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

Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia

Compiled by Dr. Ronel Nel

IOSEA Marine Turtle MoU Secretariat • Bangkok, Thailand

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

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2012 Update

Complied by Dr. Ronel Nel

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Acknowledgements

The content of this report is a compilation of published information and data contributions from country representatives, various organizations and experts. Experts who have contributed data, publications or reports include: Drs Nick Pilcher (Marine Research Foundation, Sabah, Malaysia), Manjula Tiwari (NOAA, La Jolla, USA), Kartik Shanker and Naveen Namboothri (Centre for Ecological Sciences, India), Colin Limpus (Environmental Protection Agency, Queensland), and Peter Richardson (Marine Conservation Society, UK). Fisheries-related data were provided by Alexis Gutierrez and Keith Bigelow (NOAA, on bycatch in the Western Central Pacific Fisheries Commission area), as well as Dr. Françoise Claro (National Natural History Museum, Paris, France). Other regional experts who have provided data include Mr. Dayawan Ratnayake (Department of Wildlife Conservation, Sri Lanka) and Ms. Bui Thi Thu Hien (Marine and Coastal Resources Programme Coordinator, IUCN-Viet Nam). Dr Jack Frazier and Dr Mark Hamann provided comments on the manuscript and project concepts. We are very grateful for all of these valuable contributions and apologise for any inadvertent omissions from this list.

Ronel Nel (Compiler) and
Douglas Hykle (Editor)

Foreword

In 2006, the IOSEA Marine Turtle MoU Secretariat published the first of a series of assessments of the conservation status of marine turtles found in the IOSEA region. The *Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia*, compiled by Hamann et al., provided a comprehensive review of the available information and offered insightful recommendations to address gaps in knowledge and practical conservation/research actions. Hard copies of the report are still available from the Secretariat, upon request, and the full text can also be downloaded from the IOSEA website:

http://www.ioseaturtles.org/content.php?page=Leatherback%20Assessment.

In preparation for the Sixth Meeting of IOSEA Signatory States, held in Bangkok in January 2012, the Secretariat considered it useful to try to identify activities that had been undertaken over the last five years to close some of the gaps identified in 2006 in relation to biological, management and other issues. Such an update would benefit from first-hand knowledge of IOSEA Advisory Committee members, from information readily available from personal contacts with leatherback experts working in the countries concerned, and possibly information contained in recently published or unpublished papers.

Dr. Ronel Nel (Chair, IOSEA Western Indian Ocean – Marine Turtle Task Force) kindly offered to take on the challenge of communicating with interested partners and compiling the available information in the present document, which has been further edited by the Secretariat. We hope you agree that the exercise has been useful and very informative, demonstrating areas of progress in leatherback conservation in the IOSEA region over the past five years.

At the same time, many important gaps in knowledge and basic conservation/research action remain. The recommendations section from the 2006 assessment contained some excellent suggestions – both specific and general – for necessary follow-up work. These have been reproduced in Appendix 1 of the present document and are further supplemented with some simple project concepts outlined in Section 7. It is hoped that a few of these ideas might be developed further and funded with existing or new IOSEA resources, and/or with matching funds sought elsewhere.

This 2012 update of the state of leatherback conservation in the IOSEA region is arguably the most comprehensive assessment currently available, but it remains incomplete. Some researchers may have been overlooked inadvertently or were impossible to contact. Some may be withholding information for publications that hopefully will materialise in the future; while others may not recognise the value of contributing to a collective initiative, preferring instead to concentrate on their own individual projects. In any case, we are very grateful to everyone who has contributed valuable information and we remain hopeful that, through this modest publication, more researchers working with leatherback turtles in the region will be encouraged to participate in the next update in the years ahead.

Douglas Hykle
IOSEA Coordinator
Bangkok, October 2012

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IOSEA Leatherback Turtle Assessment – 2012 Update

1. Introduction

For ease of comparison, the following text is structured using the same headings of the 7-page synthesis section of the 2006 *Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia*, compiled by Hamann et al. , which has been reproduced in Appendix 1. Blue-coloured blocks interspersed throughout the document contain text extracted verbatim from the original report, reflecting the situation as it was known in 2006. All of the other text in this document represents more recent information that has been compiled for this update.

2. Summary of Population Status and Trends - End of 2011

Since the 2006 Leatherback Assessment, a number of new initiatives have occurred across the IOSEA region. New sites have been monitored in the south-western Indian Ocean, particularly in Mozambique, satellite tags were deployed on leatherbacks in the Bay of Bengal, foraging studies (by means of aerial surveys) as well as fisheries interaction studies have been conducted around the South China Sea area, and the Western Pacific region has had a substantial number of papers and reports published between 2007 and 2011.

Many of these efforts started before the 2004 Indian Ocean tsunami and continued afterwards, and were not necessarily in response to tsunami impacts. The Bay of Bengal – East Indian Ocean rookeries were the worst affected by the tsunami, as permanent modification of the coastline took place. Effects were further observed in nesting activities, monitoring and conservation actions, especially for the two years following. Sporadic surveys of nesting beaches and foraging areas resumed throughout the region, but with inconsistent effort mostly due to financial constraints.

The present (post-2004) assessment is still deemed Data Deficient for three of the four sub-regions, namely: Western Indian Ocean, Bay of Bengal - East Indian Ocean, South-China Sea area and Western Pacific (Fig 1, page 24). However, good data have been collected consistently in the Western Indian Ocean for the last 5 seasons. The short-term population trend is deemed "stable". The number of leatherback nests in South Africa and Mozambique has been similar over the last 15 years (<100 females).

The main documented nesting sites in the Bay of Bengal - Eastern Indian Ocean have been, and are still, in the Nicobar and Andaman Islands. Monitoring efforts on Little Andaman indicate that nest numbers have recovered to be in a similar range as before the tsunami habitat impacts. Another regional highlight was the proclamation of the Chagos Archipelago Marine Protected Area, the world's largest no-take MPA.

The South China Sea area has had little consistent effort, generally, and the rookeries with consistent effort (e.g. Terengganu, Malaysia) have very few leatherback nests left. The low level of dispersed nesting throughout remote areas of Viet Nam makes it very difficult to assess the status of the population in that country.

Significant effort was made particularly around the West Pacific. Substantial rookeries are still doing relatively well in Papua, Papua New Guinea, and the Solomon Islands – with collective rookery size estimated to be ~ 5000 - 10,000 nests per annum. Some genetic studies have been conducted, and more than 120 satellite tags have been deployed across the Pacific region over the last decade. These studies have provided some of the best data available for leatherback turtle habitat use, suggesting a single Western Pacific genetic stock, but with clear differences in nesting and migration patterns based on summer and winter nesting events. Even though this effort has not been consistent, it was substantial and contributed to important conservation actions such as the proclamation of an area of critical habitat along the west coast of the United States, which is the foraging habitat for West Pacific leatherbacks.

More generally, little fisheries bycatch data are available for the IOSEA region, with no indication of the magnitude or trends. The paucity of information on bycatch remains an area of concern.

3. Comparison with the 2006 Leatherback Status Report Synthesis

A. Nesting Areas

Hamann et al (2006) confirmed that there are four main areas of leatherback turtle nesting (Figure 1) 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.

South Africa

Two papers reviewed the long-term data from the South African programme (Nel et al, 2012 submitted and Thornson et al., 2012). From these analyses, it is clear that there was a strong initial increase in the leatherback population between 1960 and 1975, after which the annual nesting numbers stabilized despite changes in offshore threats. Still, the population nesting in South Africa is around 70 females per annum. Thornson et al (2012) also highlighted that there is a detectability issue in the leatherback population. It is possible that the population is increasing but, as nesting is scattered and at low density, the existing monitoring may not necessarily capture the (increasing) trend adequately, because it is not increasing consistently across the nesting/monitoring area. This effect may be a manifestation of a range expansion – i.e. increase in the population

outside of the monitored or index areas, since these may not be the preferred habitat for leatherbacks (Nel et al, 2012; Thornson et al., 2012). An expansion of the monitoring area is suggested, towards the south and into Mozambique.

Mozambique

Mozambique has shown improvement in monitoring effort of the nesting beaches. There is apparently consistent monitoring across 11 leatherback rookeries (since 2007/8 season) with data being contributed to the Mozambique turtle group (Videira et al 2011, Videira et al 2010). A total of 81 leatherback emergences were reported across all these monitoring sites with the highest number (35) over the 32km between Dobela and Melongane in the south. More than 700 loggerhead emergences were reported over the same area.

Madagascar

Leatherback nesting in Madagascar is still incidental with no consistent monitoring in place. However, monitoring of other turtle species is more common through the efforts of NGOs working in local communities including the efforts by Blue Ventures and Reef Doctor (see Humber and Hykle 2011).

2. Bay of Bengal and north-eastern Indian Ocean - Sri Lanka, Andaman & Nicobar Islands (India), Thailand and Sumatra – Java 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 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.

Sri Lanka:

Very little information was available on the status of leatherback turtles in Sri Lanka for the 2006 report (by Hamman et al) and little has changed. There are some reports of scattered nesting in the south of Sri Lanka but no quantitative measures. Ekanayake et al (2002) reported 55 leatherback nests over 5 years (1996 – 2000) at Rekawa beach, although the total population size was estimated to be around 200 females per annum (Ekanayake et al 2002). Despite a reasonable size, the population seems to be in decline; Sunday Times reported that leatherback numbers at Rekawa have been in decline from 1996 to 2010 (16 October 2011: http://sundaytimes.lk/111016/News/nws_18.html).

Brodie et al (2008) reported specifically on the (non)impacts of the 2004 tsunami on Sri Lankan turtles. Nesting at Bundala National Park, South East Sri Lanka was unchanged in the year after the tsunami compared to previous years. The number of leatherbacks nesting at this site specifically is still very small (<10 females per annum).

India (Nicobar & Andaman):

Little information is available on the extent of leatherback nesting on mainland India, but the Nicobar-Andaman complex is reported to be a population of global significance. It was estimated that these islands have annual nesting numbers of females in the order of 1000 across the area.

The Bay of Bengal was significantly affected by the 2004 tsunami with erosion of the Indian coastline. As a result the Nicobar Islands submerged in part, and the Andaman group was uplifted (Swaminathan et al 2011). However, these changes were not devastating to leatherback nesting or turtle nesting in general.

Regular monitoring of leatherback turtle nesting was undertaken at the nesting sites of Little Andaman Island prior to 2004. Nesting numbers ranged between 40 and 100 per annum (Swamanithan et al 2011); and for the two years after the tsunami (2005 – 2007) nesting events were scarce to absent. From 2008 onwards, nesting seems to have recovered and numbers are of a similar range to the early 2000s (Swaminithan et al 2011). On South and West Bay of Little Andaman, long-term monitoring programmes have been established (see Swamanithan et al 2011). The specific results for these two bays are as follows: South Bay had a total of 38 nests in the 2007-08 season, 59 nests during the 2008-09 season, 7 nests during the 2009-10 season, 58 nests during the 2010-11 season and 37 nests during the 2011-12 season. West Bay had a total of 91 nests during the 2010-11 season and 148 nests during the 2011-12 season (Naveen Namboothri, Indian Institute of Science, pers comm). It is difficult to establish a trend over such a short time but indications are that this sub-population is small but stable with some inter-annual variation.

A rapid survey was conducted during the second week of February 2011 at the Galathea Bay beach (Great Nicobar Island), which was previously one of the most important leatherback nesting beaches in the region. More than 200 leatherback nests were recorded on a two kilometre beach immediately south of the Galathea River mouth, suggesting recovery (Kartik Shanker, Indian Institute of Science, pers comm). However, Andrews et al (2006) indicated that nesting on these beaches prior to the tsunami ranged from 400 to 500 per annum; and SWOT & OBIS-SEAMAP reports indicate leatherback nesting of > 500 nests in 2003. A more complete survey is thus necessary to establish the spatial extent of nesting and the range of inter-annual variation.

Thailand (Andaman Sea coast) & Indonesia (Sumatra):

Leatherback nesting sites has declined along the coast of Thailand (Andaman Sea) / Indonesia (Sumatra) although a few scattered nesting events still take place annually. Aurregi (2007; in SWOT Vol 2) reported on 6 leatherback clutches at South Thailand (Phuket); and consistent low-level nesting has been reported at Amandangan (Indonesia), with 10 – 20 clutches per annum (Muurmans, M, 2008 & 2009 in SWOT & OBIS-SEAMAP). Combined this is a very small rookery.

Southern Indonesia (including Java):

Widespread, low-density nesting occurs along the Indian Ocean margin of southern Indonesia. Consistent low density nesting – reported in 2004/2005 to be around 15 clutches, with a maximum of 10 females at Ngagelan (East Java) – seems to be the norm (Putra 2005 in SWOT & OBIS-SEAMAP). Between 1 and 14 nesters were reported per annum in Alas Purwo National Park (East Java) and 1 to 3 leatherback females per annum in Bali (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008).

Northern Australia:

Very low-density nesting has been reported for decades (ca. <10 females) along a few sites in the Northern Territories of Australia (Limpus 2009) with no obvious changes reported in recent years.

Timor Leste:

No new reports received of either nesting or sightings (as per Hamman et al 2006).

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.

Malaysia:

All sea turtles in Malaysia have been in decline, with the leatherbacks of Terengganu probably showing the most dramatic decline (from 10 000 in the 1950s to less than a dozen per annum at the turn of the 21st century; Chan 2006). Monitoring projects are on-going, but very few nests are reported (2 – 3 nests per year). The eggs are moved to a government hatchery but no successful hatching has been reported in recent years (Nick Pilcher, Marine Research Foundation, pers comm). Malaysia has done much to protect turtles at sea and on nesting beaches, with nests being moved to hatcheries, but there is no sign of recovery yet. There are reports of nesting in northern Sulawesi without any confirmation or indication of size (Anonymous 2010).

Viet Nam:

Hamann et al (2006) reported that about 500 females nested throughout the six provinces of Viet Nam, but declined during the 1970s and 1980's to less than 10 nests per annum. However, this is likely to be an underestimate since area of potential nesting beaches encompasses over 500 km (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). In the six mentioned provinces, much of the coastline was undeveloped and had not been surveyed until 2007. However, in recent years aquaculture operations for fish production have proliferated along the coast, and the resulting disturbance is likely to have made these areas much less attractive for leatherback nesting (Earl Possardt, USFWS pers comm.) No new information is available to provide an indication of current nesting numbers. All marine turtles are protected by a national decree since 2002, but nests and nesting females are subject to local harvest with the exception of a short 14-km stretch of beach in Quang Tri Province where a community-based conservation project began in 2007 (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008).

Only one beach in Trieu Lang commune (Quang Tri province) has showed signs of nesting leatherbacks (in 2005 and 2007) but no clutches have been recorded since then (Bui Thi Thu Hien, IUCN Vietnam, pers comm).

Outside Japan

No information available; but Japan is expected to be relatively unimportant for nesting leatherback turtles.

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.

Dutton et al (2007) reviewed the genetic and population structure of leatherbacks in the Western Pacific and, although the data are still incomplete, reported 28 nesting sites of which 21 were previously unknown or poorly described nesting sites. The collective number of nests per year among the 28 sites (Figure 2 & Table 1) was estimated at ~5000-9200 nests, with four sites in northwest Papua hosting 75% of the nests (Dutton et al, 2007). This paper also indicated a single genetic stock amongst these Western Pacific rookeries. Follow-up work is in progress (by Ricardo Tapilatu and colleagues from UNIPA, with help from Dutton et al. from NOAA, but progress on this currently unavailable; Nick Pilcher, Marine Research Foundation pers comm).

Indonesia (northwest Papua):

Hitipeuw et al. (2007) reported northwest Papua as the last remaining substantial nesting population in the Pacific Ocean. The data collected from 2001/2 – 2004 indicated that Jamursba Medi received from 1865 to 3601 nests per season; and Wermon 1788 to 2881 nests per season (Hitipeuw et al 2007). More recent work (by Tapilatu et al *in review*) estimated that the annual number of nests at Jamursba Medi has declined by 80.6% over the past 27 years, from 14,522 in 1984 to 1,532 in 2011. Nesting at Wermon has only been monitored since 2003, but appears to show a similar rate of decline to Jamursba Medi, decreasing 38.5% from 2,994 nests in 2003 to 1,292 in 2011. Even though these seem to be the largest of the West Pacific rookeries, Hitipeuw et al (2007) recommended establishing a protected area as a matter of urgency before this rookery (Jamursba Medi) is also depleted.

Papua New Guinea (PNG):

The estimates from beach counts between 1999 and 2004 indicated a small proportion of leatherback turtles nesting on the east coast of PNG, with most occurring along the Huon coast (Benson et al 2007a). An aerial survey along Huon Gulf beaches in 2004 indicated the number of nests to be in the order of 500 – 700 nests per annum. These numbers also suggest long-term decline, as previous records indicated larger population numbers. Pilcher (2012) provided nesting data from seven sites along the Huon coast between 2000 and 2012. Bearing in mind data and monitoring constraints, it seems as

though the population is stable with an overall number of nests reported between 250 and 500 per annum.

Solomon Islands and Vanuatu:

The Solomon Islands (along with PNG) may host the last key rookeries of leatherback turtles in the area (see Figure 1 & Appendix 2). The nesting experienced in Vanuatu may be scattered nesting events from a larger population hosted by PNG and Solomon Islands (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). Petro et al (2007) documented from archival data and interviews that leatherback nesting occurs throughout many Vanuatu islands, with an annual number of nesters ranging from 1 to 13 individual females. This is the estimate of the number of nesting individuals frequenting the most important nesting site in Vanuatu: Volta beach, Epi Island (Petro et al 2007). No long-term quantitative data are available to assess trends, but the combined rookery size seems to be less than 100 nesting females per annum, However there is low confidence in these estimates. Follow up surveys are suggested (Petro et al 2007).

Eastern Australia:

Leatherback nesting along the eastern Australian coast has always been sporadic but declining since the mid-1980s with the last recorded nesting along the Queensland coast in 1996 at Harvey Bay (Limpus 2009).

B. Non-Breeding Areas (Foraging Grounds and Migratory Corridors)

A. Spatial Mapping/Identification

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 in most cases there have been few efforts made to collect fisheries-based bycatch information.

Western Indian Ocean:

Satellite tagging of leatherback turtles in South Africa has continued since 2006 with each season's data showing an expansion of the range used by leatherback turtles. The foraging area away from the nesting ground has now been mapped from central Angola, along the African west coast, to the Mascarene plateau of the central Indian Ocean (De Wet, unpublished data). It is evident that leatherback turtles frequent sea mounts and plateaus of the Western Indian Ocean (WIO) and East Atlantic. In general, the Mozambique Channel and the east coast of South Africa are used as interesting habitat. The Agulhas current acts as a distributor of adult females and it is suspected to do so also for hatchlings.

An aerial survey of marine megafauna in the WIO by Van Canney et al (2010) indicated an apparent foraging "hotspot" for leatherbacks off western Madagascar. No size class nor origin of the individuals is known.

North-east and East Indian Ocean:

Satellite tagging of seven post-nesting females has provided some indication of feeding habitats of this population (see next section for details), however the tracks were scattered with no clear migration path or foraging ground indicated. No bycatch information has been reported.

South China Sea area:

No specific information is available. See review by Benson et al (2011) under the satellite tracking section for the West Pacific.

West Pacific:

Benson et al (2007a&b) reported on post-nesting migrations of leatherback turtles from Jamursba-Medi (Papua, Indonesia) and Huon Gulf (Papua New Guinea). Females departing from PNG moved south towards higher latitudes in the direction of New Caledonia, Vanuatu and New Zealand (Benson et al 2007a); whereas the females from Jamursba-Medi, Indonesia, swam across the north Pacific towards the United States' west coast (Benson et al 2007b). Three of these individuals also moved towards the South China Sea and the Sea of Japan (Benson et al 2007b). The separation in foraging area is dependent on turtles being summer or winter nesters (Benson et al 2011). The winter nesters around PNG, Solomon Islands, and southern Papua migrate towards the East Australia Current, Tasmania and the Tasman Front whereas summer nesters move north towards the South China Sea, Equatorial Eastern Pacific, and central California (Benson et al 2011). Benson et al (2007c; 2011) continued to document the foraging habitat use along the US west coast. This combined study is one of the best to date published on leatherback turtles.

B. Satellite Telemetry

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 several cases 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 peninsula Malaysia there is little known about the "at sea" components of leatherback turtle life history in the IOSEA region.

Western Indian Ocean:

A total of 32 satellite tags have been deployed to date on leatherback turtles in South Africa to map both inter-nesting and post-nesting habitats. Whereas leatherback nesting beaches in South Africa are confined to the iSimangaliso Wetland Park, a UNESCO world heritage site, inter-nesting excursions are made mostly outside of the park boundaries, stretching into Mozambique and the edge of the South African EEZ (Vogt 2011). Studies of these post-nesting migrations have indicated that leatherbacks frequent the waters of six nations (Angola, Namibia, South Africa, Mozambique, Madagascar and Mauritius), as well as the high seas once they leave the nesting area.

North-east and East Indian Ocean:

PTTs were installed on seven leatherback turtles that nested on the West Bay beach, Little Andaman Island during the month of January for two continuous years (2011 and

2012). The data indicate that all of the turtles headed off in a southward direction. One of the transmitters lasted for less than a day. The turtles with PTT nos. 103334 and 113332 travelled in a south-westerly direction: 103334 was last recorded about 600 kilometres south-west of Sri Lanka while 113332 was last recorded less than 1000 km north-east of the Madagascar. Turtles with PTT numbers 103333, 103335, 113333 and 103402 all travelled predominantly in a southerly direction. 103335 travelled about 2800 kilometres and was last recorded close to the island of Cocos Keeling. The turtle with PTT no. 103333 was last recorded a few kilometres off the coast of Timor-Leste.

South China Sea area:

Benson et al (2011) reviewed the results of the satellite tag deployments on 126 transmitters applied to leatherbacks from the Western Pacific region; to date one of the best studies on turtle telemetry. Of these 126 deployments, a large proportion of the animals came into the South China Sea to forage. This study indicated separation of foraging habitat based on nesting season and location.

An aerial survey conducted during 2010 assessed the number of leatherbacks the Sulu-Sulawesi region as foraging habitat. During 86 hours of aerial survey flight time, 19 leatherbacks were encountered (Anonymous 2010). No trends can be identified from this once-off survey, nor the home rookeries of these individuals. However this survey does confirm that the Sulu and South China Sea areas are substantial foraging grounds for leatherback turtles (Anonymous 2010).

West Pacific:

Benson et al (2011) reviewed the results of the satellite tag deployments on 126 transmitters applied to leatherbacks from the Western Pacific region. Winter nesting females moved southward to waters off of Australia and New Zealand. This study indicated the separation of foraging habitat based on nesting season and location (Figure 3).

4. 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 to 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 origin (by breeding area) of leatherback turtles being captured throughout their dispersed foraging and migratory distribution of the IOSEA region.

Western Indian Ocean:

Sex ratios and kinship analysis of leatherback turtles is underway. Samples have been collected from South Africa for three seasons (2009/10 – 2011/12) from adult females and hatchlings from > 60 nests. However, preliminary results are not yet available.

North-east and East Indian Ocean:

Skin samples from more than 30 female leatherbacks from Little Andaman Island have been collected for population genetics studies which are currently underway. No results are available yet (Kartik Shanker, Indian Institute of Science, pers comm). Tissue samples are reported to have been collected from specimens in Thailand, however no information is available on any genetic analyses that may have been conducted (Douglas Hykle, pers comm.).

South China Sea area:

No information available.

West Pacific:

Dutton et al (2007) reported on genetic analyses of skin samples taken from nesting females or dead hatchlings from various sites in Papua and compared to samples taken from Solomon Islands and PNG (from the West Pacific Region). A total of 6 haplotypes were identified from the 106 samples of which all the haplotypes were previously sampled from Dutton et al (1999) – the global leatherback assessment. The genetics failed to indicate population differentiation among nesting sites within this region, and the population was concluded to be of a single West Pacific genetic stock. This was either due to a lack of analytical power or ongoing gene flow. Follow-up work was recommended (Dutton et al 2007).

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
- Inter-nesting areas

Of the 10 nations with current leatherback turtle nesting, five have included some of the leatherback turtle rookeries within protected areas.

Western Indian Ocean:

One PhD student (Tucek) is currently revisiting the nesting attributes of the South African leatherback population as described by Hughes (1974). The intended date of completion should be at the end of 2012. This study is also investigating the sex ratios (using histology) and nest temperatures of both loggerhead and leatherback rookeries, as well as aging of loggerhead and leatherbacks at sexual maturity. Tucek et al (accepted, Endangered Species Research) has indicated age at maturity for South African loggerheads to be around 22 years. No information is yet available for leatherbacks.

North-east and East Indian Ocean:

No information available.

South China Sea area:

No information available.

West Pacific:

A number of papers recently published (or in preparation) are reviewing the status of various rookeries throughout the region, however no specifics are currently available. None of them are based on long-term data. (See Benson et al 2007a).

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 the Papua region.

Western Indian Ocean:

Satellite tagging has been done for 32 leatherbacks in South Africa. Inter-nesting areas (Vogt 2011) as well as broad foraging areas have been identified. Work done post-2002 has not yet been published as these investigations are still ongoing, with an additional 20 tags to be deployed in 2012/13. No satellite tags are known to have been deployed on leatherbacks in the WIO outside of South Africa.

North-east and East Indian Ocean:

Seven satellite tags have been deployed on post-nesting females off the Andaman Islands but transmission times were limited for many of the animals. The final destinations reached ranged from close to Madagascar in the Western Indian Ocean to the Timor Sea off of Timor Leste (see also satellite tracking section, above). It is difficult to identify particular foraging areas based on the results of these limited deployments.

South China Sea area:

No specific information available. See Benson et al (2011) for details. Anonymous (2010) encountered 19 leatherbacks in the Sulu-Sulawesi region through aerial surveys. Even though individuals are encountered it is not clear as to the spatial and temporal distribution of animals in this region.

West Pacific:

Despite the recent investigations, particularly satellite tagging studies, little information on non-nesting beach aspects is available for this region. Benson et al (2011) gives the best description of leatherback habitat use for the region obtained from 126 satellite transmitters. No in-water studies, age or growth information is available.

5. 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 economic aspects of marine turtle bycatch. Bycatch and fisheries based mortality needs to be addressed by Fisheries and/or Government organizations. This will take a coordinated international effort similar to those undertaken in the Atlantic and Pacific Ocean fisheries.

In April 2012, the Indian Ocean Tuna Commission (IOTC) adopted an updated resolution (12/04) on the conservation of marine turtles, which supersedes an earlier recommendation (05/08) and resolution (09/06) on the same topic. The new resolution draws attention to the IOTC Scientific Committee's concern "that the lack of data from Contracting Parties and cooperating non-contracting Parties (CPCs) on the interactions and mortality of marine turtles from fisheries under the mandate of the IOTC undermines the ability to estimate levels of turtle bycatch and consequently IOTC's capacity to respond and manage adverse effects of fishing on marine turtles".

The new resolution clarifies that it applies to all fishing vessels on the IOTC Record of Fishing Vessels, and reinforces the need for CPCs to report annually to the IOTC Secretariat all

interactions and mortalities of marine turtles in fisheries under the IOTC mandate. Resolution 12/04 also addresses a number of relatively minor shortcomings in its predecessor and recognises progress that the IOTC Secretariat has made in the last two years to develop Marine Turtle Identification Cards (in cooperation with IOSEA and other collaborators), including handling guidelines for fishermen. Among other things, the resolution now calls for the development of improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials; and its provisions on safe handling of accidentally captured marine turtles now apply to all species, not only hard shelled turtles. Leatherback turtles were excluded from previous consideration, apparently because of concerns raised by Japan about the practicality of fishermen bringing on board large animals.

Western Indian Ocean:

South Africa has conducted a number of studies reviewing fisheries impacts in longline fisheries (Petersen et al 2009, De Wet, unpublished data), Thornson et al 2012), and in bather protection nets (Brazier et al 2012). All studies on longlining indicated disproportionately high catches of leatherbacks relative to their abundance and it is still the most significant threat to leatherbacks. The second largest threat to turtles (both loggerheads and leatherbacks) appears to be bather protection nets. Despite these threats, both loggerhead and leatherback populations are stable (Brazier, et al 2012). No information was available for Mozambique, other than the indication that harvesting is an ongoing threat at sea and on beaches (Videira et al 2011).

North-east and East Indian Ocean:

A few new MPAs have been declared in the sub-region with the most substantial one being the Chagos Archipelago MPA (Koldeway et al 2010). This does not include nesting habitat but does include foraging areas for a number of turtle species including leatherbacks. Despite the absence of bycatch information, the MPA should provide protection to turtles.

South China Sea area:

A rapid bycatch assessment was conducted in 2007 in Sabah to identify bycatch rates and hotspots, during which leatherbacks were identified as a bycatch species (Pilcher et al 2009). Since 2007, TED trials have also been ongoing in Sabah as part of a separate project to mitigate primarily green sea turtle interactions in shrimp trawl fleets. These trials were extended to the east coast of Peninsular Malaysia in 2011. No leatherbacks have been entrained in these shrimp fisheries to date (Nick Pilcher, Marine Research Foundation, pers comm).

West Pacific:

Donoso and Dutton (2010) reported on bycatch in Chilean fisheries, based on data collected from 2001 to 2005). Leatherbacks were most frequently caught at a rate of 0.0268 / 1000 hooks. However, it is uncertain if these are leatherbacks that nest in exclusively in the eastern Pacific (Shillinger et al 2008), rather than those that migrate from the western Pacific based on satellite tracks.

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. Every effort must be made not to repeat what has happened at Rantau Abang.

Western Indian Ocean:

The nesting beaches of South Africa are still very well protected, with egg take being incidental (<1 nest per annum). Mozambique is assumed to have more incidents, with ~10 incidents recorded per annum (Videira et al 2011). However, as monitoring and conservation protection has expanded, with consistent monitoring occurring across 11 leatherback rookeries since the 2007/8 season, egg take is assumed to be on the decline. Egg take in Madagascar is unknown but the number of nests is small so the effect of any egg take relative to the nesting population could be significant.

North-east and East Indian Ocean:

While green, ridley and hawksbill turtles are known to be harvested/poached for consumption in the Andaman and Nicobar Islands, there is little or no evidence to suggest that adult leatherbacks or hatchlings are harvested for their meat. Leatherback eggs are taken and stuffed hatchlings used to be sold (Rajagopalan 1984). The current extent of these practices is uncertain. The small rookeries in East Java and Bali seem to be well protected, but occasionally eggs do end up in local markets (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). Next to poaching, monitor lizards seems to be the biggest problem in those rookeries.

South China Sea area:

Malaysia has indicated that historical egg take, in association with coastal pressures and incidental captures, has been a large problem, sufficient to collapse the nesting at Terranganu. Nesting/hatching has been reduced and is now incidental. Many of the clutches are relocated to hatcheries, with incubation occurring almost exclusively in hatcheries over the last 6 years. However, the overall hatching success is very low to zero (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008).

West Pacific:

Egg harvesting, along with destruction of nests by dogs, is recognised to be a problem in the rookeries along the PNG coast outside of protected areas. As many as 80% of the unprotected nests are destroyed (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). Leatherback harvesting and egg take has not yet been quantified in PNG, but there is evidence that it is taking place, especially outside of the monitoring programmes along the Huon coast.

Hatchling production

a. Hatcheries

Aside from data collected from the hatchery programme in Malaysia and South Africa, 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 one nation (plus some of the commercial hatcheries in Sri Lanka occasionally incubate leatherback turtle eggs).

Western Indian Ocean:

N/A

North-east and East Indian Ocean:

Brodie et al (2008) refer to hatcheries in southern Sri Lanka (including 9 government-operated hatcheries that occasionally incubate leatherback eggs). The outcome and hatching success is unknown.

South China Sea area:

Malaysia indicated that historical take has been a large problem (especially in Terengganu), with much of the incubation of sea turtles now relocated to hatcheries. In general the hatching success had been acceptable 40 – 50% but with a possible female bias (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008) due to very warm incubation temperatures in polystyrene boxes. In the last 6 years, incubation temperatures have been dropped but hatching success also declined to almost zero.

West Pacific:

Low hatchling production – due to erosion, inundation, egg poaching and dogs – has been identified as a problem in the rookeries of PNG (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). Hatcheries or egg relocation programmes have been suggested as alternative conservation strategies, and bamboo grids are currently used to lower predation risk. An experimental study to evaluate hatchling production and factors impacting hatchling production in Jamursba-Medi and Wermon in Papua, Indonesia, has been underway since 2005. The results are to be presented in Ricardo Tapilatu's dissertation. (Outcomes are currently unknown.)

b. Beach temperatures

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.

Western Indian Ocean:

Sex ratio and incubation temperature experiments are underway (in a PhD study by Jenny Tucek) which should be completed at the end of 2012. Current indications are that both leatherback and loggerhead hatching sex ratios are female biased (Tucek,

unpublished data). No information is available for Mozambique or Madagascar, but as both of these areas are expected to have higher sand temperatures, they are likely to produce mostly females.

North-east and East Indian Ocean:

Nest temperatures are being monitored since 2008-09 (Kartik Shanker, Indian Institute of Science, pers comm). No results are currently available.

South China Sea area:

In situ nest production in Malaysia has diminished, with most hatching now taking place in hatcheries. It is easier to control temperature, but the recent lowering of temperatures with the aim of adjusting sex ratios has been accompanied by a decline in hatching success (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). The reasons are unknown, and urgent research into the problem is necessary.

West Pacific:

Sex ratio work is underway in Jamursba-Medi and Wermon in Papua, Indonesia, the results will be part of Ricardo Tapilatu's dissertation. Some discussion of sand temperatures is available in Tapilatu and Tiwari (2007). Key results indicate that nest temperatures differ between these two areas, due to sand colour and monsoon rains; but no detailed sex ratio data are available yet. The overall hatching success at both these sites was low (<50%) Tapilatu and Tiwari (2007). Steckenreuter et al (2010) reported male-biased sex ratios for hatchling production from the Huon Coast (PNG).

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.

Western Indian Ocean:

South Africa will enter its 50th year of standardised, quantitative monitoring in the 2012/13 season. Recent modifications include double flipper tagging (since 2004), supplemented by limited PIT and relatively frequent satellite tagging. Mozambique has added 11 additional rookeries to the previous site (Ponto Du Oura to Melongane) which has been monitored since 1996.

North-east and East Indian Ocean:

The monitoring programme at Little Andaman Island, Andaman and Nicobar Islands, India, has been consistently followed for the past four years at both the sites. The turtles are also being double tagged. Recently a long-term habitat-monitoring programme has been initiated at both sites with the aim of understanding changes in beach profiles and habitat quality.

South China Sea area:

No information available.

West Pacific:

Frequent monitoring is continuing at key sites in Papua (Jamursba-Medi, Wermont), Indonesia, PNG (Huon coast) and Solomon Islands. However most of these sites lack sufficient funding to ensure sustained quantitative monitoring. Vanuatu has more than 200 volunteer turtle monitors across most of the islands supported by a single manager. The monitoring is therefore irregular and likely to be unsystematic (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008).

6. 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, economic 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, economic, cultural or ecological) that may occur as a result of management.

Western Indian Ocean:

Direct harvesting of sea turtles still takes place throughout the Western Indian Ocean, with a combined mortality estimate of all species reaching > 12 000 turtles per year, mostly from the subsistence fisheries in Madagascar (De Wet unpublished data; Humber et al 2010). These catches are dominated by green turtles and loggerheads, with leatherback turtles being a very small contribution. Other contributions to turtle mortality include pelagic longlining, which catches loggerheads and a disproportionately large number of leatherbacks (Petersen et al 2009; De Wet unpublished data), bather protection nets catching loggerhead and green turtles (Brazier et al 2012) and trawling (De Wet unpublished data). At least 59 (unidentified) turtles were killed off the beaches of Mozambique in 2010/11, with seven nests having been raided (Videira et al 2011).

North-east and East Indian Ocean:

Harvesting of turtles and turtle eggs has a long history in this region with very heavy levels of take. All local species of turtle have been harvested, representing somewhere between 3000 and 4000 turtles in Tamil Nadu alone (Rajagopalan 1984), where leatherback eggs were reported to be a delicacy. These practices seem to have been less intense on the Nicobar-Andaman islands, although the people of Andaman did eat turtles, excluding leatherbacks; as did the people of Nicobar (even less so). However, on occasion they would use turtle meat as bait to catch sharks (Rajagopalan 1984). Even then, it was recognised that these practices were unsustainable, and restrictions were implemented. However, the current extent of meat and egg harvesting is not well documented. It is suspected to have declined with the decline in turtle numbers. Wallace et al (2011) highlighted the turtle rookeries of olive ridleys, loggerheads and hawksbills of the Bay of Bengal to be amongst the highest global conservation priority for turtles. Leatherbacks in the Bay of Bengal were also rated as being at high risk, and under great threat (Wallace et al 2011).

South China Sea area:

There are no reported direct takes of leatherback turtles in the South China Sea, and those caught in Viet Nam are apparently released. Malaysians and Filipinos do not consume turtles, although egg consumption is evidently acceptable to Malaysians (Nick Pilcher pers com).

West Pacific:

Suarez and Starbird (1995) reported an extensive subsistence leatherback fishery off the Kei Islands, Indonesia. This fishery seems to have been in place and part of the local culture for centuries. Approximately 200 animals were harpooned in just three months of 1994, with as many as 13 taken in one day. It was realised that the fishery was not sustainable and that alternatives must be found. Local consumption of females has reduced the number of individuals in the Solomon Islands, as well as in some provinces of PNG, but female leatherbacks are considered sacred at most of the important rookeries of Papua (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008). Egg harvesting has been more pronounced (Hitipeuw et al 2007).

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.

Western Indian Ocean:

Predation has recently been assessed on the nesting, egg and hatching component of the South African loggerhead and leatherback rookery. The overall conclusion is that natural and human-induced mortality is very low (De Wet, unpublished data). The largest known predation impact on eggs and loggerhead hatchling was from dogs and ants, with honey badgers being the major predator of leatherback nests. Both of these sources contributed to <8% mortality of the nests. No information is available for rookeries outside of South Africa.

North-east and East Indian Ocean:

Leatherback nests of the Little Andaman Islands are being heavily predated upon by water monitor lizards and wild pigs. More than 80% of the nests in these sites were found to be predated upon.

Leatherback nests of the Galathea Bay nesting beach, Great Nicobar Island were found to be heavily predated upon by feral pigs.

South China Sea area:

There are no significant reports of predation on leatherback nests largely, due to very low nesting numbers and significant protection in Malaysian hatcheries, combined with undocumented frequency of nesting/hatching in Viet Nam and no reported nesting in Philippines. Levels of predation are undocumented in Viet Nam (Steering Committee, Bellagio Sea Turtle Conservation Initiative, 2008).

West Pacific:

Extensive predation of nests/eggs by pigs, dogs, and lizards occurs on the beaches of Papua (Tapilatu and Tiwari 2007). Combined with collection of eggs by local people, beach erosion and inundation, hatchling production is severely compromised.

Leatherback turtle nesting in South Africa (and Mozambique)

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 nesting population has occurred. Therefore, close attention should be paid to the assessment of current and future nesting leatherback turtle data so that management and remedial actions can be quickly taken if needed

Modelling of population numbers has been completed, revealing a stable (marginally increasing) population, with better protection in Mozambique making a positive contribution.

A workshop held in November 2011 highlighted leatherback monitoring issues. The South African government has consulted on a draft turtle policy as part of a wider Ocean Policy, and has expressed interest in expanding the turtle monitoring in South Africa, including hatchery-related research. Current trend analysis describes the leatherback population as small but stable. However, the reasons for the absence of recovery is not clear since hatching success is high (>70%, Tucek, Unpublished data), and offshore threats relatively well controled. Research continues in order to elucidate the apparent "lack of recovery".

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.

Data collection in relation to nesting distribution has not improved significantly since 2006. However, a large number of satellite tagging studies are underway in all regions, which provide some idea of inter-nesting, or post-nesting distributions. Further, two aerial surveys (one in the Sulu-Sulawesi Sea, and one in the Mozambique Channel) has highlighted suspected foraging areas (rather than nesting areas) for leatherback turtles.

Lack of bycatch reporting

High seas (RFMOs) do call for data collection but countries reluctant to collect or report data.

As mentioned above, the Indian Ocean Tuna Commission has adopted a comprehensive resolution (12/04) that focuses specifically on mitigation of fisheries-turtle interactions. However, a September 2012 meeting of the IOTC Working Party on Ecosystems and Bycatch (WPEB) highlighted the paucity of bycatch data in the IOTC area of competence.

IOTC and IOSEA are presently collaborating through a consultancy that aims to collate all available turtle bycatch data in the IOTC region, and assess the populations vulnerable to turtle fisheries. The initial results of this study should be available towards the end of 2012.

7. Recommendations for conservation/research projects arising from the 2006 Leatherback Assessment and 2012 Update

The original leatherback assessment and the present update include many recommendations of additional work that needs to be conducted in order to address identified gaps and support ongoing leatherback conservation efforts. Taking advantage of the presence of interested experts attending the Sixth Meeting of IOSEA Signatory States, held in Bangkok in January 2012, the following list of potential small-scale interventions/tasks/projects was drawn up. While IOSEA is unlikely to be in a position to mobilise financial support for all of them, it is hoped that resources can be found for several projects to be initiated over the next 1-2 years.

The following project concepts, covering the entire IOSEA region, warrant further elaboration and detailed costing before they can be considered for possible funding. In particular, the methodology and expected outputs need to be defined more clearly. The list of project concepts should not be considered exclusive. Further project proposals developed with reference to the gaps/recommendations identified in 2006, contained in Appendix 1, may be considered.

Provisional list of project concepts

Western Indian Ocean: Provide partial support or help to leverage funding for a post-graduate study to investigate the hatching success and incubation temperature of leatherback rookeries in Mozambique. This research should be done in conjunction with sub-regional experts (Dr Ronel Nel/South Africa).

Northern Indian Ocean: Devise a low-cost monitoring protocol, identify and monitor index sites consistently for a period of 3-5 years in Sri Lankan leatherback rookeries, and collect genetic samples as a contribution to a region-wide assessment. Possible collaborators: local conservation bodies (e.g. Turtle Conservation Project (TCP) – Sri Lanka) and interested experts (e.g. MCS/Dr Peter Richardson).

Habitat Rehabilitation: Assess the extent of use of exotic vegetation to stabilize beach/dune systems and the impacts thereof through a questionnaire survey throughout the IOSEA region. If appropriate (based on the survey results), develop a short paper that outlines the problems associated with using for example *Cassuarina* trees in beach/dune stabilization and provide recommendations and guidelines as to the sensible removal of these trees from beach dune/ecosystems. Commission an expert desktop study to conduct the survey and develop the paper.

Thailand & Malaysia (+ other programmes): Review egg relocation and hatchery practices and, where appropriate, suggest and implement management interventions to enhance hatching success and produce balanced sex ratios. Short-term expert consultancy.

Indonesia (Java/Sumatra): Engage with local environmental agencies and NGOs (e.g. through a workshop) to document the extent of leatherback nesting, particularly in Java/Sumatra and disseminate education and awareness materials, to stimulate future data collection and the establishment of turtle monitoring programmes, where relevant.

Papua New Guinea: Aerial surveys have identified Buang-Buasi and Kamiali as important nesting sites. It has been suggested to establish long-term monitoring to determine nesting abundance trends in PNG (Dutton et al 2007). *IOSEA to engage with experts working in the region to identify opportunities for support (e.g technical training, data management systems, education and awareness) to enable local communities to establish inexpensive monitoring programmes.*

Additional Suggestions:
The Steering Committee (Bellagio Sea Turtle Conservation Initiative, 2008) highlighted erosion as an expanding issue, along with predation at some to key island rookeries. Targeted support for technical training for egg relocation of "eggs/nests at risk" may assist in enhancing hatching success.

An Action Plan has apparently been developed through a Memorandum of Understanding (MOU) among Indonesia, Solomon Islands, and Papua New Guinea to support field conservation efforts and establish effective institutional and funding mechanisms to implement management activities in a sustainable manner. Implementation of this plan should be a priority.

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Figure 1

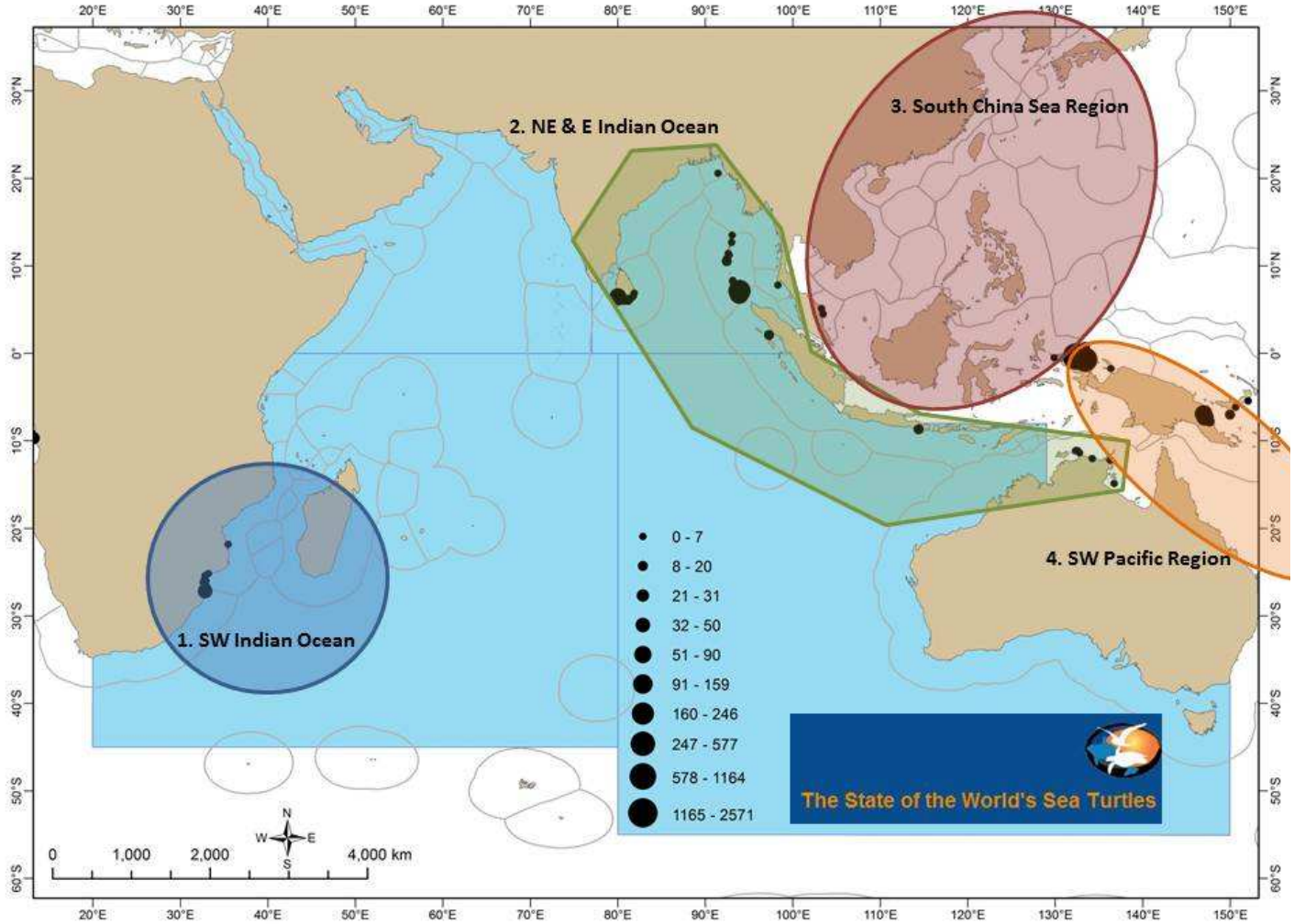

Figure 1. Locations of leatherback rookeries and the four areas as discussed in the report following Hamann et al 2006. (These areas are not reflecting genetic or regional management units).

Figure 2

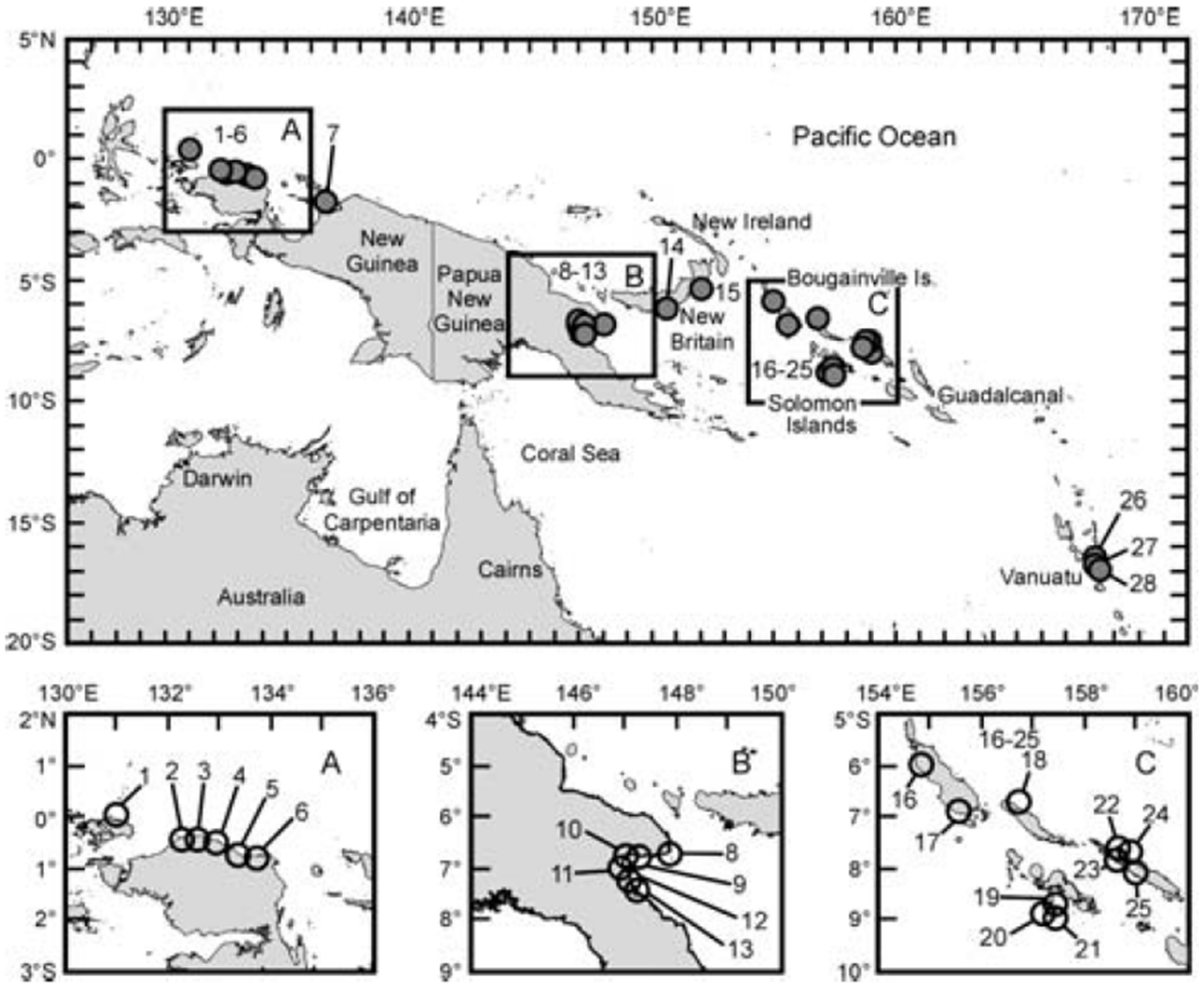

Figure2. Locations of significant (.20 nests/season) nesting sites for leatherbacks identified in the western Pacific. Names of the nesting sites are given by the corresponding numbers of the locations listed in Table 1 (From Dutton et al (2007).

Figure 3

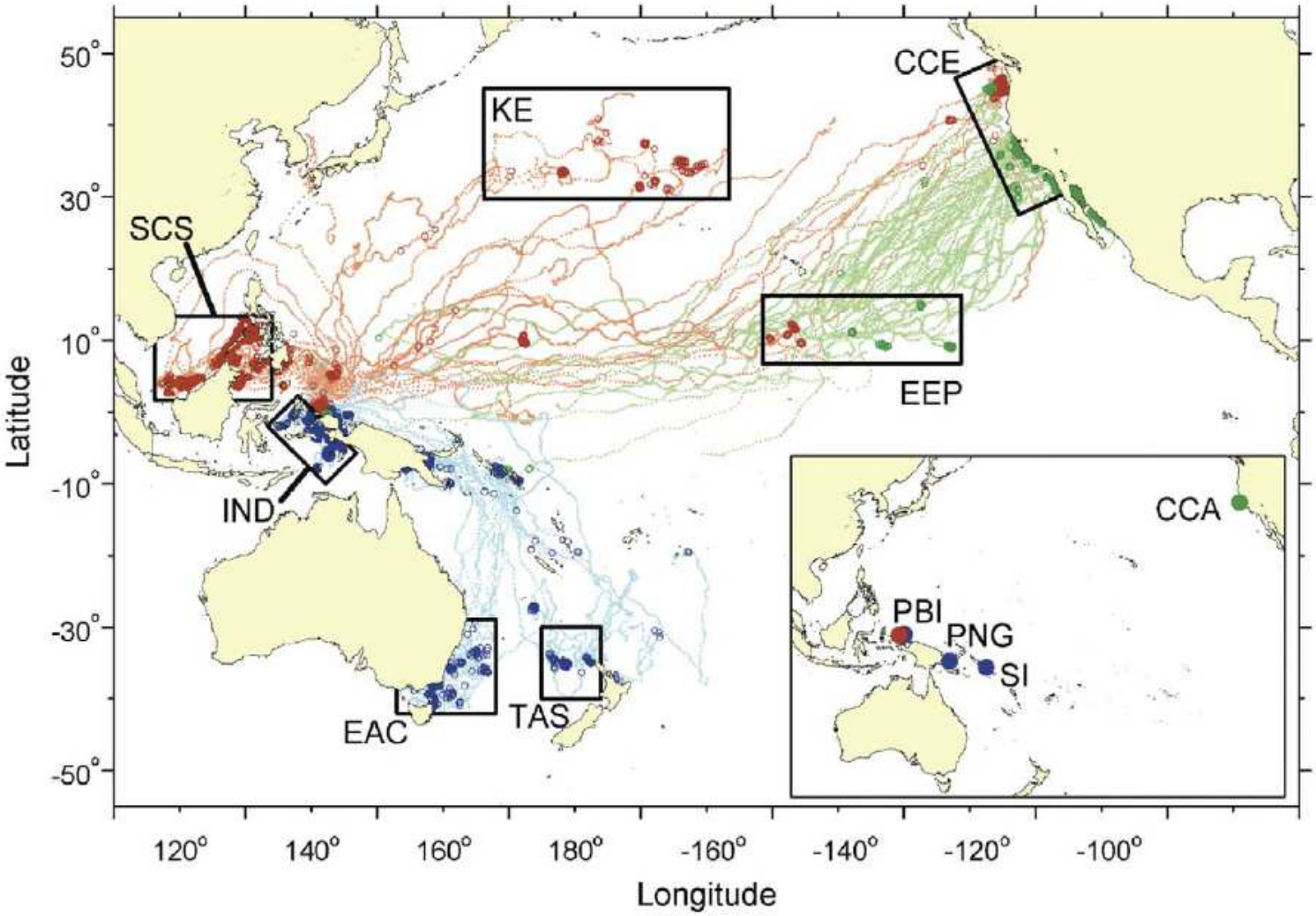

Figure 3. "All 126 deployments presented as probability of transit. Large, darker circles indicate Area Restricted Search (ARS) behaviour; small, lighter dots indicate transiting behaviour. Colour of track indicates deployment season: red=summer nesters, blue=winter nesters, green=deployments at central California foraging grounds. Inset shows deployment locations; PBI = Papua Barat, Indonesia, PNG = Papua New Guinea, SI = Solomon Islands, CCA = central California. Black boxes represent ecoregions for which habitat associations were quantitatively examined (see text): SCS = South China, Sulu and Sulawesi Seas, IND = Indonesian Seas, EAC = East Australia Current Extension, TAS = Tasman Front, KE = Kuroshio Extension, EEP = equatorial eastern Pacific, and CCE = California Current Ecosystem" (From Benson et al 2011).

Table 1

Table from Dutton et al (2007). Site numbers relate to beaches in Figure 1.

PAPUA		**Number of Dc Nests**
1	Raja Ampat	
2	Jamursba-Medi	1865–3601
3	Wermon	1508–2760
4	Mubrani-Kaironi	20–25
5–6	Sidey-Wibain	20–25
7	Yapen Isl	
PAPUA NEW GUINEA		
Huon Gulf		500–1150
8	Finschhafen	
9	Bukaua	
10	Labu-Tale	
11	Buang Buassi	
12	Kamiali	
13	Paiawa	
New Britain		140–260
14	Fulleborn	
15	Korapun	
Bougainville		160–415
16	Empress	
17	Tokuaka	
SOLOMON ISLANDS		
Choisel		50
18	Vachu River	
Western Province		123
19	Baniata	
20	Havila	
21	Quero	
Isabel		640–717
22	Rakata	
23	Sasakolo	
24	Lilika	
25	Katova	
VANUATU		31–50
26	Malakula	
27	Votlo	
28	Southern	
TOTAL		**5067–9176**

Appendix 1: Leatherback turtle synthesis (extracted from Hamann et al, 2006)

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 in most cases there have 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 several cases 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 “at 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 origin (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

Of the 10 nations with current leatherback turtle nesting five have included some of the leatherback turtle rookeries within protected 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 the Papua 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. This 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. Every effort must be made not to repeat what has happened at Rantau Abang.

Hatchling production

Aside from data collected from the hatchery programme in Malaysia and South Africa, 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 one nation (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 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 remedial actions can be quickly taken 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.

Recommendations for leatherback turtle conservation

These three tables of recommendations were developed through plenary and working group discussions held at the IOSEA Memorandum of Understanding's Fourth Meeting of the Signatory States (Muscat, Oman, March 2006).

Gap	Nations/agencies	Project context/aim	Expected outcomes
Regional and national fisheries based projects			
High seas and within EEZ bycatch (pelagic fisheries)	Nations of the IOSEA region and Nations (outside IOSEA) deploying foreign fishing fleets into the region. International fisheries management agencies	Work within national and regional fisheries bodies to develop programs and activities such as onboard observer programs, and bycatch assessment/quantification and mitigation projects (including gear modification and improved fishing practices to reduce bycatch). Advocate for regional and national fisheries bodies' policies to incorporate turtle bycatch assessment and mitigation strategies Investigate/ advocate for investigation of seasonal and spatial closures as a management tool for reducing bycatch.	National bycatch observer, assessment and quantification programs established. National and/or regional bycatch mitigation projects established Coordinated regional approaches to bycatch management and illegal fishing established Reduced mortality of marine turtles
Within territorial waters bycatch (coastal fisheries)	States of the IOSEA region	Determine the spatial and temporal variation in distribution and impact of fishing effort. There is a particular need for the development of gear modification and/or use to achieve reduction in turtle mortality in gill nets [c.f. achievements such as TEDs and work in progress with long line fisheries]. Assess the impact of fisheries to inter-nesting, migrating & foraging turtles Assess the impacts of ghost nets and plastics pollution	Improved understanding of bycatch "hotspots" which will aid in fisheries bycatch management. National and/or regional bycatch mitigation projects established Improved understanding of the impacts that bycatch may have on turtle at particular life history stages Reduced mortality of leatherback turtles
MPAs	States of the IOSEA region	Protection and adequate management of already identified critical habitats (nesting, inter-nesting, feeding and migratory) Identification of further critical habitats – especially inter-nesting, feeding and migratory)	MPA networks (community-based and/or formally gazetted) that provide adequate protection and management across critical leatherback habitats

Gap	Relevant nations	Project aim	Expected outcomes
Regional and national genetic based projects			
Population genetics - Leatherback turtle nesting down through the Andaman Sea, southern Indonesia to northern Australia and in Sri Lanka have not been genetically identified.	Sri Lanka, India, Indonesia, Thailand, South Africa, Papua New Guinea, Australia and Mozambique	Determine the genotype of leatherback turtles nesting in Sri Lanka, India Thailand and Indonesia [Sumatra] and compare these with published haplotypes	Understanding of the genetic structure of leatherback turtles to be used as a base for monitoring and management
Genetics of bycatch/strandings/direct take [development of an organized collection program]	Countries with leatherback turtle bycatch programs and/or direct take [Australia, Eritrea, Sri Lanka, South Africa (shark nets) & Indonesia (Kei Is.)]	Using genetic markers identified for nesting populations, determine population structure of marine turtle bycatch or stranded turtles	Stock based threat analysis to be used as a base for monitoring and management
Biological data			
Quantify key demographic parameters [reproductive output, clutches per season, remigration interval and annual survivorship]	Each nation with nesting leatherback turtles	Conduct annual saturation tagging census at an index rookery within each genetic management unit for a minimum of six consecutive breeding seasons	Improved understanding of the biological structure of leatherback turtle populations to be used as a base for monitoring and management
Incomplete mapping of the breeding distribution and census	The priority areas are Sri Lanka, southern Indonesia to north western Australia and Philippines.	Complete the mapping and develop a six year census project at index beaches.	6 year (& then ongoing) determination of size of nesting population
Limited understanding of post nesting distribution of female leatherback turtles	Sri Lanka, India, Indonesia (predominately southern)	Satellite telemetry study to define geographical scale of migration pathways	Improved understanding of the structure of leatherback turtle populations to be used as a base for monitoring and management
Limited data on hatchling production including sex ratios and health and survivorship of hatchlings	South Africa, Mozambique, India, Sri Lanka, Indonesia and Papua New Guinea and Thailand	Determine; (1) survivorship of eggs and hatchlings (inc. natural egg loss, predation and human use), (2) clutch size, (3) beach temperatures, (4) temporal and spatial patterns of nest distribution and survivorship (5) socio-economic drivers that	Improved understanding of the biological structure of leatherback turtle populations, in particular aspects related to egg and hatchling mortality to be used as a base for monitoring and management

Gap	Relevant nations	Project aim	Expected outcomes
		underlie egg take and (6) Implementing management options to maximize hatchling production	
Pervasive egg depredation over multiple rookeries.	India, Indonesia and Papua New Guinea	Develop a cost effective method of managing predators to produce enough hatchlings to sustain a population such as threat removal, deterrents or barriers.	Reduced mortality of leatherback turtle clutches from predation. The data can be used as a base for monitoring and management
Egg take a) illegal take of eggs b) excessive legal take of eggs in some rookeries c) In most cases these egg takes have not been assessed for sustainability d) In most cases a lack of community based awareness or action exist to ensure adequate hatchling production Take of turtles Lack of real incentives (such as creation of alternative livelihoods) to encourage community support for conservation to ensure adequate hatchling production. A defined need for collaborative, community based projects to maintain adequate hatchling production and reduce or eliminate the direct take of turtles. Inadequate enforcement of existing legislation/ policy	Indonesia, India, Sri Lanka, Papua New Guinea	Determine the enforcement, regulatory and socio/economic drivers that underlie legal or illegal egg or turtle take Design a targeted education approach (by Govt and/or NGO) to raise awareness about the level of hatchling production that is needed to ensure sustainable populations. Where necessary, strengthen policy, legislation and enforcement of egg and turtle protection measures Create and implement incentives (such as creation of alternative livelihoods) to encourage community support for conservation to ensure adequate hatchling production. Develop collaborative, community based projects to maintain adequate hatchling production and reduce or eliminate the direct take of turtles.	Improved understanding of the social, economical and ecological aspects related to the management of leatherback turtle populations Decreased mortality of leatherback turtle eggs, or turtles. Improved social and cultural awareness about leatherback turtle conservation and management Improved socio-economic conditions of coastal communities that participate adjacent to rookeries Decreased mortality of leatherback turtle eggs, and improved hatchling production

Gap	Relevant nations	Project aim	Expected outcomes
Hatcheries that are functioning with reduced hatch success and producing incorrectly imprinted & physically compromised hatchlings and manipulated sex ratios.	Sri Lanka and southern Indonesia	For Governments, regulatory agencies and NGO groups to develop a coordinated education and enforcement approach to change hatchery practice that results in high rates of hatching success of healthy and correctly imprinted hatchlings that are released on the night of emergence	Decreased mortality of leatherback turtle eggs, and improved production of high quality hatchlings