback turtles in south Queensland waters in recent decades.

3.2) Seasonality of leatherback turtles occurring in coastal or offshore waters
Leatherback turtles can be found foraging year round in Australian waters.

3.3) Size range of leatherback turtles foraging in Australian waters
Leatherbacks in Australian waters range in size from small immature turtles, CCL =30.5cm, up to large adults (Prince 2004).

Table 3. Review of threats to leatherback turtles in Australia (foraging and nesting)

Threats at this site/area	Current occurrence	Historical records
Exploitation of nesting fem.	Nil known	Rare; traditional use only
Egg collection	Nil known	Rare; traditional use only
Coastal development	Nil	Nil
Artificial lighting	Nil	Nil
Coastal erosion	Nil	Nil
Trawl Fisheries: combined State and Federally managed trawl fisheries	Rare; Negligible mortality (Robins and Mayer 1998)	Rarely caught, most released alive. <1 death per decade during 1970s-1990s.
Longline Fisheries: Australian East Coast and West Coast Tuna and Billfish Longline Fisheries	Catch and mortality is being quantified; ~60% of total turtle catch may be leatherbacks and mortality is believed to be low (Robins et al. 2002).	-
Gillnet Fisheries	No known occurrence in recent years	**Taiwanese drift net fishing, 1985-1986, off Arnhem Land**: catch & mortality not quantified **Northern Australian barramundi gillnet fishery**: low catch rate, <1 leatherback death per year. **Tuna drift net fisheries in southern Australia**: unquantified effort, catch and mortality; probably appreciable
Lobster fisheries: Tasmania, Victoria, South Australia and southern Western Australia	Turtles are entangled in the floatlines to the traps. Catch and mortality are not quantified; Many captures occur annually; estimated 75% of leatherbacks are released alive (Bone 1998).	No data
Crab fisheries: southern Queensland	0.14deaths/yr during 1990-2003	No data
Vehicles	Nil	Nil
Sand mining	Nil	Nil
Unregulated hatcheries	Not applicable	Not applicable
Natural threats/predation	Nil	Fox predation of eggs on south Queensland beaches; possibly common during 1970-1980s.
Boat strike: Queensland	0.07deaths/yr during 1990-2003	No data
Accidental deaths in Qld shark Control Program	0.25deaths/yr during 1996-2003.	Catch and mortality unquantified in the early years of this program that commenced in 1960s.
Ingestion of marine debris	0.07deaths/yr during 1990-2003	No data

3.4) Information on the diet of leatherback turtles

Leatherback turtles in Australian waters have been recorded feeding on large planktonic animals including jellyfish such as *Catostylus* spp. (Bone 1998, Cogger 1992, Limpus 1984, Limpus & McLachlan 1979) and *Pyrosoma* spp. (Prince 2004). Over the continental shelf they will feed at all levels of the water column from the surface to the bottom (Limpus 1984).

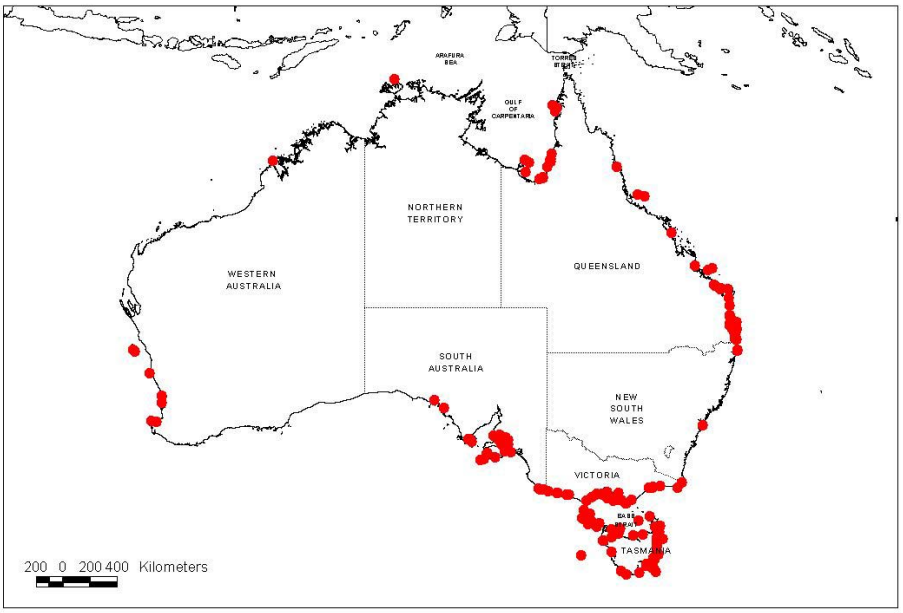

Figure 2. Distribution of foraging area records for *Dermochelys coriacea* in Australia (From Limpus (in press)). There are additional records from southern Western Australia not included in this figure.

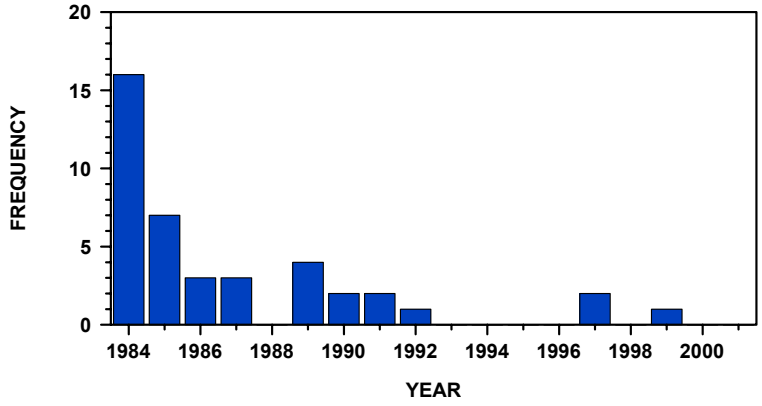

Figure 3. Declining annual capture of *Dermochelys coriacea* on Queensland Shark Control drum-lines at Point Lookout as an index of abundance of the species in south Queensland waters. Data set supplied by Queensland Shark Control Program and commences with the employment of the current contractor in 1984. The fishing effort has been approximately constant with 24 drum-lines deployed in approximately the same locations in each year. The turtles were tangled, not hooked, and almost all were released alive.

3.5) Other biological studies conducted on leatherback turtles in the foraging areas
High levels of arsenic compounds were recorded in a leatherback from the Western Australian coast (Edmonds et al. 1994).

3.6) and 3.6 Threats to leatherback turtles
See section 2.9 and Figures 2 and 3.

3.8) Other activities being undertaken to improve the conservation of leatherback turtle foraging populations
Large TED openings are used in prawn trawl fisheries in northern and eastern Australia.
Training in dehooking, handling and resuscitation of turtles is provided to crews and observers on tuna and swordfish longline boats.

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