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TSRA's turtle & dugong project officer Moses Wailu and Mark Hamann demonstrate turtle tagging to a class of school kids from the Mer Campus of Tagai State College, Torres Strait, Australia (photo: Nancy FitzSimmons).

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Editorial: Creating Community Collaborations

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Throughout the South Pacific and South East Asian region, stories, songs and art - some of which have survived 1000s of years - are testament to the strength of both the socio-cultural connection many peoples have with marine turtles and of their cultural management protocols. In recent times there has been an expansion of western biological science into the region as more and more turtle researchers embark on turtle tagging studies. With the introduction of tools such as flipper tags and satellite tags, the ways turtles can strengthen links between communities are being highlighted to both local groups and western scientists. Satellite tracks and tag returns reveal to all the way turtles move between reefs, islands and countries (also see Limpus article this issue). And although the turtles don't know it, the simplicity and appeal of this information means turtles are creating new connections among the human communities they pass near, and strengthening old ones. Examples of connections are the travels of turtles like "*Lady Vini*", a post-nesting hawksbill turtle that was tracked via satellite by the Samoan Ministry of Natural Resources, Environment & Meteorology as she swam some 4700 km through the EEZs of seven nations in the South Pacific Ocean (www.sprep.org/turtles/topics/tracking.htm), or Adelita the loggerhead turtle that J. Nichols and colleagues tracked from Mexico across the Pacific Ocean to Japan (www.turtles.org/adelita). These tracking exercises are certainly boosting our knowledge of biology, but perhaps more importantly the turtles' travels help create and maintain a regional network of turtles, people, communities and community-based projects. One challenge for researchers or agencies using tracking or tagging information will be to collect data to assess the value of socio-cultural connections. Doing this will enhance the full potential of the technology and boost the likelihood of positive outcomes from the work (e.g. Godley et al. 2008).

Marine turtles are easy to love but difficult to manage. Their cultural importance connects them intrinsically to the Indigenous people of the region. They also have economic and ecological value to the non-indigenous population. For example, studies on tourism values on Australia's Great Barrier Reef revealed that each turtle is worth up to $1000 to dive tourists (Stoeckl & Birtles unpublished data). Turtle watching at Mon Repos, a loggerhead rookery in southern Queensland, is worth around $2 million annually to the local economy, as people flock to the seaside town to watch turtles lay eggs (Tisdell & Wilson 2005). Furthermore, there are many examples of turtles being used as symbols for exclusive resorts or flagship species for non-government organizations (e.g. Frazier 2005; Eckert & Hemphill 2005). However, because they are migratory, long lived species, exposed to multiple and compounding threats their management at ecologically and politically relevant scales can be problematic.

The large geographic area and large number of coastal communities complicate turtle management in the region. Large instruments like Marine Protected Areas (MPA) often do not cover the entire geographic scale of populations. Even the Great Barrier Reef Marine Park, one of the world's largest MPAs, does not cover the complete geographic extent of several populations of marine turtles that breed within its boundaries (Dryden et al. 2008). Similarly, international instruments (e.g. Inter-American Convention for the Protection and Conservation of Sea Turtles) can also contribute to mismatch between local and regional (Campbell et al. 2002). At the other end of the management scale there is strong interest in, and in some case a push for, coastal communities to develop, or participate in, various forms of community based or co-management programs (DEWHA 2005; Pomeroy and Rivera-Guieb 2006; Campbell et al. 2009). Most of these programs operate at a localised level compared to the full extent of turtle migration and habitat use (Campbell et al. 2009). It may be that some degree of mismatch between the scale of management and the ecological scale of the species is unavoidable. Perhaps the saying 'think global act local' has relevance in this context and the strength of localised management lies in the sum of all its parts.

Local turtle management or monitoring initiatives that are based upon clear, well-defined objectives aimed at meeting a common goal, such as those under a regional plan, will offer the best chance of success. While there is a need to acknowledge the ecological scale relevant to management of marine turtle populations (see Campbell et al. 2009), there are other scale issues that may have more influence on the success of community based or co-management, and these may be easier to address. The scale of the knowledge base (local/traditional etc compared with scientific), as well as political, governance and temporal scales all influence key factors of management, local or otherwise. The pathway to species recovery, or even to determining species status can take decades; thus long term commitment to management programs, and programs that are robust enough to survive changes in the political sphere, are likely to be a significant driver of their success. Resilience can be achieved through having mechanisms that use monitoring and evaluation tools to underpin an adaptive management framework.

One mechanism to counter the challenge of managing migratory marine species such as turtles is to create and maintain collaborative communities. That is, promote links not only between local communities or groups but also encourage links among the various stakeholder groups—from local fishers, hunters and community leaders, to researchers of various disciplines, monitoring and evaluation specialists who can help guide the adaptive framework, managers of not only species and habitats, but people skilled in project management, as well as time and risk management and Government/policy experts at a variety of levels. In the sea turtle world, initiatives such as Native Oceans, Sea Turtle Symposia, and regional participation in cross-cultural projects or exchanges are likely to be key drivers in the long-term success and adaptability of collaborative arrangements. At the regional level, networks and partnerships created by the South Pacific Regional Environment Program and IOSEA MoU initiatives (e.g. Year of the Turtle) are good examples of successful multi-nation collaboration and capacity development. It would be interesting to evaluate the value of these initiatives, especially over longer-time frames. At the national level, the Australian Governments Partnership Approach for the Sustainable Management of marine turtle and dugong advocates cultural-based management and creation of partnerships, however implementation is hindered through lack of dedicated financial support.

When I speak with the Torres Strait Islanders as we walk their beaches tagging turtles, they tell me they are concerned that the positive monitoring or management efforts of one community may be overshadowed by less effort in another area of the region, or another sector – such as fisheries. After participating in their own management process, training workshops, and for some Islanders their attendance in the 28th Annual Sea Turtle Symposium in Loreto, Baja-California in 2008, Torres Strait Islander enthusiasm for keeping their culture alive and healthy by embarking on turtle management projects is strengthened with the knowledge that they are not alone, and there are eyes and ears of other like minded groups of people throughout the region with similar goals.

In this edition of Marine Turtle Newsletter we present a selection of articles on marine turtles from the South Pacific Region. Col Limpus' paper sets the scene of turtle migration linking communities. He started tagging turtles in foraging areas of the Great Barrier Reef in the 1970s and his article shares with us some of the incredible migratory pathways he has discovered through tag recoveries and gives us a timely reminder of the value of collecting biological data outside of nesting beaches. Moreover the issue also showcases some of the community-orientated work that is currently underway in the region. Papers highlight results from community-based monitoring of biological data as well as catch rate and hunting trends and patterns of turtle use. In addition, each of the articles provides information towards answering key knowledge gaps for turtle management in the region. Although mis-match of scale is inferred (e.g. enforcement in Tonga – see Havea & Mackay this issue), each article presents data that can be used to help Government agencies or regional planning bodies such as SPREP in developing monitoring or management plans for marine turtles. Furthermore, this issue of MTN will roughly coincide with the 29th Annual Sea Turtle Symposium in Brisbane, Australia. This symposium will bring together people from 15 South Pacific nations, most of whom will be attending the symposium for the first time. Thus providing a valuable meeting and discussion place to share thoughts with, and learn from, the global participants.

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Mixed Stocks of Green Turtles Foraging on Clack Reef, Northern Great Barrier Reef Identified from Long Term Tagging Studies

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In ~April 2007, a villager from Wotje Atoll in the Marshall Islands went to nearby Erikub Atoll to hunt turtles. Erikub Atoll is one of the important green turtle, *Chelonia mydas*, rookeries within the Marshall Islands (Pritchard 1977, Puleloa & Kilma 1992) in the western Pacific Ocean – one of the more remote turtle breeding sites in the world. A tagged green turtle was captured on the beach that was originally tagged 17.7 yr earlier on 18 July 1989 and 3,880 km distant at Clack Reef (14.067°S, 144.250°E) in the northern Great Barrier Reef (GBR), Australia. It had been tagged originally as a large immature female with a curved carapace length (CCL) = 83.5cm. This presumed breeding event represents the largest displacement recorded for a turtle that has a feeding history within the Great Barrier Reef. It also is the first record of a turtle from an Australian feeding area that has crossed the equator to a breeding site in the northern hemisphere. This is also one of our long growth intervals, reinforcing our understanding of the extreme age to first breeding and long generation time that has been developed from modelling of growth data derived from green turtles foraging in the GBR. This turtle has opened our minds to consider greater migratory capacity for the species than we previously considered for green turtles from eastern Australia (Limpus *et al*. 1992). This tag recovery has prompted us to reconsider what can be learned from a structured tagging-recapture study of marine turtles. A summary of long-term results from tagging green turtles foraging at Clack Reef is presented as a case study.

Clack Reef and adjacent Corbett Reef in the northern GBR form one of several green turtle foraging sites selected for long term tagging-recapture studies of green turtles in eastern Australia in the mid 1980s. Limpus & Reed (1985), Limpus (1992, 1993) and Limpus *et al*. (1994, 2005) have described the methodologies used in this type of foraging area study. These reefs were initially assessed during a one day visit in 1987 and systematically sampled for turtles during mid-year, two week long visits in each of 1988, 1989, 1990, 1991 and 1997. A total of 1298 green turtles (876 females, 323 males, 1 with abnormal gonads [intersex], 98 sex not determined) were captured using the turtle rodeo capture method during 8 December 1987 to 24 July 1997. Each turtle was double tagged with standard titanium flipper tags. These turtles ranged in size from large adult males and females down to small immature turtles that had recently recruited to benthic foraging from the oceanic pelagic post-hatchling phase (midline CCL range = 29.8-123.0 cm). Turtle sex and maturity was determined by visual inspection of the gonads using laparoscopy. The entire population was strongly biased to females: the sex ratio of small immature turtles (CCL <65.1cm) was 1 M : 4.2 F; sex ratio of large immature turtles (CCL >65.0 cm) was 1 M : 2.2 F and the adult sex ratio was 1 M : 2.1 F. The female maturity ratio was 1 adult to 2.48 immature. The male maturity ratio was 1 adult to 1.64 immature. The large difference in sex ratio identified between small immature turtles and larger turtles could be an early signal of climate change/global warming causing a shift in sex ratio bias among small turtles towards females resulting from warming of nesting beaches (Limpus 2006, Hamann *et al*. 2007). However, other factors may be influencing the sex ratio in this foraging area, including changing proportions of recruitment from the respective

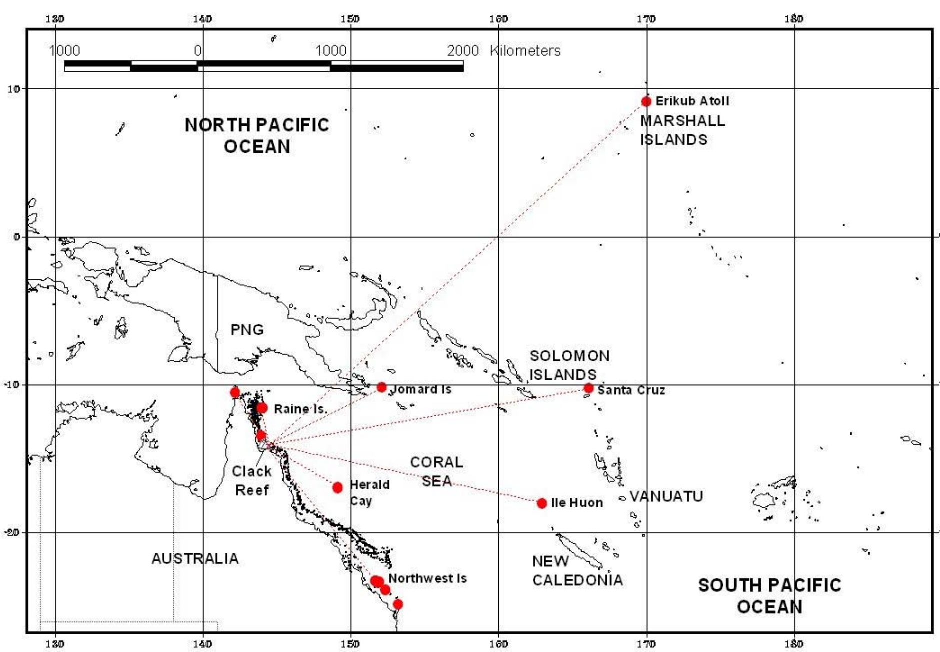

Figure 1. Distribution of breeding site captures (dots) of green turtles that have been recorded foraging on Clack Reef, northern Great Barrier Reef

Country	Genetic stock	Breeding site	Latitude, longitude	Minimum displacement (km)	Turtles recorded
Australia	nGBR	No.7 Sandbank	13.450°S, 143.983°E	85	1
		Raine Is.	11.600°S, 144.007°E	285	29
		SW Torres Strait	10.580°S, 142.220°E	457	1
	Coral Sea	Herald Cay	16.983°S, 149.133°E	615	2
	sGBR	Northwest Is.	23.300°S, 151.700°E	1,300	4
		Wreck Is.	23.330°S, 151.950°E	1,319	1
		Heron Is.	23.433°S, 151.917°E	1,328	2
		Lady Musgrave Is.	23.900°S, 152.383°E	1,395	2
New Caledonia	NewCal	Ile Huon	18.047°S, 162.959°E	2,051	1
Solomon Islands	?	Santa Cruz	10.500°S, 166.000°E	2,422	1
Papua New Guinea	?	Jomard Is.	10.216°S, 152.150°E	953	1
Marshall Islands	?	Erikub Atoll	9.133°N, 170.033°E	3,880	1

Table 1. Distribution by genetic stock of tagged adult female green turtles, *Chelonia mydas*, from the Clack Reef, northern Great Barrier Reef foraging area that were also captured at breeding sites. Genetic stocks are identified after Dithmers et al. (2006).

genetic stocks as a result of long term changes in incubation success at the rookeries (Limpus *et al.* 2003), each with a potentially different hatchling sex ratio.

In addition, with repetitive captures, site fidelity to nesting and foraging areas was identified. For example, X37735 (adult female) was tagged while nesting at Northwest Island in the southern GBR on 14 Jan 1985, CCL = 108.0 cm. She was next captured at Clack Reef on 11 July 1988 at a minimum post-breeding migration distance of 1300 km. Laparoscopic examinations showed that she did not prepare for breeding in 1986, 1987 or 1988. She again was not preparing to breed when recaptured at Clack Reef on 16 June 1989 but she prepared for breeding the following year and was recaptured back nesting at Northwest Island on 18 December 1990 after a 6 yr remigration interval. Following unsuccessful nesting attempts on Northwest Island on 18, 19 and 22 December 1990, she was recorded for a further three unsuccessful nesting attempts on Wreck Island (19 km displacement) on 23, 24 and 25 December before returning to Northwest for her next nesting attempt on 27 December 1990. She was again recaptured back at Clack Reef on 14 June 1991 where she was healing her ovaries following the 1990 breeding season and not preparing to breed for the 1991 breeding season. She was recaptured for her next breeding season at Northwest Island on 24 December 1995. The repeated measurements during this 11 yr period indicated that she had grown 0.5 cm CCL. This female illustrates the long term fidelity that the species displays not only to respective breeding sites but also to foraging areas. Long term fidelity to a foraging area is a common feature of green turtles within Eastern Australia. It is this fidelity to localised foraging areas that has enabled in-depth studies of the growth of our green turtles (Limpus & Chaloupka, 1997; Chaloupka *et al*. 2004). No foraging green turtle tagged at these reefs has been recorded shifting to forage at a different locality. Given this site fidelity to a foraging area, turtles sampled at a foraging site such as Clack Reef should represent a locally confined population of turtles, at least over the short term of a few years.

Long term simultaneous monitoring of both foraging and nesting areas allowed recording of breeding migrations for these turtles. Forty-six of the Clack Reef foraging females have been recorded at breeding sites (Table 1, Figure 1). Dethmers *et al*. (2006) identified many of the genetic stocks (management units) for green turtles in the Australasian region. The majority of the breeding migrations from Clack Reef involved females from the northern GBR (nGBR) genetic stock whose rookeries lie within 500 km to the north of Clack Reef. The next most abundant stock represented among these breeding migrants was the southern GBR (sGBR) stock whose rookeries lie approximately 1,000 – 1,500 km south of Clack Reef. These are the two largest stocks of green turtles in the wider Coral Sea region (Limpus *et al*. 2003). Small numbers of Clack Reef turtles originated from other stocks in the region, each with smaller population sizes: the Coral Sea stock approximately 600 km to the east and the New Caledonian Stock at 2,000 km distant. The individuals that bred in Papua New Guinea, Solomon Islands and Marshall Islands are from populations that have not been genetically assessed for stock identification. Given the distance separating these breeding sites from the breeding sites of defined stocks, it is highly probable that one or more independent stocks are also represented among these additional international migrants from Clack Reef (Dethmers *et al*. 2006). These migration tag recoveries provide clear evidence of mixed stocks foraging in this area of the northern GBR with the nGBR stock being the major dominant stock for adults while the sGBR stock is present at about 30% of the frequency of the nGBR stock. Without more information on the size of the populations within the other stocks and the proportion of females tagged within each population, the relative significance of the remaining stocks within the Clack Reef region cannot be evaluated by tag recovery methods.

Mark-recapture studies like the above provide information on the breeding population associated with the adult female population. However, comparable assessment of the stock composition of immature turtles can not be readily obtained by tagging studies alone. Genetic analysis using mtDNA sequencing can provide an estimate of stock composition across all age classes and both sexes (Velez-Zuazo *et al*. 2008). Precision of genetic stock assessment depends on the relative distinctiveness of the genotypes present within the respective stocks. Mark-recapture studies provide direct evidence of association of individual turtles with specific nesting beaches. The genetic studies cannot at present link individual turtles to specific nesting beaches within the breeding range of a stock. Tagging and genetic studies will complement each other in providing a more robust measure of stock assessment in foraging area studies. Tissue samples have been collected from the Clack Reef turtles for future genetic stock assessment.

How representative is the stock composition of green turtles foraging on Clack Reef relative to other foraging areas within the GBR region? The GBR provides extensive and diverse habitat for foraging green turtles, spanning approximately 2,300 km of the east Australian coast across ~15° of latitude (9.5 °S - 24.5 °S) with 3,650 reefs and shoals occupying ~26,000 km^2 (Hopley *et al*. 2007). There are additional substantial areas of seagrass habitat within the bays and estuaries along the coast. Within this vast foraging habitat, there is no uniformity within the localised green turtle foraging populations at widely separated sites. For example, 94% of the breeding migrant green turtles that forage in western Shoalwater Bay (20.333 °S, 150.200 °E) identified through tag recoveries were from the sGBR genetic stock (Limpus *et al*. 2005). This contrasts with the nGBR dominance of the foraging turtles at Clack Reef. Therefore, stock assessment (both genetic composition and demographic composition) at only a few "representative" sites within the GBR is unlikely to provide a reliable description of the stock composition for its vast herds of green turtles. Limpus *et al*. (2003) examined the relative proportion of tag recoveries of nGBR stock to sGBR stock green turtles in 1° latitudinal blocks along the east Australian coast and demonstrated a consistent trend from nGBR stock dominance in the north to sGBR stock dominance in the south.

Examination of the Clack Reef tagging project has brought a timely reminder that well designed flipper tagging and/or PIT tagging projects have much to offer for providing cost-effective and strategic demographic and behavioural data needed for guiding sustainable management of marine turtles. This is particularly so for comprehensive tagging-recapture projects centred on foraging populations. The strength of data derived from flipper-tagging studies is even more powerful when the tagging studies are supported by demographic studies to determine sex, maturity and breeding status of the turtles and studies to determine genetic stock composition.

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Feeding Ecology of Green Turtles (*Chelonia mydas*) from Shoalwater Bay, Australia

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Understanding the habitat usage and dietary requirements of a species is fundamental to its conservation. Although the diet of green turtles (*Chelonia mydas*) has been characterised for many populations around the world (reviewed by Bjorndal 1997), it is important to characterise the feeding ecology of distinct foraging populations in order to manage each effectively. Green turtles have a unique life history in terms of their foraging ecology. As small turtles they inhabit the open ocean, feeding omnivorously on pelagic material (Bolten 2003), but at approximately five to ten years of age green turtles in the Western Pacific recruit to an inshore neritic habitat and become primarily herbivorous feeding predominantly on seagrass and / or macroalgae (Bjorndal 1997; Limpus *et al.* 2005). Diet in green turtles is primarily driven by availability of a prey (Garnett *et al.* 1985), but some level of selectivity in feeding has also been demonstrated (Bjorndal 1985; Brand-Gardner *et al.* 1999; Fuentes *et al.* 2006). In Moreton Bay, Australia immature green turtles were found to select plants with higher concentrations of nitrogen and lower levels of fibre (Brand-Gardner *et al.* 1999) and in the Caribbean turtles have been observed to crop *Thalassia testudinum* to maintain new shoots that are higher in nitrogen and lower in lignin (Bjorndal 1985). Both these examples demonstrate a potential nutritional advantage through selective grazing, however, green turtles do not necessarily feed on either seagrass or algae to the exclusion of the other. Mixed diets are common (Bjorndal 1997) and sometimes also include mangrove (Limpus & Limpus 2000). Small amounts of animal material have often been described in green turtle diet, although these were initially thought to be incidental ingestions where animals were associated with benthic foods (Brand-Gardner *et al.* 1999; Mortimer 1981; Read & Limpus 2002). Recent studies have demonstrated green turtles in neritic habitats also target and consume significant amounts of gelatinous animal material from the water column (Arthur *et al.* 2007; Heithaus *et al.* 2002; Seminoff *et al.* 2006b), although the nutritional value that animal material contributes to metabolic activity is currently not known.

Shoalwater Bay is a shallow embayment in Central Queensland, Australia. It provides suitable foraging habitat for a large resident green turtle population (Limpus *et al.* 2005). Although never quantified, turtles in Shoalwater Bay have been reported to forage on seagrass, macroalgae, mangrove leaves when accessible and mangrove fruits when available (Limpus & Limpus 2000; Limpus *et al.* 2005). Here we quantify the diet of resident green turtles and opportunistically examine the digestive processes and foraging behaviour through a feeding history of one adult female that was found freshly dead at the site using nutrient and stable isotope analysis to address the physiological and biochemical processes that may be involved in digestion.

Shoalwater Bay (22º20S, 150º 12E) is located in the central section of the Great Barrier Reef Marine Park, Queensland, Australia. The maximum water depth in the bay is 11 m and a 7 m tidal range creates vast intertidal seagrass beds with mangroves on the landward fringe. Rocky reefs surrounding headlands provide substrate for macroalgal attachment (Lee Long *et al.* 1997).

Characterisation of the resident turtle population's diet was undertaken during three two-week sampling trips in winter (June-July) of 2002-2004. Turtles were captured using the turtle rodeo technique (Limpus & Reed 1985) and the habitat in which the turtle was first observed (seagrass flat, mangrove habitat or rocky reef) was noted at the time of capture. All turtles were either tagged immediately, or, in the case of recaptured turtles, their current tag was recorded. Turtles were weighed, their curved carapace (CCL) measured and they were sexed in accordance with Queensland Turtle Conservation Project protocol (Limpus *et al.* 1994). Based on laparoscopic observation of gonad maturity, turtles were assigned an age class of immature (small CCL < 65cm and large CCL > 65cm), pubescent or adult (Miller & Limpus 2003).

A random sub-set of turtles was selected for diet analysis and a diet sample was obtained from the lower oesophagus / crop using the stomach flush technique (Forbes & Limpus 1993). The content and relative volume of prey items was determined after the methods of Forbes (1999) and Read (2002). Briefly, a dissection microscope was used to visually identify all dietary material. The sample was then quantified using a marked eyepiece graticule where-by the prey item under each point was identified and the relative volume of each food type calculated as the proportion of diet (Channells 1981; Cribb 1983, 1996; Huisman 2000; Lanyon 1986). Diet data are presented as the mean (±SE) and the frequency of occurrence where the diet item is present and where it contributes >5% and >50% of the sample volume. This measure is important because some turtles feed on one type of food to the exclusion of others. As such, the average volume ± a measure of variation may not represent the true importance of the diet item to the minority of turtles that eat that item exclusively (Garnett *et al.* 1985).

A non-metric multidimensional scaling approach was used to determine whether there was an effect of the sampling year, sex, age class or habitat in which the turtle was captured on the composition of diet. Using Primer 6 (V6.1.11, Primer-E Ltd. Plymouth), proportional data were transformed using the 4th square root to ameliorate the magnitude of the most common diet items and a Bray-Curtis similarity matrix was established for all samples. A one-way analysis of similarity (ANOSIM) was used to assess the effect of sex and sampling year on diet composition (Clarke & Gorley 2006). Where a significant difference ($p<0.05$) was observed for sampling year, a subsequent pairwise test was used to compare years. In addition, a similarity of percent contribution (SIMPER) analysis was undertaken to establish which diet items contributed the most to the difference between years. As there was an effect of year, each sampling period was considered separately to assess the effects of age class and habitat in which a turtle was captured on the composition of diet. A two-way crossed ANOSIM was used to examine the effect of age across habitats and the effect of habitat across age groups.

In July 2001 an adult female green turtle (CCL = 107.0 cm) was found freshly dead within the region described above for live turtles. A necropsy did not find a conclusive cause of death, however, the alimentary tract was full of food and the carcass was robust suggesting that the turtle had been foraging normally up until its death. The alimentary tract of this turtle was examined to assess longer-term feeding patterns than could be established by sampling the most recent feeding event in live turtles. Sub-samples of dietary material were collected from the crop (1), stomach (1) and at 1 m intervals along the small intestine (4) and large intestine (9). The composition of sub-samples was determined visually and in the small intestine, where it was possible to separate these components, the dry weight biomass of seagrass, mangrove leaves and mangrove propagules was determined to estimate the dominant ingested food source at different feeding periods. In addition, plant samples from the alimentary tract, as described above, and tissue samples from the pectoral muscle (6) of the dead turtle were collected and immediately frozen (-20 °C) for nutrient and stable isotope analysis. Prior to analysis samples were dried at 60 °C for 48 hrs and ground using a ball mill grinder. Turtle tissue samples were not lipid extracted.

To characterise the mechanical breakdown of ingested material through the digestive tract, the particle size distribution of the sub-sample from the crop and the lowest part of the large intestine (16 m) was determined. The sub-sample was sieved into the following categories: <1.0 mm; 1.0–3.5 mm; 3.5–5.0 mm; and >5.0 mm, and the dry weight biomass of each category determined. To investigate digestive processes along the alimentary tract the carbon (C) and nitrogen (N) content and the stable isotopic signature of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) were measured from bulk material within the alimentary tract, and in the small intestine seagrass and mangrove leaves were separated and analysed. Plant material was prepared following the methods of Grice *et al.* (1996). Nutrient and stable isotope analysis was undertaken at Griffith University Stable Isotope Analysis Laboratory using an Isoprime (GV Instruments) mass spectrophotometer coupled to a EuroVector EA 3000 elemental analyser with continuous helium carrier flow. Stable isotope ratios of ^{13}C:^{12}C and ^{15}N:^{14}N were expressed relative to PeeDee Belemnite (PDB) standard for C and N_2 in air for N. Totals for C and N were expressed as % dry weight (DW) of the material. To investigate the dominant assimilated food source(s), the C and N content and $\delta^{13}C$ and $\delta^{15}N$ values were also determined for turtle muscle tissue and for field sources of seagrass leaves and rhizomes + roots *A. marina* mangrove leaves, propagules and algae.

A t-test (Statistica V6.1, Statsoft Inc., Tulsa, USA) was used to test for significant differences in %C and %N content of seagrass and mangrove collected in the field with samples collected from the small intestine of the dead turtle. To assess the assimilation of nutrients from potential food sources into turtle muscle tissue the SISUS (Stable Isotope Sourcing Using Sampling) mixing model

Diet Item	Frequency (%)	Mean (+/- SE)	Frequency >5%	Frequency >50%
Cymodocea serrulata	18.5	1.0 (0.4)	4.7	0.7
Halodule spp.	93.4	26.9 (2.2)	74.7	17.1
Halophila ovalis	41.1	T	2.7	0
Zostera muelleri	97.2	58.6 (2.7)	88.3	63.5
Total seagrass	**100**	**85.5 (1.9)**	**100**	**88.6**
Aglaothamnion spp.	0.7	T	0	0
Amphiroa spp.	0.7	T	0	0
Bostrychia tennella	3.4	T	2.1	0.7
Centroceras spp.	1.3	T	0	0
Cerium spp.	8.9	T	0	0
Chondria spp.	0.7	T	0	0
Codium spongiosum	0.7	T	0	0
Coelarthrum spp.	2.1	T	1.7	0
Dasya spp.	1.4	T	0.7	0
Hypnea spp.	58.9	2.7 (0.6)	16.4	0.7
Gracilaria spp.	23.3	4.1 (1.1)	10.3	4.7
Laurencia spp.	9.6	T	3.4	0.7
Melanamansia glomerata	0.7	T	0.7	0
Polysiphonia spp.	15.1	0.1 (0.0)	0	0
Pterocladia spp.	0.7	T	0.7	0
Tolypliocladia glomerulata	2.7	T	0	0
Unidentified red algae	5.4	T	0.7	0
Total red algae	**74.7**	**9.4 (1.7)**	**27.4**	**6.7**
Enteromorpha spp.	0.7	T	0	0
Total green algae	**2.1**	**T**	**0**	**0**
Colpomenia sinuosa	0.7	T	0	0
Total brown algae	**0.7**	**T**	**0**	**0**
Avicenna marina fruit / leaves	12.3	1.4 (0.5)	6.2	0.7
Total mangrove material	**12.3**	**1.4 (0.5)**	**6.2**	**0.7**
Lyngbya majuscula	18.5	T	3.4	0
Oscillatoria spp.	1.3	T	0	0
Unidentified filamentous algae	6	T	0	0
Total filamentous cyanobacteria	**24.7**	**T**	**3.4**	**0**
Shell material	21.9	T	0	0
Unidentified crustacean	6.8	T	0	0
Unidentified egg mass	4.1	1.3 (0.8)	3.4	1.4
Unidentified sponge	1.3	T	0.7	0
Total animal material	**31.5**	**1.7 (0.8)**	**3.4**	**1.4**
Unidentified material	72.6	1.5 (0.2)	6.7	0

Table 1. The diet of green turtles in Shoalwater Bay, Australia in winter 2002-04. Frequency = percentage of samples in which the diet item was observed. T = trace or mean <1% of the overall relative volume. The frequency >5% and >50% represents the percent of samples observed where the relative volume of the diet item was greater than 5% and 50% of the total volume of the sample respectively (n=146).

	Proportion of material in alimentary tract (%)			
Ingested material	4 m	5 m	6 m	7 m
Seagrass	85	97	35	48
Mangrove leaves	13	3	65	52
Mangrove propagules	2	0	0	0

Table 2. The percentage of seagrass leaves, mangrove leaves and propagules based on dry weight biomass in sub-samples from 1 m intervals along the small intestine.

was employed. SISUS is a Bayesian mixing model and software package for source partitioning using stable isotopes (Erhardt 2008). The $\delta^{13}C$ and $\delta^{15}N$ values of six potential source diet items were included in the model: red algae (3), seagrass shoots (3), seagrass rhizome + roots (2), mangrove epicormic shoots (2), mangrove leaves (4) and mangrove propagules (3). These were compared with $\delta^{13}C$ and $\delta^{15}N$ values of turtle muscle from one individual (6) assuming a constant discrimination of +0.17‰ for $\delta^{13}C$ and +2.8 ‰ for $\delta^{15}N$ for all food types (Seminoff *et al.* 2006a), 100% source assimilation for all sources and a source concentration as determined by %C and %N analysis. No additional linear constraints were applied to this model.

One-hundred and forty six green turtles (CCL = 39.9 – 115.6 cm) were stomach flushed in Shoalwater Bay in winter 2002-2004. During this time, green turtles in Shoalwater Bay were primarily consuming seagrass and the most common species found in diet samples were *Z. muelleri* and *Halodule* sp. (Table 1). *Halophila* sp. and *C. serrulata* were also present, but in fewer diet samples and in smaller quantities. Red alga was also common, found in 74.7% of samples, but only contributing a mean relative volume of 9.4% and this was generally made up of *Hypnea* sp. and *Gracilaria* sp. Although red algae wasn't a dominant food type overall, some samples were predominantly red algae. In 6.7% of samples examined, red algae made up more than half the relative volume of the diet sample. The low overall mean proportion of red algae in diet is due to the fact that while some turtles ate a lot of red algae many had not consumed any. Green and brown algae species were rarely found and only constituted trace amounts of diet samples. The fruit of the mangrove *A. marina* was often found in diet samples in 2003 and 2004, but only in two samples in 2002. Overall, it only contributed a small amount to diet, but one sample contained more than 50% mangrove material. Conversely, the cyanobacteria

	Proportion of dietary material (%)	
	Crop	Large intestine
Particle size	1 m	16 m
> 5 mm	86	5
3.5 – 5 mm	1	17
1 – 3.5 mm	10	65
< 1 mm	3	13

Table 3. The particle size distribution of sub-samples from within the crop and the lower end of the large intestine in the green turtle.

L. majuscula was common in green turtle diets in 2002, but not in other years, and when present only constituted an average of 2.9% of volume. Animal material was often found in samples, but generally only in small amounts, most commonly as tiny gastropod shells, which did not constitute a large proportion of the diet. The only exception to this occurred in 2002 when the majority of the diet samples from two adult females were found to be unidentified gelatinous egg masses.

There was not a significant difference in the composition of diet samples collected from male and female turtles (ANOSIM: Global R = 0.009, p =0.373), however, there was a significant difference between sampling years for both sexes combined (ANOSIM: Global R = 0.134, p = 0.001). The SIMPER analysis showed 2003 and 2004 samples were the most similar (Dissimilarity 38.6%) compared with 2002, which had dissimilarity of 44.9% to 2003 and 43.5% to 2004. The diet items that contributed most to this dissimilarity were *Halodule* sp. *Z. muelleri*, *L. majuscula*, *Hypnea* sp. *Halophila* sp., *Gracilaria* sp. and *C. serrulata*. As the year of capture led to significant differences in the composition of diet, we examined the effects of age classification and habitat in which the turtle was captured for each year separately. In all three sampling events there was not a significant difference in the composition of turtle diet between age groups (considered across habitat types) or across habitats (as observed across age groups) using a two-way crossed ANOSIM model. Throughout the alimentary tract of the dead turtle the following organisms were observed: leaves of the seagrass species *H. uninervis*, *Z. muelleri*, *H. ovalis*; leaves and propagules of the mangrove *A. marina*; unidentified red sponge; and unidentified solitary ascidian. Seagrass was observed from all sub-samples along the alimentary tract, whereas mangrove leaves and propagules, and the red sponge were found in the small and large intestine and the solitary ascidians were only found in the large intestine. Although seagrass was ubiquitous throughout the gut, mangrove and algae were not evenly dispersed and were found as clumps amongst the seagrass. Mangrove leaves were the dominant component of the sub-sample in the small intestine at 6 and 7 m (65 % and 75 % of the DW respectively), whereas at 4 and 5 m seagrass was the dominant component (85 and 97 % respectively, Table 2).

There was obvious breakdown of the ingested plant material along the alimentary tract. In the crop and small intestine plant material was in small pieces but readily identifiable, however, in the large intestine only the veins of mangrove leaves and very small pieces of seagrass leaves were identifiable and these were surrounded by unidentifiable viscous green digesta. In comparison, the animal material, sponges and ascidians were intact and appeared undigested. There was a greater proportion of smaller particles at the end of the alimentary tract compared with the crop. In the crop, 86 % of the material was greater than 5 mm diameter, whereas at the end of the lower intestine only 5 % of the material was greater than 5 mm. The percentage of particles less than 1 mm increased from the crop to the end of the lower intestine, 4-13 %. The dominant particle size at the end of the digestive tract was 1–3.5 mm (Table 3).

Carbon content of fresh field samples was greater in mangrove leaves compared with seagrass leaves (Figure 1). There was no significant difference in the %C (T-test: t = -1.01, df = 6 p = 0.35) and %N (T-test: t=-0.11, df = 6, p = 0.97) composition of ingested seagrass material in the small intestine compared with samples collected in the field. However, the %C (T-test: t=3.18, df = 6, p =

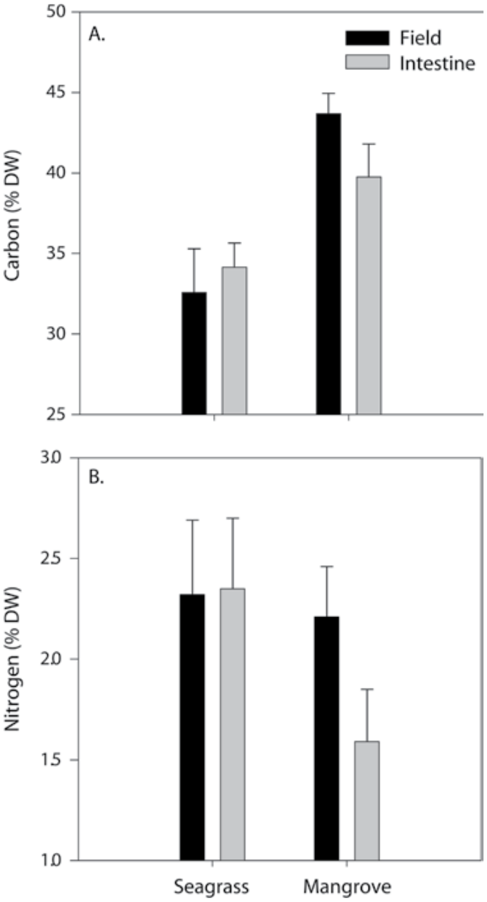

Figure 1. Comparison of carbon (A) and nitrogen (B) content of seagrass and mangrove leaves collected in the field and from the small intestine of a adult green turtle in Shoalwater Bay. Average + SD.

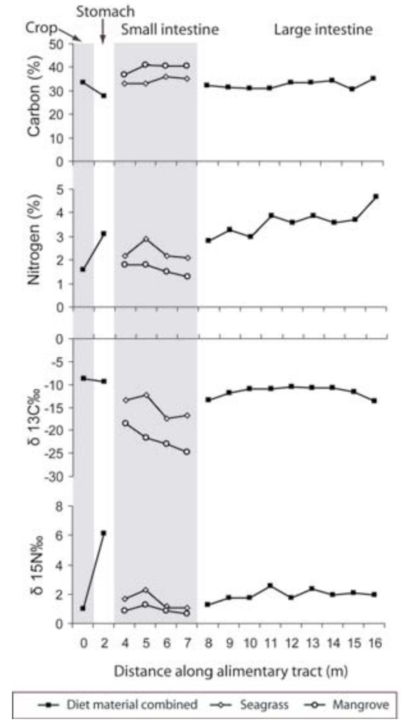

Figure 2. Carbon and nitrogen content and δ15N and δ13C (‰) of diet material collected along the alimentary tract of an adult green female turtle found freshly dead in Shoalwater Bay, winter 2001.

0.02) and %N (T-test: $t=3.42$, $df=6$, $p = 0.01$) of mangrove leaves was significantly lower in the small intestine compared with samples collected in the field (Figure 1). Within the gut, %C was lower in the large compared with the small intestine (Figure 2). The N content of ingested material in the large intestine was higher (average 3.6 ± 0.2) than in the small intestine (average 2.0 ± 0.2; $p < 0.001$). The N content of mangrove leaves decreased through the small intestine, and the N content of the composite large intestine material increased towards the lower end of the large intestine (Figure 2). The $\delta^{13}C$ of mangrove leaves became more negative through the small intestine and was consistent through the large intestine. The $\delta^{15}N$ value was enriched in stomach contents (6.2 ‰) compared with all other locations along the alimentary tract (0.7-2.6 ‰; Figure 2).

The $\delta^{13}C$ signatures of available food sources were all distinct: seagrass (mean = -10.4 ‰), algae (mean = -14.1 ‰) and mangrove (mean = -26.6 ‰; Figure 3). However, potential food sources had similar $\delta^{15}N$‰ signals (0.0 - 1.5 ‰), except seagrass roots (-1.6 ‰). Turtle tissue was found to have $\delta^{13}C$‰ signature (-10.5 ‰) that was similar to that of seagrass (-10.4 ‰), whereas the $\delta^{15}N$‰ signature (3.0 ‰) was enriched by 1.4 – 3.3 ‰ when compared with the average seagrass (-0.3 ‰), mangrove (0.7 ‰) and algae (1.6 ‰) values (Figure 3). The SISUS mixing model found the feasible source contribution of seagrass leaves to be highest with a mean of 81.4% (SD ± 1.4%) followed by seagrass roots (16.1 ± 0.5%), red algae (1.4 ± 1.1%), mangrove propagules (0.3 ± 0.3%) and mangroves shoots and leaves (0.3 ± 0.2%).

Green turtles in Shoalwater Bay appear to be primarily herbivorous, but opportunistic in their foraging behaviour. All turtles considered in this study ingested seagrass, but many also consumed mangrove material and red algae. Only two turtles were determined via stomach lavage to have consumed significant amounts of animal material. However, the authors acknowledge the potential for pelagic gelatinous animal material to be overlooked using this sampling technique (Arthur *et al.* 2007). The composition of green turtle diets was found to be significantly different between sampling years, primarily due to the quantity of the seagrass *Halodule* sp. in the diet and the presence of *L. majuscula*. This suggests that although turtles predominantly consume seagrass, the abundance of each seagrass species may vary from year to year. Similarly, when ephemeral blooms of *L. majuscula* grew over the seagrass in 2002 turtles were observed to consume small amounts, but this was obviously not a preferred food (Arthur *et al.* 2006).

Zostera muelleri was the most commonly encountered species in diet samples (97.2%) and contributed the greatest mean volume (58.6 %; Table 1). *Halodule spp*. also contributed significantly to diet while *H. ovalis* and *C. serrulata* contributed only small amounts. These findings may reflect the abundance of these species in the Western Bight of Shoalwater Bay. Both *Z. muelleri* and *Halodule spp*. are abundant in the area, and although *Halophila spp*. is present, it is not as common as *Z. muelleri* and *Halodule* spp. (Kay 2003; Lee Long *et al.* 1997). Interestingly, *C. serrulata* was not noted to be present in Shoalwater Bay in 1997 seagrass surveys, however, it was found in surveys conducted in 2002 where it was recorded very occasionally and made up less than 0.1% of seagrass present (Kay 2003). In Moreton Bay, *H. ovalis* was described to be the preferred species for green turtle consumption when compared with *Halodule uninervis* and *Z. muelleri* and this was attributed to the lower fibre content of this species (Brand-Gardner *et al.* 1999). Although selectivity was not examined in the current study, the frequency but low contribution of *H. ovalis* in diet samples suggests that turtles may consume it when available, but as there was less present in the environment it did not contribute significantly to overall diet.

Red algae and mangrove material were both commonly observed in green turtle diet samples. Although common, they did not contribute as much volumetrically to diet as the seagrasses (Table 1). Red algae may provide an alternate food source when seagrass is limited, and could potentially provide a nutritional advantage for those turtles able to access areas in which the algae grows (Brand-Gardner *et al.* 1999). Similarly, mangrove fruit has previously been documented in the diet of green turtles from Shoalwater (Limpus & Limpus 2000) and Moreton Bays (Read & Limpus 2002), and in Western Australia an adult green turtle was observed feeding on the leaves of *A. marina* (Pendoley & Fitzpatrick 1999). Brand-Gardner *et al.* (1999) suggested that green turtles preferentially consume diet items of greater nutritional value. In this study mangrove leaves from the field had higher C content than seagrass, but N content was similar (Figure 1). It is not known whether mangrove material and red algae confer other nutritional advantages, however, the behavioural adaptation required to feed on these items is consistent with that of an opportunistic and versatile forager.

The continuous presence of seagrass throughout the alimentary tract interspersed with clumps of mangrove material in the single adult female that was found dead during this study is suggestive of transitory feeding behaviour where the turtles move up into the mangroves with the high tide and forage on mangrove propagules and leaves whilst they are accessible at the top of the tide and then move back to the seagrass beds with the receding tide. This supports observations made by Limpus & Limpus (2000) where they describe alternating bands of seagrass and mangrove material through the gut of another deceased turtle from this region.

Although we were only able to sample one dead animal through the entire alimentary tract, the diversity of food in the most recent feeding events observed in the live turtles reflects the diversity of foods observed through the entire digestive tract of the dead turtle. Based on estimates of digesta time of green turtles this could reflect 6-30 days of feeding (Amorocho & Reina 2008; Brand-Gardner *et al.* 1999) and begs the question as to whether all turtles always feed on a variety of items or whether they have a preference for certain food types. Based on the SISUS mixing model, the stable isotopic signature of muscle tissue from the dead turtle suggests that even though she consumed multiple food items, seagrass was the major contributor to growth and tissue production with an average of 97% of feasible source contribution to tissue accounted for by seagrass leaves and roots combined. This suggests that even though other diet items are consumed, they are either not digested or nutrients derived from these food sources are only a minor component of

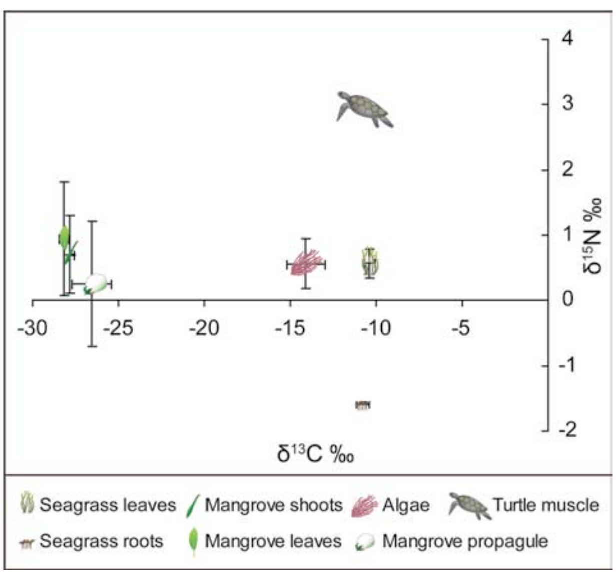

Figure 3. Stable carbon and nitrogen isotopic signatures for potential food sources for green turtles in Shoalwater Bay presented as the mean ± standard deviation, compared with the carbon and nitrogen stable isotopic signature of muscle tissue from one adult green turtle.

nutrients assimilated into the muscle matrix. However, it should be noted here that the model was based on the assumptions that the discrimination value for all potential food types was the same (0.17 ‰ for δ^{13}C and 2.8‰ for δ^{15}N) and that these values would accurately reflect discrimination in a wild adult turtle when they were derived for juveniles turtles held in captivity (Seminoff *et al.* 2006a). It is possible that other diet items may also be assimilated, but due to the large volume of seagrass consumed, seagrass appears to be the dominant source of nutrients assimilated for muscle production in this turtle.

Although sponges and ascidians were not included in the mixing model, we do not anticipate that they contributed significantly to green turtle nutrition because they were visually observed to be intact throughout the length of the alimentary tract. While particle size of the digestive material clearly decreased through the alimentary tract (Table 3), a trend reflected in the obvious breakdown of ingested plant material, the breakdown of fauna (ascidian and sponge) was not obvious. It is possible that as hind gut fermenters (Bjorndal *et al.* 1991) they are not capable of digesting these items that may pass through the alimentary tract without the turtle obtaining any nutritional value.

The break down and assimilation of seagrass and mangrove leaves appear to occur at different locations through the alimentary tract. The lower C and N content of mangrove leaves in the small intestine compared with fresh leaves collected from the field indicates the release of nutrients from mangrove leaves in the crop, stomach and small intestine of the green turtle. The decline of N in mangrove leaves along the small intestine provides further support for this hypothesis. In contrast, there was no significant difference in C and N of seagrass leaves in the small intestine compared with fresh field material, and there was no obvious decline along the small intestine indicating little digestion of seagrass material in the crop, stomach and small intestine of the green turtle (Figures 2 & 3). The high N content and δ^{15}N signal of ingested material in the stomach may indicate a release of enzymes from the turtle that could aid nutrient release from the mangrove leaves. Although seagrass is the main diet of the turtle and contributes most to tissue production, mangrove leaves and propagules provide an opportunistic food source from which nutrients are released faster than the most common food source, seagrass.

The C content of ingested material in the large intestine is lower than both seagrass and mangroves leaves in the small intestine, indicating that C release from both of these food sources occurs here. This is consistent with hind gut fermentation (Bjorndal *et al.* 1991). The higher %N in the large intestine compared with the material in the small intestine, and the increase along the hind gut may reflect the increased load of fermentative bacteria relative to ingested plant material (Yamamuro *et al.* 2004). The δ^{13}C and δ^{15}N in the large intestine may also reflect the presence of these bacteria. Few studies have utilised stable isotopic analysis to assess digestion and assimilation of food in marine vertebrates (Guelinckx *et al.* 2008). Here we provide preliminary evidence to suggest that nutrient content and stable isotope analysis of material in the digestive tract may provide additional tools in understanding the physiological and biochemical mechanisms involved with digestion and assimilation of nutritional sources in sea turtles. Stable isotope data give an indication of the type and location of different digestive processes whereas nutrient content of the material gives an indication of the timing and location of nutrient release, and potentially assimilation from different food sources. This approach has also demonstrated that there may be differential breakdown and assimilation of nutrients from different food sources in green turtle digestive tracts.

This is the first study to quantify the diets of green turtles in Shoalwater Bay for all age groups across multiple years. It demonstrates the importance of seagrass habitats to this large foraging population and will aid in the conservation and management of green turtles in Queensland. In addition, this study highlights the value of following foraging behaviour of green turtles through time as individuals may change their behaviour and adapt to the availability of food items. Although opportunistic foraging on mangrove leaves is likely to provide a food source higher in C and with a faster release of nutrients than seagrass, the volume of seagrass consumed by turtles in Shoalwater Bay means that in terms of tissue assimilation, seagrass is the most important source of tissue C and N. Finally, we also explore the value of using multiple approaches to understanding sea turtle feeding ecology and suggest the benefits of using nutrient and stable isotope analysis to explore nutritional physiology in marine turtles.

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Does Fiji's Turtle Moratorium Work?

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Marine turtles are of cultural and spiritual importance to indigenous Fijians. The cultural significance of marine turtles is illustrated in the stories, traditions and contemporary activities of many coastal indigenous communities and is acted out in numerous ceremonies such as the installation of paramount chiefs, funerals, marriages and other traditional occasions (Guinea 1993; Morgan 2007). The meat of green turtles (*Chelonia mydas*) is used preferentially at these traditional occasions (Guinea 1993; Morgan 2007).

Trade in marine turtle products also had significant value within the Fijian economy in the early 1800s (Guinea 1993). During that period, a large turtle fishery operated in Fiji to source both meat and shell trade for Asian markets. Fiji also hosted a smaller industry that used hawksbill turtle (*Eretmochelys imbricata*) scutes to make various artefacts including toilet sets, cigarette cases and jewel boxes (Levy 1949, cited by Guinea 1993). Later, during the 1980s and 1990s, marine turtles were sold at many of the commercial markets of Fiji. Green and hawksbill turtles were the most common, but Doyle (1998) reported the sale of loggerhead turtles (*Caretta caretta*) in the markets of Suva in 1997. Today, turtles continue to play a significant role in the subsistence economy of many Fijian communities (Hirth 1971, Jit 2007).

Concern over the decline in marine turtles led the Fiji Government to place a one year ban on the harvest of marine turtles in 1995, which was facilitated by considerable public outreach during the *Year of the Sea Turtle* initiative coordinated by the South Pacific Regional Environment Programme (SPREP). A three year ban was then implemented from May 1997 to December 2000, followed by an amendment to the Fisheries Act in 2004. The amendment provided for a moratorium, effective from February 2004 until 31 December 2008, on killing of turtles; digging and poaching of eggs; and all sales of turtle flesh and shell. The amendment also included a provision for exemption from the moratorium for take for traditional purposes (Government of Fiji 2004).

The open sale of turtles in the markets no longer occurs but there is anecdotal information that there is still a substantial catch of turtles for subsistence and traditional use and a possible black market for commercial sales (Seeto, J. pers obs. March 2008). This study details the extent of turtle use in the following locations in an attempt to assess the success of the current moratorium: 1. handicraft and municipal markets on the island of Vitilevu; 2. four villages among the Mamanuca Islands.

Market survey at Vitilevu: A market survey for turtle products was carried out, following the recommendations of Tambiah (1999), at 102 different shops in handicraft centres and municipal markets at seven locations around the island of Vitilevu from April 2006 to February 2007. The survey targeted centres and markets frequented by tourists (Figure 1). Any turtle carapaces or derivatives such as combs, spoons, bangles, necklaces and pendants on display at the surveyed shops were recorded. The curved carapace lengths (CCL) of carapaces were measured, and they were photographed and identified to species. Informal interviews were carried out with vendors to ascertain additional information about sale prices and markets, as well as fishery information such as location and date of capture. Vendors were generally cooperative, with all but one allowing inspection of their products.

Village surveys in the Mamanuca islands: Household surveys about turtle use were carried out in four villages in the Mamanuca islands. The Mamanuca's consist of 27 islands southwest of Vitilevu, most of which are popular tourist destinations with hotels and resorts. The villages of Solevu, Tavua, Yanuya and Yaro were surveyed, which are located on the largest islands of Malolo, Tavua and Yanuya (Figure 2).

Acceptable and traditional village protocols were followed with respect to informing village chiefs and elders about the survey and requesting permission. The household surveys involved in-depth, interviews carried out in the Fijian language. Households were

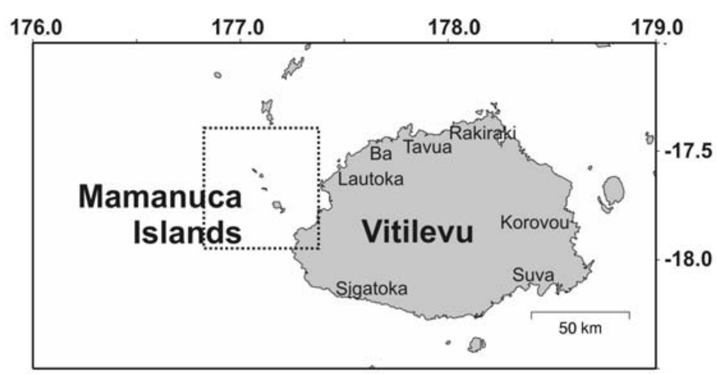

Figure 1. Map of Vitilevu Island, Fiji showing sites of the market survey. Map produced using MAPTOOL (http://www.seaturtle.org/maptool/).

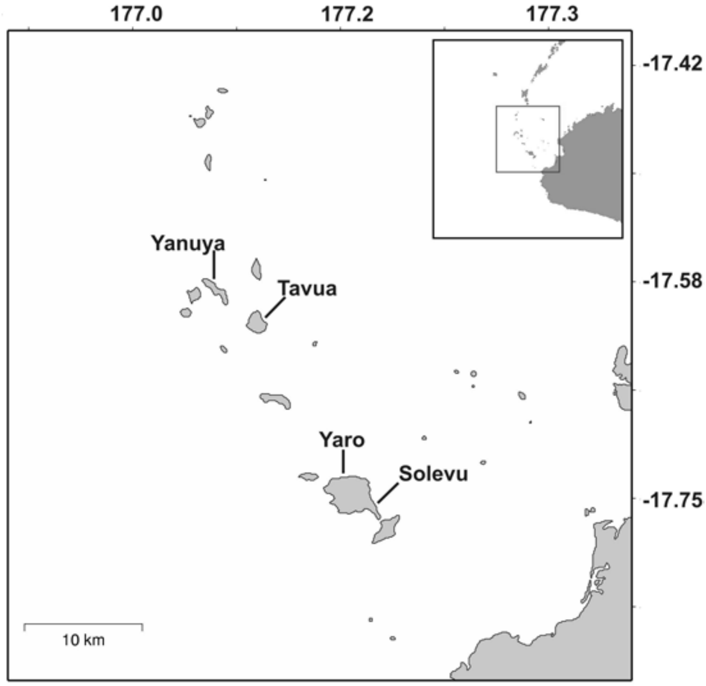

Figure 2. Map of the Mamanuca Islands showing the resorts and the villages surveyed Map produced using MAPTOOL (http://www.seaturtle.org/maptool/).

chosen ad-hoc for interviews. The interviews sought information on the numbers and species of turtles consumed, as well as the nature of the events for which turtles were harvested. A turtle conservation awareness presentation was carried in each village following the household surveys, which featured open discussions with the communities on the turtle conservation issues, especially with regard to the provisions for traditional use within the existing turtle harvest legislation. This process also yielded anecdotal information, which was also recorded.

Market Surveys at Vitilevu: A total of 102 shops or stalls were visited and 28 hawksbill and 29 green turtle carapaces were found (Table 1). The cost of the carapaces depended on their size,

Location	Shops	Hawksbill			Green		
		Apr 2006	Dec–Feb 2006-07	Total	April 2006	Dec–Feb 2006-07	Total
Suva	68	16	8	24	13	7	20
Sigatoka-Coral Coast	5	2	0	2	3	0	3
Nadi	15	0	2	2	2	4	6
Lautoka	10	0		0	0		0
Ba	1	0		0	0		0
Tavua	1	0		0	0		0
Rakiraki	1	0		0	0		0
Korovou	1	0		0	0		0
Total	102	18	10	26	18	11	29
CCL ±SD (range)		44.4±11.71 (37.5-73.8)			49.9 ±5.66 (40-66.5)		

Table 1. Turtle carapaces found in markets and tourist shops in Vitilevu, Fiji 2006-2007.

Item	Number	US$	FJ$
Bangles	136	9	15
Necklace/pendants	55	1.80-12	3-20
Earrings	36	6	10
Rings	3	9	15
Hair Combs	28	6	10
Spoon	1	3	5

Table 2. Numbers and prices of turtle carapace products found in the handicraft market in Suva, Fiji 2006-2007.

with prices ranging from US$14 to US$124 (FJ$25 to FJ$200). The average price for a hawksbill carapace was US$37 (FJ$60), whereas that of green carapaces was US$42 (FJ$67). During the survey carried out from December to February, a large quantity of derivatives and products were found in the Suva handicraft market (Table 2). No turtle products were found in the Lautoka municipal market during this survey.

The carapaces on sale ranged from 37.5-73.9 cm CCL for hawksbills, and 40-66.5 cm CCL for green turtles. The mean CCL of hawksbills was 44.5 cm, which was slightly smaller than the mean CCL of green turtle carapaces found (49.9 cm), but was not significantly different (Figure 3). The majority of the shells for both species are below adult sizes for these species in the region (see Hirth 1997 and Marcovaldi et al. 1999), indicating that most are juveniles, with a few carapaces of sub-adults.

The carapaces on sale in the Nadi area were reported to be from the Lau island group in eastern Fiji, while the vendors in Suva reported that carapaces are brought in from outer islands in the Northern and Western areas of Fiji and along the outer coastal settlements of Suva.

Mamanuca Village Surveys: The household surveys revealed that during 2007 a total of 261 turtles were consumed in the four villages of Yaro, Tavua, Solevu and Yanuya (Table 3). Of these turtles, 34% (n=88) were harvested for subsistence consumption whereas 66% (n=173) were consumed during traditional occasions, including funerals, weddings, birthdays and other church or school functions (Figure 4). Most of these turtles were consumed during the months of January to September.

Detailed data on species captured were not collected, but the villagers indicated that most were hawksbills, which seems likely given that there is limited amounts of typical green turtle foraging

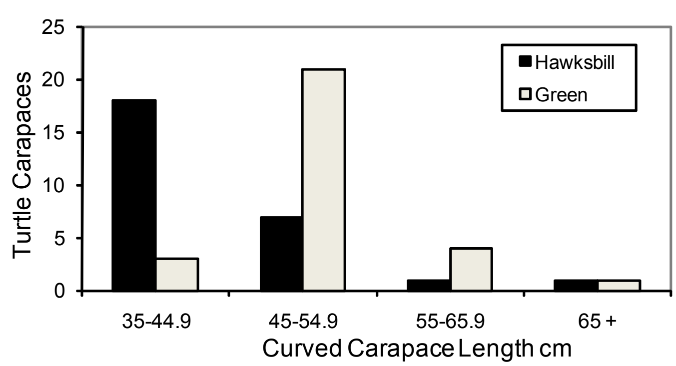

Figure 3. Frequencies of the CCL of turtle carapaces found in markets and tourist shops in Vitilevu, Fiji 2006-2007.

	Villages	Subsistence consumption	Traditional Consumption Funerals	Wedding	Others	Total
Jan-April	Tavua	6	1	0	0	1
	Yaro	6	3	1	17	21
	Solevu	7	7	0	3	10
	Yanuya	34	33	6	17	56
May-Sep	Tavua	4	45	0	0	45
	Yaro	4	12	0	4	16
	Solevu	4	0	0	0	0
	Yanuya	21	22	0	0	22
Oct-Dec	Tavua	0	0	0	0	0
	Yaro	0	0	0	1	1
	Solevu	0	0	0	0	0
	Yanuya	2	1	0	0	1

Table 3. Turtles consumed in 2007 by villages of Tavu.

habitat (e.g. seagrass beds) in the Mamanucas' waters. In addition in Fiji and elsewhere in the Pacific hawksbills are not considered toxic unlike in other areas of the Indian and Pacific oceans, where chelotoxicity has been documented (Fussy et al. 2007).

The carapaces sold in the municipal markets at Vitilevu are largely from juvenile or sub adult turtles, and as reported by Hirth (1971), appear to be sourced from the Northern and Western areas of Fiji and along the outer coastal settlements of Suva. Carapace vendors in the Suva area suggested that customers buying hawksbill turtle shells often originated from Asian countries and anecdotal information from the respondents in the Suva market also suggests the presence of an illegal trade of hawksbill shells with Asian fishing boats. The quantities of turtle products found in the Suva markets indicate the presence of a trade that is in direct contravention of Fijian legislation.

Significant implementation and enforcement of the moratorium for non-subsistence use has occurred in various parts of Fiji and this appears to be reflected in the survey results (Table 1). For example, the survey revealed no turtle products in the handicraft market in Lautoka, where vendors reported that the Department of Fisheries conducted an awareness campaign on illegal trading of CITES listed species or derivatives in early February 2008 Similarly, CITES posters and leaflets were found posted in a handicraft market along

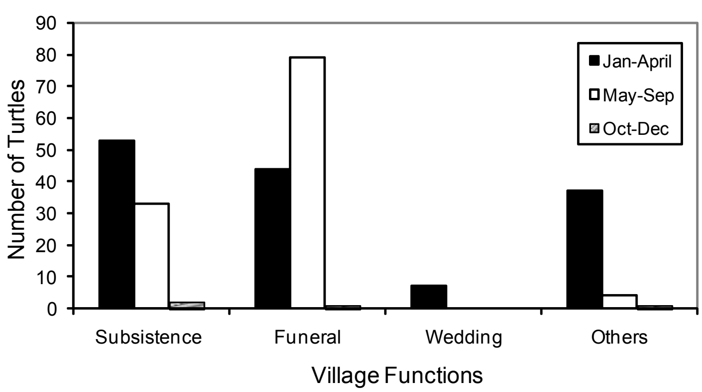

Figure 4. Numbers of turtles consumed for subsistence and various traditional occasions in 2007 by the four villages in the Mamanuca Island Group, Fiji.

the coral coast, suggesting that there has been some effort at raising awareness of the moratorium.

Mamanuca Survey: The household survey conducted in the four villages of Mamanuca suggested that 261 turtles were harvested in 2007 with 66% used for traditional occasions. However, there were no requests to the Minister of Fisheries for an exemption to the legislation. The respondents reported that the application for permits to harvest turtles was not a priority as most of them were not aware of the turtle moratorium. This issue as raised by our survey was the first time that they had been made aware of the moratorium.

The results from the villages in the Mamanuca Islands confirm anecdotal information from other villages and suggest that illegal harvesting of marine turtles still continues amongst coastal communities. In spite of the turtle awareness focused on households during the 2007 survey, a follow up survey is recommended to monitor any change on turtle harvest for 2008. There are no data on turtle populations in Fiji but all evidence (Batibasaga et al. 2003) suggests a decline in nesting green and hawksbill turtles.

The results of these surveys confirm that turtles continue to be harvested in Fiji in contravention to the current legislation, and that the provisions and processes that allow traditional take are poorly understood with low compliance in the study areas. The data suggest that there is a need for greater awareness amongst these communities, as well as amongst the traders in local markets where compliance with and enforcement of the current legislation is weak. More effort is required by the authorities and other interested parties to ensure that the current Moratorium is more effective, so that it is not only enforced, but is understood by those it is designed to regulate. Therefore this paper strongly recommends that the Turtle Moratorium (expired 31 December 2008) should be extended for the next 10 years.

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Marine Turtle Hunting in the Ha'apai Group, Tonga

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The Kingdom of Tonga in the South Pacific is composed of at least 170 islands of which 36 are inhabited. These islands are grouped into three main scattered groups of Islands: Tongatapu (where the capital and International airport are located), Ha'apai and Vava'u located within latitudes 15-23 °S and longitudes 173-177 °W (Figure 1). Two main species of marine turtles are present in inshore waters: the hawksbill *Eretmochelys imbricata,* and green *Chelonia mydas* although fishermen do recognize loggerheads (*Carreta caretta).* In the Tongan language *Fonu Koloa* is hawksbill, greens are often called *Tu'a'uli* but there are a number of different names depending on sex and size and variation on colour. Males are called *Ika ta'ane* or *Hulemui*, while females and immature may be called *Tu'a polata, Tu'a kula* (redish shell), *Aleifua,* or *Tufonu* (Pritchard 1981). Loggerheads are called *Tungange* but can also be referred to as *Tufonu*.

There has been limited research on marine turtles in Tonga. There are unpublished Tonga Fisheries Division reports from the 1970s (Koloa 1972, Braley 1974) that have been summarized in Bell et al. (1994) but there appears to be no recent surveys. Based on the 1970s surveys, nesting takes place for both greens and hawksbills from October to February, with peak nesting occurring in December. Most of the nesting occurs in the Ha'apai Group, with hawksbills predominating. The 1973 survey (Braley 1974) found signs of nests and nesters on eight of the 13 islands visited in Ha`apai while green turtles nests or nesters were found on only two or three uninhabited Islands that included Nukulei and Luanamo Islands. However, almost all sites showed signs of egg collection and disturbed nests, and reports were also received of nesting turtles being taken, in addition some former nesting areas were no longer receive nesting turtles. In this paper we summarise results of a one month survey of turtle hunting and nesting in the Ha'apai group by the principal author, a Tongan speaker with family ties to Ha'apai.

The survey was conducted during December 2007-January 2008) in three islands in Ha'apai, each with one village: Oua, Ha`afeva and Tungua Islands (Figure 1). These islands were selected because they had been identified in earlier surveys as communities involved in turtle hunting (Bell et al 1994). In addition Oua is involved in a pilot Special Management Area with the Department of Fisheries. Semi structured interviews based on a detailed prepared questionnaires were carried out with 50 fishermen: 22 from 'O`ua, 14 from both Tungua and Ha'afeva. Key fishermen were selected based on their experience and knowledge of marine turtles, in order to obtain the most complete data. Numbers of fishermen interviewed varied from island to island as some of the younger men were on temporary work (seasonal fruit picking) in New Zealand. Nevertheless, it was estimated that 90% of the active fishermen were interviewed. Fishermen were asked to estimate the number of turtles they had caught during the current year (2007) and queried on fishing

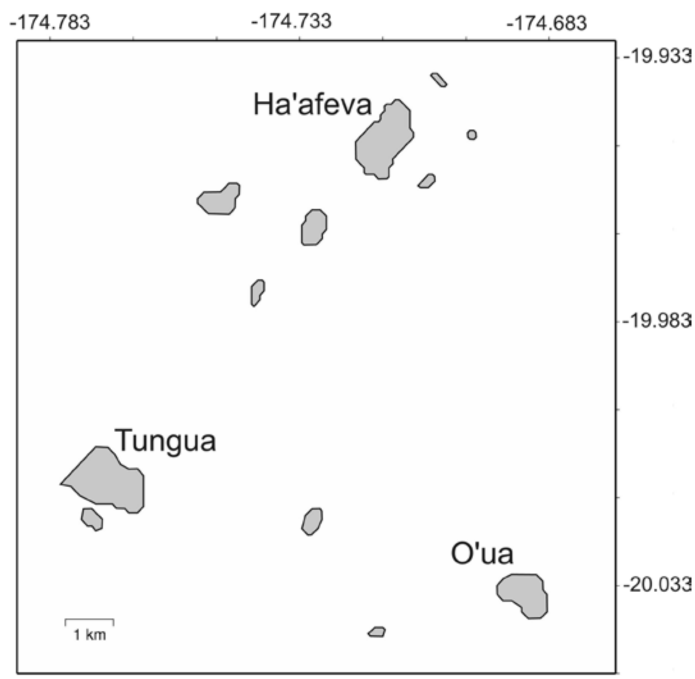

Figure 1. Map of Tonga showing study sites in the Ha'apia Group

methods, traditional and subsistence catch, disposition of the catch, and perception of the stock status.

There were 608 marine turtles reported caught during 2007, with hawksbills being captured twice as often as green turtles (Table 1). Fishermen in O'ua caught turtles for home consumption and some local sales or barter. In Ha'afeva, turtles were caught for home consumption, some local sale, and also traditional occasions particularly for the quarterly meeting of the Siasi Tonga Hou'eiki (Church of Tonga). Fishermen in Tungua, with the largest catch, use some for local subsistence but is primarily used for a commercial market with a local middleman buying the turtles and arranging for transport and sale mainly to the main island of Tongatapu. There may also be a smaller shipment of turtles to Tongatapu from other villages; Fonua (2005) provides a photo of 5 turtles being shipped to Tongatapu from Ha'afeva for distribution to relatives. The price of turtles supplied by local informants was US$3.50 (7 Tonga Pa'anga or TOP)/kg for sale in the local village and US$5 (10 TOP)/kg for the commercial market. Large turtles could bring $US150 (300 TOP).

In both O'ua and Ha'afeva the average catch was 7.6 turtles per fisherman while in Tungua they captured an average of 23.9 turtles per fisherman with 4 fishermen catching from 30 to 100 turtles per year (Table 1). These large catch rates would appear to be the result of the recently developed commercial fishery and may be putting considerable pressure on the sustainability of the turtle harvest.

As most of the turtles that are consumed locally were cooked in the shell in an earthen oven (*Umu*), following which the shells are discarded, it was not possible to measure shells to determine sizes. However, the survey responses suggested that turtles were of medium size, probably in the 50-70 cm size range. This may be the result of the Tongan Fisheries regulation that sets a minimum shell width of 45 cm for captured turtles. A few large adult turtles, including occasional nesting turtles, were also reported caught.

Turtles were captured in a variety of ways (Table 2). Free diving is done by expert divers who know where turtles rest or sleep. Spearing is a targeted turtle hunting activity normally conducted from a boat but the fishermen may also jump in the water and chase the turtle in order to spear it. Spear-fishing is an incidental capture of turtles when fishermen are targeting coral reef fish but spear turtles when they find them, particularly if the turtles are resting. Nets are used traditionally for capturing large turtles for traditional events and tend to target green turtles. These nets called *kafafonu* previously were made from twine spun from coconut husks (*kafa*). Previous reports (Fuka 1979 quoted in Bell et al 1994) suggest these nets had a mesh size of 41 cm (16 in). New materials such as cotton multifilament and monofilament appear to have replaced the traditional nets, and a monofilament net was observed being made in Ha'afeva during this survey. The mesh size was not measured but the fishermen indicated it was 91cm (36 in). This large mesh size would only catch large adult green turtles. In Ha'afeva, the fishermen also used a traditional fence (weir) to hold the turtles captured for cultural activities. Other capture methods included *tuli* (chasing after the turtle until it tires) and capture of nesting turtles.

Overall 62% of fishermen used spearing and spear-fishing. In O'ua and Ha'afeva, the largest number of fishermen used spear-fishing. In Tungua, 43% of the fishermen used free diving alone. These fishermen are renowned for their freediving skills and knowledge of turtle feeding or resting areas. Fishermen in O'ua and Ha'afeva also occasionally used the more traditional method of net fishing, and although they catch large turtles, they usually catch less than 10 turtles per year in the nets.

Fishermen were asked if the turtle populations were increasing or decreasing (Figure 2). It is interesting that in spite of previous reports and an apparent decline in nesting turtles, <50% of fishermen reported that turtle stocks are declining and almost 40% indicated stocks were increasing. In O'ua, almost 60% of respondents suggested a decline in stocks, possibly because of increased awareness of turtle conservation related to the implementation of the Coastal Community Management Plan in 2005.

As indicated previously, there is little recent information on turtle nesting in Tonga. The researcher visited two uninhabited Islands, Fonuaika and Nukulei, searching for nesting turtles, tracks or nests. A nesting survey in December 1971 (Koloa 1972) found 12 nests (no species listed) on Fonuaika, while a survey in December 1973 (Braley 1974) found 5 nests (probably green) and one green nesting female on Nukulei. In our study, we did not observe nesting turtles but on Fonuaika Island, six recent hawksbill nests were observed, and on Nukulei Island seven hawksbill nests were found above the beach in the vegetation.

Overall, our survey estimated that 608 marine turtles were captured in the three villages in the Ha'apai Group in 2007. Although not all fishermen in each village were surveyed it appears most of the fishermen were interviewed particularly those that captured the most. It is not clear how representative these three villages are of others in Ha'apai, but Koloa (1973) identified 10 islands and villages in Ha'apai, including these three, where turtle hunting was practised in 1972. Thus the 608 turtles may represent a lower limit of the number of turtles captured in the Ha'apai Group. It is unknown whether this catch is sustainable, although many fishermen perceived that the catches were not declining or were stable. However, the recent increased catch rates in Tungua for the commercial market gives cause for concern. The limited data on nesting suggest the

Island	Fishermen surveyed	Species caught (%) Hawksbill	Green	Total Turtles Caught (%)	Mean (±SD) caught per fishermen
O'ua	22	111 (27.1)	56 (28.3)	167 (27.5)	7.6 (21.70)
Ha'afeva	14	84 (20.5)	23 (11.6)	107 (17.6)	7.6 (9.46)
Tungua	14	215 (52.4)	119 (60.1)	334 (54.9)	23.9 (30.37)
Total	50	410 (67.4)	198 (32.6)	608 (100)	

Table 1. Turtle catch by fisherman from three villages in the Ha'apai Group, Tonga in 2007

Islands	Diving n=12	Spearing n=10	Spear-fishing n=21	Net n=4	Others n=3
O`ua	18%	18%	50%	9%	5%
Tungua	43%	21%	29%	-	7%
Ha`afeva	14%	21%	43%	14%	7%
Overall Percentage	24%	20%	42%	8%	6%

Table 2. Methods used to capture turtles in three villages in the Ha'apai Group, Tonga

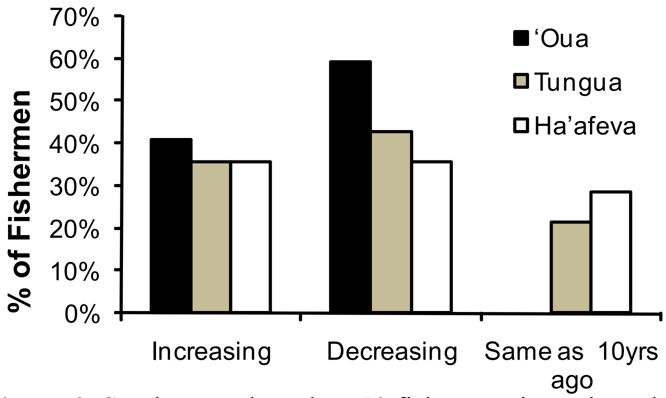

Figure 2. Stock status based on 50 fishermen interviewed in three villages in Ha'apia, Tonga

levels are similar to the 1970s but there may be a decline in green turtle nests. It is important that long term monitoring of nesting beaches and turtle catches be implemented to address the question of sustainability.

The Tonga Conservation and Management Regulation 1994 (after Bell et al. 1994) states that: *No person shall: (a) disturb, take, have in his possession, sell or purchase any turtle eggs; (b) interfere with or disturb in any turtle nest; (c) sell, purchase or export any turtle or shell thereof of the species* Eretmochelys imbricata*, known as the hawksbill turtle; (d) use a spear or spear gun for the purpose of capturing, destroying or taking any species of turtles; (e) closed seasons: All species except leatherback – November to 31 January; Leatherback – January to 31 December.* There was also a ban in Tonga on killing turtles but that was lifted in early 2005. There is a minimum size limit such that: *the width of the turtle shell not be less than 45cm* (Fonua 2005). It is obvious from this study that a number of the regulations are not being adhered to, including the sale and purchase of hawksbill turtles. Catching undersize marine turtles was reported by a few fishermen. Spears and spear-fishing are used by 62% of fishermen and the closed season is only partially respected, as in Tungua where fishermen stop commercial fishing but continue to fish for subsistence use during this period. There were also reports of nesting turtles and eggs being taken.

The challenge of effective enforcement is compounded by the remoteness and isolation of nesting islands and turtle catching areas. There are few fisheries officers located near turtle hunting areas. There is also a lack of awareness and appreciation for the need for a more sustainable approach. Unlike elsewhere in the Pacific, there is little recognition of traditional marine tenure, and the Tongan Kingdom claims authority over all marine waters below high tide. This situation is not conducive to the development of community-based management and conservation in Tonga, unlike what has occurred in other Pacific Island countries (MacKay 2004). There are, however, encouraging signs, particularly the introduction of the Coastal Community Management Plan in O`ua. The implementation of this plan has led to the establishment of village-based fisheries officers who can check the catches, monitor and report illegal fishing. They also have the power to confiscate fish caught illegally within the village fishing territory. The involvement of local fishermen and officers is a milestone and it will help with the enforcement of the regulations. This is also enlightening other communities.

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Foraging Turtles Around Tetepare Island, Solomon Islands

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The Island of Tetepare in Western Province, Solomon Islands is the largest uninhabited island in the South Pacific (Figure 1). The original inhabitants fled the island in the mid 1800s. Since then there has been very little habitation, the island has intact primary lowland rainforest and the marine resources are considered to be relatively undisturbed and in better overall condition than many other places in the Pacific. The island and the associated reef system have been repeatedly recommended for formal protection (Diamond 1976; Lees 1990; Read & Moseby 2005).

The descendents of the original inhabitants now live in various communities on adjacent islands and are recognized by Solomon Islands law as the owners of these resources. They have formed the Tetepare Descendants' Association (TDA), the largest land owner association in the Solomon Islands. They maintain an ecotourism lodge and a field research station on Tetepare. They have also established a Marine Protected Area (MPA) and have resident TDA Community Rangers who monitor the MPA and other Island resources. TDA has received financial and technical support from various sources, including volunteers supplied by CUSO (a Canadian organization), and visiting international researchers.

Tetapare and the adjacent areas of Rendova Island have been identified as an important nesting area for leatherback turtles (*Dermochelys coriacea)* (MacKay 2005) with more than 100 nests in some years and up to 35 nests on Tetepare (TDA unpublished results). A significant earthquake occurred in the Western Province of the Solomon Islands in April 2007, resulting in major landslides that buried the most significant leatherback nesting beaches on Tetepare in debris. No successful leatherback nesting has been observed on Tetepare since this time. Ongoing monitoring will be required to determine whether ongoing tidal action will restore these beaches and whether nesting success will improve again.

On Tetepare the rangers patrol and collect data from the nesting beaches and assist in protecting the locally declared Marine Protected Area. Since 2004 they have been catching, tagging and releasing other turtles on the foraging grounds during regular patrols (Figure 2). This paper reports on the results of their work.

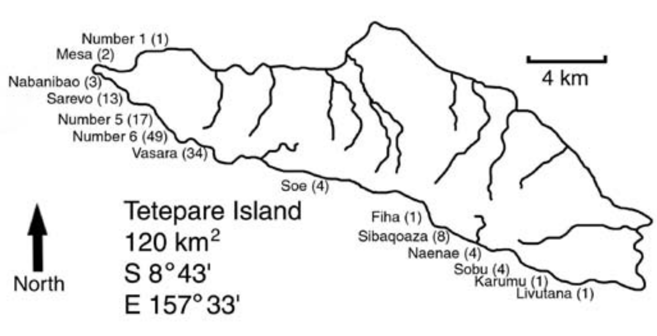

Figure 1. Map of Tetepare Island showing the locations of turtle capture.

Turtles were captured by the Tetepare rangers using a rodeo style technique in shallow lagoon waters (1-2 m deep) behind the island's barrier reefs. The rangers are efficient turtle catchers as they are skilled spearfishers and some have previously hunted turtles. Using a fibre-glass boat equipped with a small outboard engine, the capture team would patrol the lagoon at or near high tide. When a turtle was spotted at or near the surface a ranger would jump into the water and attempt to capture it at the surface. If this failed they would dive down and follow the turtle until it could be captured and brought to the surface. If the first ranger missed the jump, the patrol boat would pursue the turtle and a second jumper would attempt to capture the turtle. Once the turtle was captured and at the surface it would be brought in to the boat where it would be measured, sexed, inspected for injuries, flipper tagged and then released. Patrols were made on a monthly basis, with some captures made opportunistically.

As a follow up to this work an experienced turtle researcher (Barry Krueger) visited Tetepare in early February 2008 and worked with the rangers over a five day period using the above rodeo technique, day time SCUBA and night time free dives. Turtles were tagged, measurement data recorded and tissue samples for DNA analysis were collected (DNA sample analysis has not been completed at the time of this writing).

Green turtles (*Chelonia mydas*) are commonly found in the lagoons around Tetepare foraging on the abundant sea grass beds. From 30 May 2004 to 8 February 2008, 145 green turtles were captured, including 10 recaptures, over 58 days of capture. 136 turtles were tagged. All turtles were measured for curved carapace length (CCL), curved carapace width (CCW) and examined for marks, scars, missing flippers, barnacles, and other unusual features. All captured turtles were apparently feeding at the time of capture. The captured turtles ranged in size from 41.0 to 98.0 cm CCL and

Figure 2. TDA Rangers (from the left Moses and Hickson, and TDA tour guide Frasier) recording data and tagging a green Turtle, Tetepare Island

the majority of green turtles encountered were juveniles or subadults (Figure 3). Over the entire study period, the mean CCL was 59.4 cm and mean CCW was 54.8 cm. Mean CCL and CCW values were not different between years, although the 2008 5-day sampling had a lower but not significant mean (Table 1).

These sizes are comparable to previous work in the Solomon Islands. In a detailed foraging ground survey (1994-96) within 50 km of the hawksbill turtle rockery in the Arnavon Islands 165 green turtles were captured with a mean CCL = 56.2 cm, while those captured by fishermen when hunting were >65.1 cm (Broderick 1998), although no length frequencies or ranges were given.

The minimum size found at Tetepare (41 cm) is comparable to Great Barrier Reef stocks that recruit to the foraging grounds ca. 40 cm (Limpus & Chaloupka 1997). Larger turtles from 80 to 99 cm in the waters of Tetepare may have been adults. Limpus et al. (2003) suggested that there is considerable variation in size at first maturity for Raine Island, Northern Queensland, Australia, including some turtles with 85 cm CCL being reproductively active. Although sexually dimorphic characters of adult males such as extended tails and enlarged flipper claws were not consistently recorded, TDA rangers did document one 84 cm CCL animal with these characters in January 2005. This suggests that Tetepare is an important foraging area for green turtle juveniles, sub-adults, and some adults.

The highest concentration (82%) of captured turtles was at the southwest end of the island (Figure 1). Numerous green turtles were also seen at depths of 10-20m while SCUBA diving off the reef edge in this area. This concentration may be due to the extensive seagrass beds located here but it is also close to the Tetepare Field Station, and as such was sampled more extensively. A smaller number were captured at the southeast end. Green turtles are rarely observed along the north coast of the island and there were only two captures at the northwest end. The north coast of the island is characterized by fringing reefs and has little in the way of suitable foraging areas for green turtles.

The Rangers recaptured nine tagged turtles, ranging from 11 to 662 days at large. Only one turtle was recaptured twice. It was tagged on 6 May 2005 and recaptured on 27 January and again on

Study period	Turtles caught	Turtles tagged	Recaptures	CCL	CCW
May 2004 -Jan 2005	8	8	0	67 ±16.9 (47.0-91.3)	63.3 ±14.5 (46.5-86.4)
Feb 2005 -Jan 2006	71	67	3 in season, 1 previous year	60.1±13.41 (42.2-98.0)	54.9 ±12.1 (35.0-92.0)
Feb 2006 -Jan 2007	38	33	1 in season, 5 previous year	59.3 ±10.8 (46.0-84.0)	54.9 ±9.85 (43.0-76.0)
04-08 Feb 2008	28	28	0	65 ±13.1 (41.0-94.0)	52 ±10.7 (39.2-82.6)
Total	145	136		59.4 ±13.0 (41.0-98.0)	54.8 ±11.5 (35.0-292.0)

Table 1. Turtles captured between 2004-2008 in Tetepare. CCL = curved carapace length, CCW=curved carapace width.

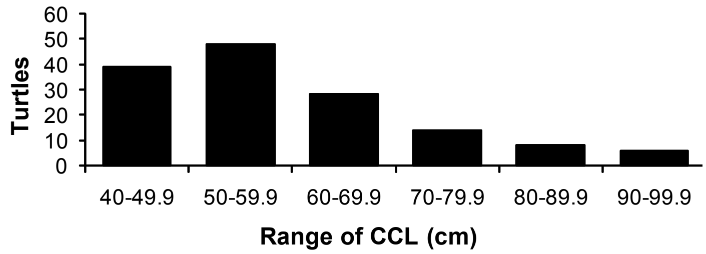

Figure 3. Size frequency (CCL) of foraging green turtles captured 2004-08 Tetepare Island, Solomon Islands

1 February 2006. This turtle was missing a full right front flipper. All the recaptures were within a few kilometers of the release sites and were concentrated on the southwest end of the island. Other tagged turtles were occasionally seen by the rangers but these turtles evaded captured. Although the sample size is small, based on six recaptures of turtles that had been at large from 229 to 662 days, the average increase in CCL was 4.68 cm/year (0.39 cm/month). This would appear to be on the high side of previously published growth rates (Bjorndal & Bolten 1988; Limpus & Chaloupka 1997) and more than double the rate of 2.16 cm/year previously reported for Solomon Islands from the Arnavon Islands (Vaughan 1981). Assuming that over the 40 to 80 cm range that this growth rate is constant, Tetapare turtles would take 10 years to grow from 40 to 85cm, the suggested minimum size of maturation (Limpus et al., 1994). The assumption of constant growth is valid for Hawaiian turtles (Zug et al 2002), while GBR turtles show a growth spurt in the 50-60 cm range (Limpus & Chaloupka 1997).

Green turtle nests are occasionally seen on Tetepare with two nests observed on Tirokofi Beach in June 2005 and two nests on Kaife Beach in January 2006. Two nesting turtles (mean CCL=96.5 cm) were tagged and measured during October and November 2006 on Rarumana and Qeuru Beaches. The nester on Queru beach was observed during a false crawl 23 days later. Local subsistence harvesters report seeing occasional green turtle nests (identified by tracks) on Queru and Tofa, the main leatherback nesting beaches. These nesting beaches were the ones most heavily damaged by the earthquakes in 2007. The nearby Hele Islands are reported to be potentially important green turtle nesting beaches, but nesting success is thought to be limited by heavy harvesting pressure on both eggs and adult turtles. No confirmed production of green turtle hatchlings on either Tetepare Island or Hele Islands were recorded during the period reported here.

While hawksbill turtles (*Eretmochelys imbricata)* are occasionally seen, only one foraging hawksbill was captured at Tetepare during the three year period. In the February 2008 survey, five hawksbills were captured: one in shallow water; two in the 12-13 m range (captured by SCUBA); and two at night when the turtles were sleeping under coral ledges (free diving to 6m). Captured turtles ranged from 41-55 cm CCL with a mean of 47.1 cm. No hawksbills have been observed nesting at Tetepare. It appears that hawksbills are much less abundant and are found in greater depths than green turtles. There have not been any hawksbill recaptures to date.

Tetepare Island is considered an important site for nesting of the highly endangered Pacific leatherbacks. This report indicates it is also an important foraging area for green turtles and supports a smaller number of foraging hawksbill turtles. The size classes present suggest that recruitment to near shore habitat for both hawksbills and greens occurs around 40 cm CCL. The presence of green turtles over 85 cm CCL indicates that some adult turtles also forage here. Preliminary estimates of growth based on recaptured turtles suggest growth is at the upper end of what is reported from the Pacific and Caribbean for green turtles and it could take at least 10 years for first recruits to reach adult size. Given the current conservation efforts at this site, the continued work of the well-trained and motivated local rangers will provide greater insight into growth, and foraging ground population size and structure of green turtles in this area. Ongoing genetic analyses of tissue samples collected from Tetepare will help determine the source rookeries of the observed foraging turtles. This information will help inform conservation efforts.

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LETTERS TO THE EDITORS

Comments on Mrosovsky's Suggestions for Orissa

I have read with interest the views and suggestions of Dr. Mrosovsky (2008) for the consumptive use as a component of a conservation strategy, for consideration in relation to the situation in Orissa. There are mainly two suggestions: (1) Legal turtle harvest (2) Removal of eggs to optimize hatching success. In this regard I would like to say that though the suggestions are sound his statement "Regionally appropriate systems are needed" is relevant here-they are not possible in Orissa.

The conditions as well as arribada frequencies are different between Orissa and Costa Rica. There is no demand either for eggs or turtle meat here. There are no natives comparable to those in Costa Rica who traditionally harvest turtles. I have always pointed out that olive ridleys have shown a lot of wisdom in choosing Orissan coast for nesting as we oriyas (oriya speaking inhabitants of Orissa) do not eat turtle eggs or meat perhaps because of the Vaishnavite (people worshipping Lord Vishnu) tradition where the sea turtle is revered as Kurma, the turtle incarnation of Vishnu. Before ban on turtle harvesting for conservation, the turtles were caught and eggs were collected by the opportunistic local fishermen for transport to Calcutta market as bengalees (Bengali speaking inhabitants of Bengal) are very fond of turtle meat. Those days are gone when the local fishermen could exploit the seasonal arrival of turtles and nesting in predictable area and time. The nesting grounds were extensive allowing for collection of boatloads of eggs in Bhitar Kanika by paying a tax of Rupees 15 per boat! I have already reported about almost a 100 km nesting area in Kanika described by Hamilton in 1708 (Mohanty Hejmadi, 2000). Astronomical number of turtles must have nested some 300 years back! Now only about 2-3 km are suitable for the nesting in the region. At present, the question of local people benefiting from legal turtle or egg harvest does not arise in Orissa. When it comes to protein we are notorious for not eating a large variety of edible fauna. We export shark fins, clams, snails, cuttlefish etc. but do not eat them. Whatever cannot be sold is discarded irrespective of the food value. The psychology of eating takes precedence over practical solutions like protein supplements etc. People will starve to death but not change their feeding habits! This is culture specific.

The unpredictability of nesting time,site, and period from year to year has made management planning difficult. Any kind of economic exploitation as suggested by him is also not possible. There is enough evidence that the turtles consider the whole of Orissan coast suitable for nesting and may nest in one area followed by another in the following year. This has baffled us because; they do gather to mate off the coast in the predictable area and time in November and December but may chose to nest in any of the month from January to April. To cope with this situation a regular hatchery program is run in the most suitable place each year by the forest department. I would like to place on record that the methodologies were standardized in a joint project run by me and the forest department (with direct involvement of Chandrasekhar Kar who has been working with the olive ridleys since their declaration as a protected species in 1975); with a generous grant from DRDO with the intervention of Dr. A.P.J.Abdul Kalam who was then heading our missile program in Wheeler Island close to Gahirmatha nesting ground. (Dr. Kalam later became the President of India). Chandrasekhar successfully utilized the agricultural nettings allowing different amounts of sunlight to set up different temperature regimes to take care of the sex ratio (unpublished results). Every year, such hatcheries are established in areas where there are indications of maximum beach erosion and therefore, loss of eggs. This is an alternative to the suggestions of Dr. Mrosovsky's to adapt to our unpredictable olive ridleys!

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Ridleys in Orissa: Reply to Mohanty Hejmadi

It is usually easier to find reasons for not doing something than finding support for experimental trials designed to learn if a proposed measure is, or can be modified to be effective and feasible. This surely is the response when it comes to questions about consumptive use of sea turtles: it cannot be successful, it should not be tried. Nevertheless, Professor Mohanty Hejmadi's (2009) thoughtful letter is welcome. Exploring different viewpoints, discussions of opinions and editorials, is one of the functions of the MTN. A few specific points in reply:

1) Sea turtle eggs and meat are still eaten in many parts of India. The pages of Kachhapa and the Indian Ocean Turtle Newsletter frequently refer to the consumption, exploitation, harvest, poaching, sale or trade of marine turtle meat and/or eggs (Bhupathy 2007; Bhupathy and Saravanan 2002; Kakodkar 2006; Katdare 2008; McCann 2007; Pandit 2008; Shanker 2003; Tripathy 2001; see also Mohanty Hejmadi 2008 for Gulf of Mannar). Such reports do not suggest that cultural practices and religious beliefs preclude the consumption of sea turtles in India.

There are indeed also places where the former poaching and consumption of sea turtle eggs and meat has ceased or is much reduced. Mohanty Hejmadi (2009) mentions the markets of Calcutta (see also Kumar 2007). It is generally thought that beach patrols and other activities of NGOs, together to some extent with regulations and enforcement, have contributed to these changes, rather than an upsurge in religious observance.

2) Even if the latter were the case in particular regions or communities, it does not negate the possibility of consumptive use of eggs obtained from thinning out of nests on overcrowded beaches. The eggs, or products derived from them, could be sold to people in other parts of India or in countries where such food is relished. It is my understanding that in Costa Rica few of the harvested ridley eggs are eaten at the beachside village of Ostional itself; most are sold in other venues. But the Ostional cooperative still benefits from these sales and thereby has a stake in the persistence of arribadas.

In Orissa it does not appear that turtle eggs were ever widely consumed by people locally. However, based on the account by Shanker and Kutty (2005), large numbers of eggs used to be collected from the Gahirmatha nesting beach. Presumably many went to Calcutta. Some were also sold locally in villages in Bhitarkanika. Large quantities of these were dried and preserved for use as feed for livestock.

3) I agree that the logistics of commerce present some challenges but these are not necessarily insuperable (see Mrosovsky 2001 for suggestions) - unless one starts with the mindset that it cannot be done. If - because of the unpredictability of where the arribadas will come ashore - hatcheries are run at the most suitable place each year, the same could be done with harvesting.

4) If consumption of doomed eggs is not permitted or not wanted, the question remains as to what if anything should be done with such wasted protein. Some options have been discussed elsewhere (Mrosovsky 2006). It is debatable whether giving animals that have failed the test of natural selection a second chance is the best.

Acknowledgements: I thank Kartik Shanker for informative suggestions.

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IUCN-SSC Marine Turtle Specialist Group Quarterly Update

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MTSG Annual General Meeting. The IUCN/SSC Marine Turtle Specialist Group will hold its Annual General Meeting in Brisbane, Australia on the mornings of February 15 and 16, 2009 from 08:30 – 12:00, prior to the inception of the 29th Symposium on Sea Turtle Biology and Conservation. As has been the case with prior meetings, we will split into two sessions; the February 15 morning session will be a forum in which MTSG Regional Vice Chairs can make brief presentations and entertain questions on the current events related to general conservation issues and their respective regions. The second morning session on February 16 will be reserved for the broader discussion of special topics; the list of special topics is not complete at the time of writing, but will likely include an overview of the MTSG "Burning Issues" process, as well as updates in critical issues such as direct take of sea turtle in Southeast Asia. The Co-chairs will notify the MTSG membership in advance of the precise venue and agenda.

Red List Assessments. MTSG Red List Focal Point, Milani Chaloupka, reports that the group has made noteworthy advancements with species assessments. A revised draft flatback assessment is nearing completion and will be circulated for comments soon to the membership. The Draft Kemp's ridley assessment is now completed and under review by Assessment Steering Committee (which is also the Marine Turtle Red List Authority). In addition, a draft regional-specific assessment for the endemic Hawaiian green turtle is completed and ready for review by the Assessment Steering Committee. A draft regional-specific assessment for the Mediterranean green turtle is also nearing completion, and will be sent on to the Assessment Steering Committee review in the months ahead.

North West Atlantic Region. Conservation happenings in the North West Atlantic Region centered on the loggerhead sea turtle. The region hosts one of the two largest nesting assemblages for the species in the world. Analyses completed this year reveal that loggerhead nesting in the region has declined over the past 20 years. Loggerhead conservation in the region will be guided by an updated recovery plan for loggerheads in the northwest Atlantic. The US Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) signed the plan in the closing days of 2008. The draft plan is at: http://www.fws.gov/northflorida/

The loggerhead is currently being considered for reclassification under the US Endangered Species Act (ESA). In 2007, NMFS and FWS received petitions requesting that the loggerhead sea turtle in the North Pacific and in the western North Atlantic be reclassified as respective distinct population segments (DPSs) with Endangered status and that critical habitat be designated. NMFS and FWS, who share jurisdiction of loggerhead turtles under the ESA, determined that both petitions presented substantial information that the petitioned actions may be warranted. Thus, NMFS and FWS committed to assess the loggerhead listing status on a global basis. DPS policy defines a population to be a DPS if it is both discrete and significant relative to the taxon to which it belongs.

NMFS and FWS convened a biological review team (BRT) consisting of federal and state agency scientists and program specialists knowledgeable in sea turtle biology and population structure. The BRT is charged with assessing the loggerhead listing status on a global basis. The BRT is reviewing data relevant to population discreteness and significance and is preparing a report with their findings, which will form the basis for NMFS and FWS to determine whether, and if so, how, the current global loggerhead listing should be modified.

Japan. In early December, Co-Chair Nick Pilcher was invited by MTSG members in Japan to make a presentation on the impacts of hatcheries and prolonged retention of hatchlings at the Symposium for North Pacific Loggerhead Turtle Conservation in Japan, held at Kagoshima University, in southern Japan. The symposium was hosted by NHK Kagoshima along with the Sea Turtle Association of Japan, USFWS, NOAA-NMFS, and Pro Peninsula. The main objectives of the workshop were to highlight the threats and impacts to loggerhead turtles in Japan and to raise local awareness of loggerhead conservation. Presentations also included views on the current threats and population status of loggerhead turtles in Japan, coastal fishery impacts and bycatch (particularly in the coastal pound nets - *teachi-ami*), coastal armoring and other barriers to sea turtle nesting, beach nourishment and effects on sea turtle nesting, along with overviews of the history of sea turtle conservation in Japan and the Fishery Agency's involvement in sea turtle conservation, and a number of presentations by the local prefecture and agencies. The meeting was a great success, with substantial coverage by the Japanese press, and a unique opportunity to share concerns and conservation stories with government agencies.

Update on Dhamra Port Situation, India. In Dhamra, the proposed meeting which had been scheduled for September last year had to be rescheduled, and is now planned for late February, 2009. The dredgers onsite continue to use dragheads at all times, and the Port, in conjunction with the IUCN staff on the ground, have developed a street dance and theatre group to highlight turtle conservation issues in the surrounding villages. This effort is a moving theatre with script, sets, costumes, lights, music, dance, and the story is of the small family of Siba Behera and his wife Paro and their two sons, Sania and Sapana. The story weaves in turtles, livelihoods, education and religion, and has been extremely well received. This local community success is thanks to Biren Bhuta, IUCN project manager.

Southeast Asia. The MTSG is also getting more involved with the direct trade and poaching of turtles in Southeast Asia. This issue was raised at the last Annual General Meeting in Loreto, and has the potential to strip the Southeast Asian region of turtles if not addressed right away. The issue has been raised again numerous times by MTSG members Chan Eng Heng from Malaysia, Romy Trono from the Philippines and Nick Pilcher at a number of fora. These efforts have resulted in the scheduling of a key meeting to be held in April with fishers and officials from Hainan and regional conservation agencies to look into avenues of addressing this worrying threat. We trust this will be the beginning of a fruitful engagement with fishers in the region to curb the loss of hundreds and hundreds of turtles each year in direct, purposeful harvests.

Bycatch Mitigation. More recently, a significant number of MTSG members have been contributing to the Technical Workshop on Minimizing Sea Turtle Interactions in Coastal Gillnet and Pound Net Fisheries, co-hosted/sponsored by the Western Pacific Regional Fishery Management Council, IUCN, National Fish and Wildlife Foundation, Save our Seas Foundation, SEAFDEC, NOAA and the IOSEA MoU Secretariat, and held in Honolulu between 20 and 22 January 2009. This workshop brought together gear specialists and turtle conservationists to push forward global efforts on mitigating turtle bycatch in coastal fisheries. MTSG members represented included Nick Pilcher, Kate Mansfield, Jeff Mangel, Joana Alfaro-Shigueto, Ana Barragan, Martin Hall, Eric Gilman, Yamin Wang, Larry Crowder, Rebeca Lewinson, Hoyt Peckham, Yonat Swimmer, Neca Marcovaldi, Milani Chaloupka, Scott Eckert, Bundit Chokesanguan, and Irene Kinan.

NEWS AND LEGAL BRIEFS

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AMERICAS

Local Group Receives GEF-SGP Grant for Sea Turtles

The St. Kitts Sea Turtle Monitoring Network (SKSTMN) has been successful in securing a Global Environment Facility–Small Grants Programme (GEF-SGP) grant for implementation of the project "Creating Sustainable Livelihoods through Community Based Sea Turtle Conservation in St. Kitts/Nevis." This is the first successful full grant provided by the GEF-SGP in St. Kitts, and the total budget for implementation of the project is $47,673.90. GEFSGP exists to address global environmental problems at the community level. Its objectives are to achieve environmental sustainability, alleviate and reduce poverty, and develop capacity. Some of the goals of the SKSTMN's funded project include the development and implementation of a turtle friendly certification process for businesses within close proximity to nesting beaches, the development of a sea turtle eco-tour package, the development of alternate employment for sea turtle fishermen and local citizens through craft making and tour guide activities, and the protection of the two main leatherback nesting beaches. It was also announced that members of the SKSTMN will begin delivering presentations on the programme to several communities in January. Schedules of these presentations will be made available on their Web site at www.stkittsturtles.com. Source: *Sun St. Kitts/Nevis*, 6 December 2008

Weather Cited in Dozens of NC Sea Turtle Strandings

Sea turtles, stunned by the cold temperatures, are washing up on Outer Banks beaches in overwhelming numbers this month - so many that rescuers can barely keep up and space for them is filling up at the North Carolina Aquarium on Roanoke Island. Michelle Bogardus, sea turtle biotechnician at Cape Hatteras National Seashore, said the sudden drop in water temperatures apparently caught the turtles -most of whom had been feeding in the Pamlico Sound - by surprise. The reptiles do not adapt well to water below 50 to 60 degrees. With about 40 strandings on Hatteras Island so far this month - double the number last November - harried stranding staff members and volunteers are spinning in circles trying to help the cold-blooded animals fast enough. Before last year, it was typical to see fewer than 10 strandings in November. Most of the turtles found alive will recover if they're caught in time, Bogardus said. Wendy Cluse, assistant sea turtle biologist with the NC Wildlife Resources Commission, said that when the turtles are cleared for release by wildlife veterinarians, they will be taken by boat to the Gulf Stream to be released. Source: *Virginian Pilot*, 26 November 2008

State Panel Floats 'Litter Tax' to Curb Debris Along Coast

The influential California Ocean Protection Council has proposed an attack on everyday threats to sea life, including a ban on some popular take-out food containers and fees on plastic and paper bags. The panel also recommended imposing upfront charges on other packaging commonly left on beaches, such as snack-food bags and candy wrappers. This so-called litter tax also would extend to cigarettes because so many butts are extinguished in the sand. The proposals must be enacted by the Legislature, which has balked at tax increases and defeated a bill last year to tack a charge on plastic bags at the checkout counter. There's also stiff resistance from powerful business interests warning of higher costs during the economic downturn. Makers of plastics said they are taking voluntary steps to cut waste. Ocean litter threatens rare sea turtles, sea birds, sea otters and hundreds of other marine species. Many animals mistake litter for food and ingest the potentially deadly debris. Eighty percent of ocean litter comes from land sources, the ocean council said. Trash gets trapped in places where ocean currents and winds converge. One of the most prominent problems is in the North Pacific gyre, where a "trash island" weighing roughly 3.5 million tons floats about 1,000 miles off California's coast. The council, established by the California Ocean Protections Act of 2004, coordinates the activities of ocean-related state agencies and proposes legislative changes. Lawmakers are expected to introduce measures for reducing ocean litter in coming weeks, but those bills may become tangled in the state's budget morass. Meanwhile, conservationists are pushing local initiatives. On Wednesday, the natural resources committee of the San Diego City Council will review a draft ordinance to prohibit major grocery stores and pharmacy chains from providing plastic carry-out bags. Bans or fees on bags have been adopted from San Francisco to Mumbai, India. The Los Angeles County Board of Supervisors has voted to impose a ban on such bags if voluntary programs to reduce their use don't succeed. Source: *San Diego Union-Tribune*, 1 December 2008

$7M Institute for Marine Mammal Studies to Open Soon

Dolphin lovers at the Institute for Marine Mammal Studies are flipping over their new state-of-the-art museum and research facility expected to open within the next few weeks. IMMS President Moby Solangi said the new 12-acre Center for Marine Education and Research will open as soon as Harrison County officials can pave the entrance along the Industrial Seaway. With more than 750,000 gallons of tank space, and a veterinary hospital and surgery center, Solangi said the facility will be unmatched by any other marine mammal research center along the Gulf of Mexico. IMMS, a nonprofit group established in 1984, will use the facility to study and treat injured animals. Those that cannot be released back into the wild could eventually be housed at the nearby oceanariums or a future aquarium on the Coast. It will be the first facility completely devoted to dolphin rescue and rehabilitation in Mississippi, Louisiana and Alabama, and the only facility capable of caring for sick and injured marine mammals. In addition, IMMS will be able to rehabilitate sick and injured sea turtles. The $7 million facility also includes a necropsy lab, a pump house for operating life-support systems, fish houses to store food and three pools capable of housing animals at any stage of rehabilitation. The facility includes classrooms and laboratories, a museum and a 200-seat auditorium. IMMS officials hope to book numerous educational tours and school field trips. Since 2006, IMMS has spread its message of conservation during more than 70 classroom visits and the institute also has rescued hundreds of stranded creatures in its 24-year history. Source: *Biloxi Sun Herald*, 29 November 2008

Researcher Recognized by Popular Science

Bringing the sexy back—leatherback that is. UBC doctoral candidate in zoology Todd Jones was named to Popular Science magazine's prestigious "Brilliant Ten" list for his success in keeping juvenile leatherback sea turtles in captivity, providing vital comparative data for research and conservation. Jones was selected along with other young scientists. Popular Science had spent six months scrutinizing hundreds of nominations received from university department heads and professional associations across the US to finalize their top ten list. What makes Jones's study unique is that it is the only one to raise more than one leatherback in captivity from hatchling to juvenile. "[Our research is the] first to answer the basic biological questions: what are their juvenile behaviours? When will these leatherbacks reach puberty? How can these patterns affect their number [in the sea]?" Jones said. Leatherbacks are not hard-shelled like most turtles, but rather their back resembles "skin, [that is] rubbery like a dolphin," and past researchers could not prevent the leatherback from "bumping into the tank walls…giving cuts and abrasions," he said. To circumvent damage to the delicate turtles' skin, Jones used a soft rubber harness that kept them from hurting themselves during the crucial development times. The result is the record-breaking two healthy two-year-old leatherback turtles swimming happily in captivity. Jones is excited to work closely with leatherback turtles, "[I see them] daily, seven days a week, 52 weeks a year" says Jones, "It didn't matter if it was a birthday or Christmas, [I] had to be there for the last two and half of years." This attitude had earned him the Dean Fisher Memorial Scholarship in marine biology in 2002 and now, got him in Popular Science's Seventh Annual Brilliant Ten, focusing on ten outstanding young scientists. On a last note, Jones offered advice: "If people are inspired and they want to help, pay attention to what they are eating….If it's seafood, check online to see if they are having an endangered species." He adds, "Pollution does end up in the ocean including plastics that can harm the ocean environment….Being aware of these everyday sustainable ways can help." Without these conservation studies, the last 5000 leatherbacks remaining may become "extinct in our lifetime," he said. Source: *The Ubyssey*, 7 November 2008

Turtle Advocate Wins Award

Jean Beasley was honored Nov. 16, 2008 in King Hall Auditorium as the 2008 recipient of the Albert Schweitzer Honors Scholars Award. The award recognized her efforts to help save sea turtles. The purpose of this award is to recognize a person in the Cape Fear area who exemplifies the attributes and ideals of Dr. Albert Schweitzer. Beasley is the founder and Executive Director of the Karen Beasley Memorial Sea Turtle Rescue and Rehabilitation Hospital located in Topsail Island, N.C. Beasley was also named the Hero of the Year by the Animal Planet Network in 2007. Her dedication to the rescue of sea turtles inspires hope for the unknown future of the animals. Beasley gave a presentation entitled "Challenges in Conservation and the Canaries in the Coal Mine." Beasley identified specific challenges sea turtles face on beaches in North Carolina. Natural predators such as raccoons, foxes, birds, crabs and fire ants are a few of the many threats facing turtles. To Beasley, the natural food chain is inescapable and unfortunately sea turtles fall into the food chain; however, the natural species that prey on sea turtles are not the biggest concern, humans are. Beach chairs, tents, balloons and fishing gear are some of the things that endanger the turtles. "Nobody can convince me that we cannot find safe ways to fish without hurting non-targeted species," Beasley said. "If we can put a man on the mood and rovers on Mars, we can do this." Other things, such as boat propellers, nets and plastic are also some of the hazards sea turtles face. Source: *UNC Seahawk*, 13 November 2008.

Turtle Attacked By Dogs Gets Treatment In Florida

A hawksbill sea turtle that was attacked by wild dogs as she nested a month ago on a beach in St. Croix, arrived in South Florida Tuesday night and was transferred to the Florida Keys-based Turtle Hospital. "She was attacked by feral dogs or maybe someone's pet they let out the door, we're not sure," Micah Rogers from the Turtle Hospital said. The situation was so bad, veterinarians brought her to South Florida to be treated at the world renowned Turtle Hospital in Marathon. American Airlines even provided the free flight to Miami International Airport. "Sandy" the sea turtle weighs 170 pounds. U.S. Fish and Wildlife Service officials discovered the injured turtle on Oct. 10 during a turtle survey in the Sandy Point National Wildlife Refuge. "Sandy" sustained serious injuries to her two front flippers and left rear flipper. "If we save her life, she is a female, she will be laying hundreds of hundreds of eggs every time she nests and if we lose her, that is how many animals we would lose," explained Rogers. The turtle was treated at St. Croix's Island Animal Clinic, but veterinarians there decided to send "Sandy" to the Turtle Hospital, a licensed veterinary facility exclusively dedicated to treating sick and injured sea turtles. Officials hope to eventually return "Sandy" to St. Croix. Source: *CBS4.com*, 12 November 2008.

OCEANIA

Endangered List Grows as Slow and Steady Lose Race

After surviving for more than 100 million years, the world's largest sea turtle has been placed on the Australian national threatened species list. Leatherback turtles, which are found in waters off NSW as well as south Queensland and Western Australia, can grow up to 1.6 metres in length and 700 kilograms. The Environment Minister, Peter Garrett, said yesterday that the turtles, which had previously been classified as vulnerable, were now considered an endangered species. "The uplisting is mainly due to the ongoing threat the turtle faces from unsustainable harvesting of egg and meat, and pressures from commercial fishing outside Australian waters," he said. The move meant that any projects or activities that could have an effect on the reptiles would need to be assessed and approved by the Federal Government before they could go ahead. It is estimated that only about 2800 adult female turtles remain in the western Pacific region, and their numbers are expected to decline due to other risks, including boat strikes and choking on plastic bags and other marine debris. A NSW orchid and a Bankstown shrub, as well as alpine bogs, grasslands and woodlands across the state, were also among the 19 species and five ecological communities that the Department of Environment listed as critically endangered or endangered. Source: *Sydney Morning Herald*, 19 January 2009

What It Costs a Turtle Hatchling to Dash to Sea

A turtle hatchling's first swim is the most critical of its life. FAs many as 30 out of a 100 perish as they head for safe deep waters. But how much does this headlong dash through the waves cost the intrepid hatchlings? Curious to know, David Booth from the University of Queensland decided to measure hatchling turtles' oxygen consumption rates as they swam for safety. Travelling north to the university's research station on Heron Island, Booth was fortunate enough to have a lab within metres of a green turtle nesting beach. Visiting the beach as the mothers-to-be lumbered up on to the sand, Booth was able to collect several clutches of eggs and move them to the edge of the nesting site for safety from other egg-laying mothers. Returning to the site several months later, Booth intercepted several youngsters before they reached the sea. Transporting them 100 metres up the beach to the research station, he fitted each hatchling with a lycra swim suit with a cord attached to a force transducer before setting the youngster free in a seawater aquarium. As soon as they entered the water, the youngsters began swimming frantically with their large front flippers, pulling against the force transducer as if they were swimming out to sea. Meanwhile, Booth measured the youngsters' oxygen consumption as they swam for 18 hours to find out how hard they were working. Booth saw that initially the animals swam very hard using their front flippers with their heads down, only switching to a 'doggy paddle' as they came up for air before returning to frenzied front-flipper swimming. But as time drew on, they spent more time doggy paddling and less time pulling with their front flippers until they eventually began taking the odd break after about 12 hours. Analysing the hatchlings' oxygen consumption, Booth found the same trend with oxygen consumption falling rapidly during the first half hour before declining more slowly and eventually levelling off after 12 hours. Calculating the amount of energy that the hatchlings consumed during their 18-hour-swim, Booth realised that the turtles carry almost 10 times as much energy in their yolk remnants as they needed to reach safety. Booth suspects that they can probably survive 14 days in the open ocean before finding food. Source: *Thai Indian News*, 12 December 2008

ASIA

Taiwan, Cook Islands Cooperating on Fishing Enforcement

Taiwan and the Cook Islands have activated a mechanism to help uncover illegal, unreported and unregulated (IUU) fishing activities. The Cook Islands in the South Pacific recently notified the West and Central Pacific Fisheries Commission (WCPFC) that it would operate a mutual fishery examination system with Taiwan. Under the deal, Taiwanese fishing boats operating in WCPFC areas are required to let Cook Islands fishery officials or police board and inspect their vessels to help crack down on transboundary IUU fishing. The Cook Islands is the second country after New Zealand to sign a mutual fishery examination agreement with Taiwan. About 1,500 Taiwanese commercial fishing boats operate in the western and central parts of the Pacific Ocean, mainly to catch tuna, sharks and sailfish. Of the total, 100 smaller longline fishing vessels, mainly used to catch tuna, that operate in open seas or in other economic zones under contract from those countries are the most likely to be targeted for inspection. Officials urged Taiwanese vessels to have their documents and fishing logbooks ready for inspection. They should also be properly equipped with fish-measuring and other monitoring equipment to help them avoid catching protected sea turtles or birds, or amassing younger fish that they are not allowed to catch. The Taiwan-New Zealand mutual fishery examination mechanism marked the first time that Taiwan had participated in such inspection efforts, which are aimed at maximizing long-term benefits from west and central Pacific fishing grounds. IUU catches can bring in up to US$9.5 billion, a World Commission on Protected Areas' High Seas Task Force study found. Up to 30 percent of IUU fishing occurs beyond national jurisdiction, where there are fewer controls, the study said. Source: *Taipei Times*, 29 November 2008

Green Turtle Rescued

A green turtle, called locally as *pawikan*, was rescued by Barangay officials and Maritime police in Tabaco City. The female turtle weighed 200 kg and measured 170 cm long and had a width of 97 cm. Senior Inspector Lupe Llorca, Tabaco City Maritime police chief, said that the green turtle was captured using a compressor in San Miguel Island in Tabaco. The turtle was reportedly brought to Barangay San Roque and was purportedly scheduled to be butchered Tuesday morning. Concerned residents, however, reported the incident to Maritime police who immediately conducted operations. The turtle was discovered near the shoreline of Barangay San Roque allegedly hidden under coconut leaves. Maritime police admitted that pawikan trade in Tabaco is quite alarming. Some fishermen would reportedly catch pawikan and sell it to Chinese clients for P60-P70 a kilo. Maritime police immediately released the rescued turtle at the coast of Barangay Salvacion also in Tabaco. An investigation is also on going to track down the fishermen who captured the pawikan. Since 2004, around twenty pawikan have been captured in Tabaco City. The city government is now conducting a study to determine if the Tabaco coastline is a breeding ground of the turtles. Source: *The Philippine Star*, 30 December 2008

Bantul Fishermen Save Giant Turtle

Fishermen at Samas beach in Srigading, Bantul, managed to save a 70-kilogram *lekang* sea turtle (*Lepidochelys olivacea*) that was stranded at the beach and trapped in a fishing net. "The turtle was at the beach. When I was dragging my net Wednesday, I felt it was so heavy," fishermen Mugari said Thursday. Together with local fishermen, Mugari brought his accidental catch to a turtle breeding center managed by local fishermen. The sea turtle is being treated by the fishermen after sustaining injuries from the net ropes. The sea turtle will be released after it has fully recovered. Samas elder Rudjito said that in 2000 the local fishermen established the Bantul Turtle Conservation Forum (FKPB) to save turtles from poaching. The fishermen also operate a breeding ground in which fishermen look out for and buy sea turtle eggs from the locals to be hatched during the egg-laying season from July to September. So far the fishermen have released more than 3,000 tukik (*hatchlings*) into the sea. Source: *Jakarta Post*, 5 December 2008

EUROPE

Fingers Pointed in Turtle Deaths

Environmentalists in Didim have claimed that 'humans not nature' may have played a sinister role in the deaths of five rare turtles found washed up along the resort's coastline. Nature lovers have called on local administrators to take more protective measures for loggerhead sea turtles as the resort has been shaken by the deaths of the endangered sea turtles near the area's fish farms. The environmentalists assert the loggerheads, already facing the danger of extinction, were hacked into pieces by an axe while on their way to the fish farms around Mandalya Bay, located between Didim and Muğla. Some of them die from becoming caught in fishing nets, while others are killed by humans, they add. In the latest incident, in which a loggerhead was found on Altinkum's beach, a spokesperson from the Didim Office of Underwater Searches Association went to the scene and took DNA samples to establish the cause of death. He reported that there was a large wound on the back of the turtle, possibly from a propeller of a boat. The Ecosystem Protection and Nature Lovers Foundation (EKODOSD) has been keeping track of loggerheads since 2004, and have records of some turtles being deliberately killed by human hands. The EKODOSD stressed the need to protect sea turtles that use the Anatolian coasts as their breeding areas. If sea turtles are lost from the seas, one result will be too many jellyfish to swim. Source: *Altinkum Voices*, 6 December 2008

AFRICA

NOAA Team to Train Fishery Observers in Senegal

Scientists from the US will travel to Senegal this week to train government officials and university students to be marine resource observers on fishing boats. The observers will collect scientific information about the health of fish stocks and the amount of incidental bycatch of marine mammals and other protected species. This information is used to manage fish stocks and protect marine resources domestically and internationally, through organizations such as the International Commission for the Conservation of Atlantic Tunas. The training program is designed to strengthen international cooperation in fisheries management. Increased international cooperation essential to stopping global overfishing and illegal, unreported and unregulated fishing. The Magnuson-Stevens Act calls for NOAA's Fisheries Service to help nations improve monitoring and compliance with international fishing rules designed to rebuild stocks to help local and national economies. The training will focus on identification of marine mammals, sharks, sea turtles and other species as well as observer safety. NOAA will provide equipment and training materials to Senegal for the program and for future training. Source: *NOAA Press Release*, 28 January 2009

Mafia Marine Life Back as Illegal Fishing Tamed

There has been a reappearance of marine life thought to have been extinct, thanks to the success of the conservation of the Mafia Island Marine Parks (MIMP). The MIMP extends across 822 km, more than 75 per cent of it is below the high water mark and is one of the few remaining reef complexes within Tanzania's coastal waters in relative intact condition and recognised internationally as a critical site for biodiversity. The MIMP warden attributed the reappearance of the marine life to eradication of dynamite fishing within the area and lessened destruction of the environment. He said that the marine park had an abundance of green and hawksbill marine turtles and researchers and other marine park personnel had come across seahorses, an indication that marine environment was clean with little or no added nutrients from human waste. By June 2008, the number of villagers involved in alternative income generating activities that include seaweed farming, beekeeping and handcraft products increased to 1,462. The warden said that environmentally friendly fishing gear like gill-nets, stake traps, hooks and lines and basket traps had been promoted through the fishing gear exchange scheme where money has been loaned to 87 fishing groups comprising about 400 fishermen to procure outboard engines, dhows and nets. He added that the status of the park's marine environment has shown a steady upward trend since 2000 when fishing pressure was high, large usage of destructive and unsustainable fishing nets, dynamite fishing trampling of intertidal habitats and mangrove cutting as well as turtle killing. Meanwhile the MIMP Tourism and Public Relations officer said that a system to record and monitor visitors of the park had been developed and an increase of visitors had been seen from 343 in 2000/2001 to 3,341 in 2007/2008. He explained that there had been a steady increase in the number of foreign tourists coming to visit the park from just 484 in 2000 to 3,107 in 2007 but said that the figures for domestic tourists showed a dwindling trend from 393 in 2000 to 159 in 2007. MIMP is charged with the responsibility of integrating conservation, protection, sustainable resource-use, social and economic development with emphasis on participation of all stakeholders especially local community. Source: *Tanzania Daily News*, 24 January 2009

INDIAN OCEAN

India Moves Ahead to Save Endangered Turtles

Though the International Union for Conservation of Nature (IUCN) has indicated a globally declining trend in the population of the olive ridley turtles due to factors like trawl fishing, destruction of habitat, global warming, etc., there are no reports showing decline in the population of Olive Ridley Turtles in India. Important steps have been taken by the central government and the state government of Orissa for the protection of olive ridley turtles. For example, the olive ridley turtle has been included in the Schedule-I of the Wildlife (Protection) Act, 1972 thereby according them highest degree of protection. The Wildlife (Protection) Act, 1972 has been amended and made more stringent. The punishments in cases of offences have been enhanced. The Act also provides for forfeiture of any equipment, vehicle or weapon used for committing wildlife offences. Wide publicity is given on provisions of the Wildlife (Protection) Act, 1972 against poaching. The central government provides financial & technical assistance to the state governments. On the level of the state government of Orissa, the main nesting grounds of olive ridley turtles have been declared as Protected Areas. Fishing in the marine sanctuary area and restricted fishing zone is prohibited. Fishermen have been advised to use Turtle Excluding Devise (TED), which is mandatory, during trawling and to avoid trawling during nesting seasons. Regular patrolling in the sea is carried out by Wildlife Department in collaboration with the State Fisheries Department and Indian Coast Guard. Co-ordination meetings have been organized with local fishing communities regularly to gain their support in protection of olive ridley turtles. Hoardings have been installed at important fishing bases for generating public awareness. A Central Monitoring Unit in the office of the Chief Wildlife Warden, Orissa, is responsible for the operation carried out in each camp on a day to day basis. A High Level Committee has been constituted by the state government under the Chairmanship of the Chief Secretary, Orissa for regularly reviewing the sea turtle protection activities in coordination with various departments and the Indian Coast Guard. Recently, this committee met 29 November 2008. Finally, the Assistant Conservators of Forests in coastal forest divisions have been declared as authorized officers under the Orissa Fishing Regulation Act, 1981 to check illegal fishing vessels entering in to the prohibited fishing zones in the Orissa coastal waters. Source: *Webnewswire.com*, 24 December 2008

Hundreds of Sea Turtles Die Along Odisha Coast

In a setback to olive ridley turtle conservation programmes, carcasses of these marine species have begun emerging along the placid beaches along the Gahirmatha marine sanctuary for the past week. As ghastly scenes of stray dogs feasting on bloated and mutilated bodies of these marine animals are too glaring to escape notice, wildlife activists are shocked over abysmal lack of protective cover to these species. A total of 372 bodies of turtles have so far been reported by government officials, who also have stepped up vigil on unlawful trawling to ensure the safety of breeding turtles. Unofficial estimates, however, put the causality figure at more than 1000. Turtles are meeting gory ends by either getting entangled in mono-filament fishing nets or being hit by trawls' propellers, according to wildlife activists. The spectre of death pervades the entire Pentha and Agarnasi coastline. It does not augur well before the onset of arribada or mass nesting of turtles, confided a forest official. Unnamed sources say that the forest department is trying to put the casualty toll on a lower scale to cover up its inefficiency, and the actual toll is at least five times higher even by conservative estimates. Source: *Kalinga Times*, 10 December 2008.

Baby Turtles Released

With 51 baby olive ridley turtles being released into the sea at Morjim on Friday, the Save Turtle' campaign launched by the forest department of Tuem, Pernem, can be termed a success. It had recently gained momentum with officials and locals intensifying patrolling along the Morjim beach. Over the years, the Morjim beach has become the favourite nesting ground for sea turtles. According to S.R. Prabhu, range forest officer, this season the first olive ridley turtle appeared for nesting in October 2008 and laid 113 eggs. Earlier, between November 2007 and February 2008, 741 eggs were laid at Morjim beach. "Though an increase in tourism activities and human intervention has disturbed olive ridley turtle nesting, this season we hope that this unique species will arrive in large numbers," a forest officer said, adding that before laying eggs, a turtle digs a cavity into the sand and lays nothing less than 300 to 400 eggs depending upon its size. Source: *Times of India*, 14 December 2008

RECENT PUBLICATIONS

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2) The editors of the Marine Turtle Newsletter to facilitate the transmission of information to colleagues submitting articles who may not have access to on-line literature reviewing services.

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