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The Indian Ocean Turtle Newsletter was initiated to provide a forum for exchange of information on sea turtle biology and conservation, management and education and awareness activities in the Indian subcontinent, Indian Ocean region, and south/southeast Asia. The newsletter also intends to cover related aspects such as coastal zone management, fisheries and marine biology.

The newsletter is distributed free of cost to a network of government and non-government organisations and individuals in the region. All articles are also freely available in PDF and HTML formats on the website. Readers can submit names and addresses of individuals, NGOs, research institutions, schools and colleges, etc for inclusion in the mailing list.

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Reference styles in list:

Vijaya, J. 1982. Turtle slaughter in India. *Marine Turtle Newsletter* 23: 2.

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Introduction

Welcome to our special issue focusing on the Western Indian Ocean! The following pages bring together information on a variety of initiatives and projects from this part of the Indian Ocean region.

Over the years, IOTN has carried overviews of research and conservation in South and Southeast Asia. We have been keen to extend this to the Western Indian Ocean to highlight sea turtle conservation issues and initiatives in the region. We hope that this will serve as an impetus for more regular contributions and updates on sea turtle work from this part of the world.

We would very much like to thank Jérôme Bourjea and Stéphane Ciccione for their key coordination role in bringing this special issue of IOTN to fruition.

Happy reading!

Chloe Schauble & Kartik Shanker
Editors

In the early 1970s, George Hughes and Jack Frazier highlighted to the scientific community that the South West Indian Ocean was an important region in the world for sea turtles. Since that time a lot of work has been done, and is still ongoing, on sea turtles in this region. For example, long term monitoring programs implemented in South Africa, French Eparses islands and Seychelles have allowed us to learn more about the long term trends in nesting activity of several species of marine turtles. However, there has been a general lack of communication regarding the huge effort that is undertaken around the status, conservation and management of sea turtles in most of the countries of this region.

In recent years, the IOSEA memorandum and its South West Indian Ocean Marine Turtle Task Force have done a fantastic job to help and structure turtle teams spread across the region. This has occurred through provision of assistance in regional cooperation and exchange of experience. Newly helped by the South West Indian Ocean Fishery Project, we expect that the creation of a reliable research and project network dedicated to sea turtles will provide the regional dynamic needed for the implementation of reliable local and regional mitigation measures in management for sea turtles, which can be compatible with local lasting development.

This special issue is thus an excellent opportunity for numerous teams that work isolated in Western Indian Ocean countries to showcase the valuable work that is done. Most of the time this work is done with few resources, but hand in hand with other teams, creating a network of knowledge and field experiences dedicated to the conservation and management of sea turtles.

Congratulations to you all for this effort!

Stéphane Ciccione (Kelonia, Reunion) & Jérôme Bourjea (IFREMER, Reunion)

Nesting beach revegetation and its influence on green turtle (*Chelonia mydas*) conservation in Réunion Island

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Before its colonisation, Réunion Island, a French island in the southern Indian Ocean, was described by navigators as an important nesting site for marines turtles (Lougnon, 1992). Unfortunately, intensive catches, the introduction of predators (such as rats), habitat degradation (beaches), and the fast development of coastal areas have led to a near disappearance of nesting marine turtles along the coast of this island. Between 1990 and 2002 only three marine turtle nesting events were observed in Réunion: one nest in 1994, one nest from which hatchlings emerged in 1996, and two tracks on a beach in 2002. These nesting events occurred at three different sites along the west coast of Réunion.

Nevertheless, despite the low numbers of turtle nesting there has also been one observation of green turtles mating near the west coast of Réunion Island and observations made by ULM (Ultra Light Motorised) and by boat have clearly documented the presence of adult green turtles in the waters around Réunion Island (Sauvignet *et al*., 2000; Jean *et al.*, *in press*).

Figure 1: Children are involved with ecological restoration of the littoral vegetation in Réunion Island. Photos: Bontoux, 2005

In 1999 a programme concerning the ecological restoration of marine turtle nesting beaches was initiated. Implemented by the CEDTM (Centre d'Etude et de découverte des tortues marines de La Réunion), it aims for the ecological restoration of the vegetation in the littoral zone. The upper beach vegetation provides protection against human activities along the coast and also plays a role in nest site choice by female sea turtles. In fact, this vegetation may serve as an important orientation clue for sea turtles near the coast, when prospecting for potential nesting sites (Luschi *et al.*, 2001; Hays *et al.*, 2003). However, many people remained sceptical about the potential impact of this programme on marine turtle nesting activity in Réunion Island. In spite of this, the Ferme Corail beach in St Leu was selected as a pilot beach because of its proximity to the CEDTM and its geomorphological and physical characteristics, i.e., sand quality, its width, low human frequentation, and little construction.

The alien species *Casuarina equisetifolia* (which had been planted to stabilize the dunes) and *Prosopis chilensis* (an invasive species) were gradually removed and indigenous species (*Ipomoea pes-caprae*, *Vigna marina*, *Canavalia rosea*, *Scaevola taccada*, *Heliotropium foertherianum*, *Thespesia populnea*) were planted. This programme was linked with an awareness programme to involve children in this ecological restoration (Figure 1). The choice of the species planted took into account the particular substrate of this sector of the island, which is composed of a mix of coral and basaltic sand and protected by a coral reef (Boullet, 2008). The species planted have a preference or a tolerance for the salty spray.

In June 2004, the first tracks and the first nesting green turtles (*Chelonia mydas*) were observed on the Ferme Corail beach. Under CEDTM surveillance, the nesting activity was followed up and nesting green turtles and their nests were monitored. Since June 2004, 12 of the 13 nesting events that have been observed on the west coast of Réunion Island, took place on the Ferme Corail beach (Table 1). An investigation showed that before the recent events, the last turtle track on a beach around Saint Leu had been reported in 1960.

Date	Beach name	No. of tracks	Species	No. of nests	Female Tag	Female size CCL (cm)	Clutch incubation period (days)
01/06/2004	Ferme corail	1	Cm	0			
19/06/2004	Ferme corail	1	Cm	0			
21/06/2004	Ferme corail	1	Cm	0			
21/06/2004	La cafrine	1	Cm	0			
23/06/2004	Ferme corail	1	Cm	1	-	-	-
23/06/2004	La cafrine	2	Cm	0		-	
11/07/2004	Ferme corail	4	Cm	2	- -	- -	82 85
29/07/2004	Ferme corail	4	Cm	1	-	-	83
18/08/2004	Ferme corail	2	Cm	0			
19/08/2004	Ferme corail	1	Cm	1	RUN0014	106	81
11/12/2004	Ferme corail	1	Cm	0			
12/12/2004	Ferme corail	1	Cm	0			
14/12/2004	Ferme corail	1	Cm	0			
18/12/2004	Ferme corail	1	Cm	1	RUN0015	109	53
14/10/2005	Ferme corail	1	Cm	1	-	-	-
27/01/2007	Nord Maharani	1	Cm	1	-	-	51
01/06/2007	Ferme corail	1	Cm	1	RUN0088	102	87
16/06/2007	Ferme corail	1	Cm	1	RUN0088		116
02/07/2007	Ferme corail	1	Cm	1	RUN0088		106
19/07/2007	Ferme corail	1	Cm	1	RUN0088		98
08/08/2007	Ferme corail	1	Cm	1	RUN0088		90
Total		**29**		**13**			

Table 1: Marine turtle nesting activity on beaches in Réunion Island. Cm = *Chelonia mydas*, - = not observed

Figure 2: Female green turtle and its track on the restored beach of St Leu (Réunion Island).
Photos: S. Ciccione, 2007

We cannot be certain that the return of the nesting females is a consequence of the ecological restoration of the upper beach vegetation (Ciccione & Bourjea, 2006). However, the local increase in the number of nesting green turtles and hatching events on the rehabilitated beach (Figure 2) have justified the extension of this programme to others beaches of Réunion Island, involving new partners and administrations. Currently in 2009, 20 hectares of beach are used for rehabilitation projects motivated by restoring marine turtle habitats. Marine turtles are now also taken into consideration in impact studies for infrastructure developments within the littoral zone. This illustrates how the success of a conservation programme can motivate politicians and investors, regardless of the reasons for its success.

Acknowledgement

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Reproduction biology of green turtle in Itsamia, Mohéli (Union of Comoros)

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Introduction

Mohéli is the most important site of the Comoros Archipelago for the reproduction of *Chelonia mydas* (Frazier, 1985). Created in 2001, the Mohéli Marine Park (MMP) includes all the southern area from Miringoni Itsamia covering more than 40000 Ha. The fringing reef surrounding the MMP is well developed and between 250-1300m wide. Itsamia is the Eastern village of the MMP. Since 1994, the Association pour le Developpement Socio- Economique d'Itsamia (ADSEI) has been preserving the importance of the beaches of Itsamia for green turtles through protective actions. Currently, the beaches of Itsamia are one of the more important nesting sites for *Chelonia mydas* in the South West of the Indian Ocean. About 3000 females nest per year on the five beaches monitored daily by the ADSEI/MMP field guards (ADSEI, *unpublished data*) as part of a monitoring program that has been running since 1998. A few *Eretmochelys imbricata* are observed too. The present study describes data collected between April and June 2009.

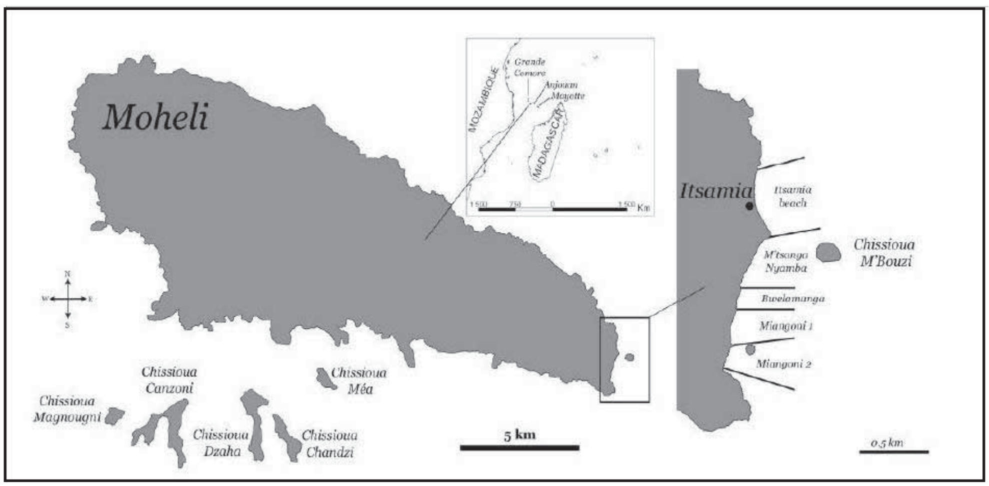

Figure 1: Map of Itsamia and the Moheli, Union of Comoros. (Courtesy: J. Bourjea)

Materials and methods

Each female that laid was measured (curved carapace length - CCL) and tagged with a monel tag. Sixty nests were monitored to determine clutch size and emergence success (Miller, 1999). During the ovoposition, 10 eggs were measured and weighed from each nest. A Wemco temperature logger was positioned in the centre of the clutch for 30 nests. The nest location was indicated by a net. These nets were examined twice per day to monitor if the emergence had occurred. Fifteen emerged individuals per nest were measured (straight carapace length - SCL) and weighed before being released on the beach. Once 72 hours had passed since the last emergence, nests were excavated to categorize nest contents and determine hatchling and emergence success (Miller, 1999).

Results

Means are presented with associated standard deviations. During the study 742 females were measured, and the mean CCL was 108.12 ± 5.29cm (range: 92-129). The average clutch size was 116 ± 24 eggs. The mean egg size and weight were respectively 42.38 ± 1.32 mm and 42.50 ± 3.88 g. The mean length and weight of hatchlings was 47.43 ± 1.51mm and 21.42 ± 1.85g. Three of the 60 nests monitored were destroyed by females during the study, and two nests laid by the same female did not hatch. The hatching success was 75.3 ± 33.37 % (range 0-146; n=57). The emergence success is 64.80 ± 29.00% (range 0-100; n=57).

Nesting females dug up four of the 30 temperature loggers during the study. Table 1 and Figure 2 suggest that nest temperature may be different between the two beaches studied, although the sample size at Itsamia is small.

Nests	Mean temperature of incubation (°C)				
	Entire duration	Range	1st Third	**2nd Third**	3rd Third
Overall (n=26)	**32.38 ± 1.09**	30.43 - 34.28	30.86 ± 1.19	**32.54 ± 1.41**	33.74 ± 1.08
IT (n=6)	**31.11 ± 0.63**	30.43 - 32.14	29.35 ± 0.52	**30.97 ± 0.70**	33.01 ± 0.93
TS (n=20)	**32.76 ± 0.89**	30.90 - 34.28	31.32 ± 0.92	**33.02 ± 1.21**	33.95 ± 1.05

Table 1: Temperature of incubation for 26 nests of *Chelonia mydas* at Itsamia (Mohéli – Union of Comoros). April to June 2009. IT= Itsamia beach, TS= Mtsanga Nyamba beach.

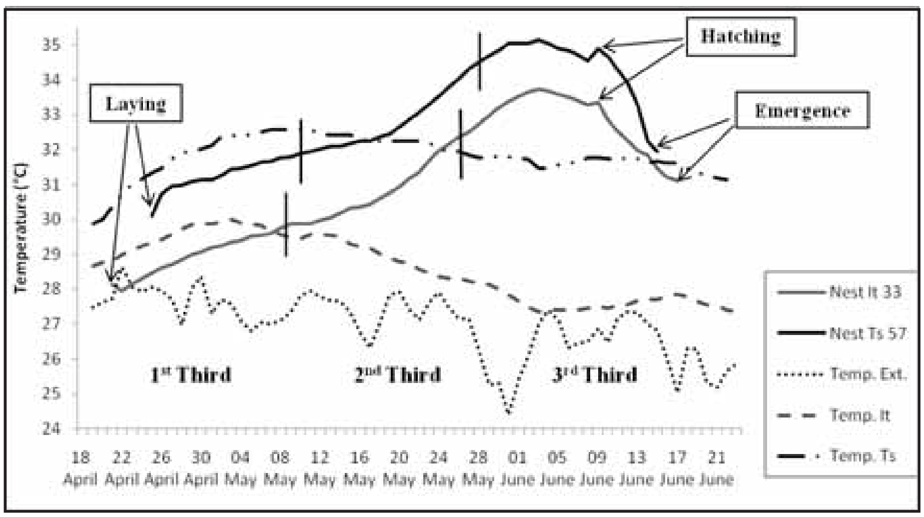

Figure 2: Temperature profile for two nests (It 33 and Ts 57) and three control loggers: Air temperature (Temp. Ext), sand temperature at 70 cm deep on Itsamia beach (Temp. It), and sand temperatureMtsanga nyamba beach (Temp. Ts). The vertical bars indicate the thirds of the incubation. Itsamia (Mohéli – Union of Comoros).

The mean temperature during the 2nd third of the incubation determines the sex ratio of the clutch (Yntema & Mrosovsky, 1980; Davenport, 1997; Godley *et al.*, 2002). Even if the precise pivotal temperature is unknown for the species in Mohéli, the temperature during the 2nd third of the incubation period for the nests monitored was higher than 30°C during the study (Figure 2). So the sex ratio may be biased in favour of the females. Additionally, analysis of the temperature profiles shows that for 11 of the 26 nests the critical temperature of 35°C was exceeded during the incubation. The mean duration spent beyond this temperature was 11.55 ± 7.81 days (range=1.4-23.9, n=11).

Conclusion

This study confirms the importance of Itsamia as a site for green turtle reproduction, with 742 females tagged during four months on two of the five beaches of Itsamia. Clutch size was close to the mean number of eggs for *Chelonia mydas* (113 ± 4 eggs, Miller, 1997). Egg size and weight in Itsamia was slightly lower than the mean values for the species (44.9 ± 0.7 mm and 46.1 ± 1.6 g, Miller, 1997). On the other hand, the size and weight of hatchlings was similar to the mean values for the species (46 - 57 mm and 20 - 25 g, Pritchard & Mortimer, 1999). The fact than the temperature in some nests exceeded 35°C can explain the relative low hatching and emergence rate observed during the study, and may have a significant impact on marine turtle reproduction in the context of global warning, though more data are needed to confirm this hypothesis.

Acknowledgements

Thanks to the ADSEI members for their involvement in the monitoring and the conservation of sea turtles in a difficult context, and the Regional Council of La Reunion and European Union for their financial support.

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Photo-identification method for green and hawksbill turtles - First results from Reunion

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Introduction

The identification of individuals within a population and the collection of reliable information on distribution, habitat use, or life history traits, are the minimum required for behavioural and ecological studies of a species. Most studies on marine turtle populations rely on standard 'capture-mark-recapture' methods based on tagging (flipper tags or Passive Integrated Transponder (PIT) tags), which is costly, induces stress to the animal, and uses tags that do not last for a lifetime (Balazs, 1999; Bellini *et al.*, 2001; Reisser *et al.*, 2008). Tags are also difficult to apply to marine animals, such as turtles, that spend most of their time on foraging grounds and at sea. For these animals, most of the 'capture-mark-recapture' studies are conducted on the beach during nesting as the females can be easily manipulated.

Conversely, photo-identification (photo-ID) relies on natural marks on the body photographically captured to identify and re-sight individuals. It can be used to complement other methods (e.g. if a tag is lost), or may eventually replace tagging (Speed *et al.*, 2007; Reisser *et al.*, 2008). This technique can also be used to quantify the period of tag attachment and tag loss and thus assist in the correction of errors in 'capture-mark-recapture' estimates (Mrosovsky & Shettleworth, 1982; van Dam & Diez, 1999). Photo-ID presents many advantages: the method is less costly, and animals are not captured physically (significantly reducing stress). However, for photo-ID techniques to work, the physical characteristics of the animal have to be stable over time, and independent of sex or age (Blackmer *et al.*, 2000; Rodriguez & Martinez, 2000; Speed *et al.*, 2007; Reisser *et al.*, 2008; Schofield *et al.*, 2008). Different photo-ID techniques have been used in monitoring of other wild animal populations (Langtimm *et al.*, 2004; Karanth *et al.*, 2006; Badford *et al.*, 2008; Gamble *et al.*, 2008; Huffard *et al.*, 2008). Most of the photo-ID methods developed for marine turtles were based on the visual comparison of the facial profile photographs according to the shape and pattern of the scutes in Chelonidae, and on the spot pattern in Dermochelidea (Richardson *et al.*, 2000; Rodriguez & Martinez, 2000; Reisser *et al.*, 2008; Schofield *et al.*, 2008).

We investigated the suitability of a new method of photo-ID based on a non-subjective and computer-assisted process using the coding of the facial profiles according to the position and the shape of the scutes using photographs. The analysis was done for green and hawksbill turtles from Reunion, Mayotte, and Mahe (Seychelles) in the Western Indian Ocean. This non-intrusive technique is of interest to researchers for identifying untagged marine turtles that cannot be caught easily in sites such as Reunion, where marine turtles forage outside the reef barrier and where nesting activity is low. The turtle population in Reunion declined dramatically after human colonisation as a result of intensive harvesting of eggs and nesting females (Dubois, 1669; Hughes, 1973; Frazier, 1975; Bertrand, 1986); however the foraging turtle population has increased over the last ten years (Jean *et al.*, accepted). Two species are regularly observed today along the coastline: the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*), which is less frequently observed than the first species (1/10; J. Bourjea, *pers. obs.*). Some recovery of the nesting green turtle population has been recorded since

2004 on one beach of the west coast (Ciccione & Bourjea, 2006; Ciccione *et al.*, 2008).

The photo-ID method

Our photo-ID method is based on the use of facial profile photographs of marine turtles. As each individual does not display the same scute pattern in the right and left facial profiles, both sides are used to characterise each individual whenever possible. Each facial profile is transformed by visual inspection into a code. This code describes the scutes on the turtle's head located posterior to the eye to the neck and from the line of the upper jaw to the top of the turtle's head (Figure 1). The first single digit of the code profile represents the number of scutes located immediately posterior to the eye, the post-ocular scutes. Thereafter, 3-digit code series represent each scute posterior to the eye, post-ocular scutes comprised, which share at least one scute border (Figure 1). The first number of the 3-digit code corresponds to the row number. The second number corresponds to the position of the scute in that row. And the third one corresponds to the number of sides of the scute (Figure 1). At the end, two codes composed of a 1-digit plus a series of 3-digit codes and defined for both profiles define the identity of one individual.

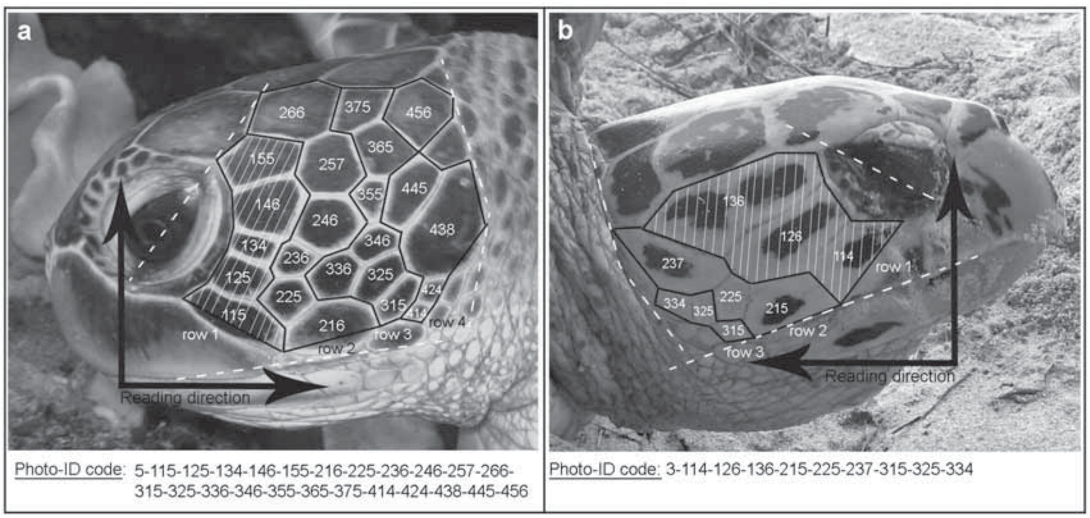

Figure 1: Coding process for a green turtle's left profile (a) and a hawksbill turtle's right profile (b) based on the position and the shape of the scutes. Limits of the profiles are indicated with white dotted lines. Post-ocular scutes (striped scutes) are located immediately posterior to the eye. Bottom-central scutes are located above the bottom limit (upper jaw).
(a) Photo: CSAL Plongée, 2008. (b) Photo: E. Talma, 2007.

We developed a MySQL database with a secured online access using both login and password to manage photographs and sighting reports. In a first step, the images converted by visual inspection or "fingerprints" are entered into the database. They are represented by the 3-digit codes of all the scutes within each profile. This step takes about two minutes per profile, when done by trained personnel. Once the image is fingerprinted, an automated search routine compares the "new" individual to the records held in the database. The system allows rapid comparison using code recognition, by basically comparing the 3-digit codes one by one, and according to other criteria (number of post-ocular scutes, species). Typically, the program searches for the most relevant code, that is the code composed of the highest number of matching 3-digit scute-codes. The larger the number of codes entered into the database, the more relevant and accurate the results will be. After the automated search is done, the 20 best matched images in the database are presented in descending order of similarity, thus reducing the number of photographs to be compared. In fact, the program selects out a set of photograph records that should be visually compared to the query image. Then, final visual comparisons of new images with those in the database establish whether a marine turtle has been sighted previously. The difference between two codes for a same photograph is mostly due to a difference in the number of sides counted for a scute (third digit of the 3-digit code). That can be explained by the quality of the picture or personal interpretation.

This recognition method was initially defined and tested on green turtles in Mayotte that were both flipper-tagged and photo-identified. A total of 14 individual green turtles were used for the validation of the method that had left and/or right profile images captured while foraging. 13 left and 12 right profile images were entered into the database, together with 28 other left and 26 other right profile images of these turtles taken at different times (Table 1). An additional 27 profiles of other green turtles photographed in Reunion were entered for the validation process as they provided additional data noise through which the program had to search. The method was similarly tested on hawksbill turtles encountered around Mahe (Seychelles) that were both flipper-tagged and photo-identified, and on untagged individuals from Reunion that were photographed two or three times when they were observed. A total of 14 individual hawksbill turtles were used for the validation of the method using left and/or right profiles captured while nesting and swimming. 12 left and 9 right profile images were entered into the database, together with 13 other left and 9 other right profile images from these individuals but taken at different times. An additional 89 profiles of other hawksbill turtles photographed in Seychelles and Reunion were entered for the validation process (Table 1).

	Chelonia mydas		***Eretmochelys imbricata***	
Total individuals*	14		14	
	Right profiles	**Left profiles**	**Right profiles**	**Left profiles**
Sightings	12	13	9	12
Re-sightings	26	28	9	13
Total	38	41	18	25
Other individuals**	12		50	
	Right profiles	**Left profiles**	**Right profiles**	**Left profiles**
Sightings	9	9	28	33
Re-sightings	2	7	12	16
Total	11	16	40	49
Total individuals	**26**		**64**	
Total profiles	**49**	**57**	**58**	**74**

Table 1: Number of individuals and profiles used for the validation tests of the photo-ID method for green and hawksbill turtles. * Tagged green turtles from Mayotte, and tagged and untagged hawksbill turtles respectively from Mahe and Reunion. ** Additional profiles entered in the database before the test: hawksbills are from Mahe (tagged and untagged) and Reunion (untagged) and greens are from Reunion (untagged).

Results

The matching tests succeeded for all the profiles for both species. The program correctly identified all the re-sightings already identified in situ by the presence of flipper tags or a series of photographs taken at the same moment. The system decreased the number of images that needed to be visually compared, to a maximum of 20 images selected from the registered data according to the input profile code. All the query profiles entered for the test matched with at least one of the top six results displayed by the system. And among the matching profiles, 94.44% profiles for greens and 78.26% profiles for hawksbills were found in the first position in the list, which revealed a better accuracy for green turtles. This variation between species appears to be related to the lower number of scutes recorded on the profile for the 14 hawksbills used (N=10.39 SD=1.63) compared to 14 greens (N=17.35 SD=2.57). This resulted in a shorter code for hawksbills made up of fewer 3-digit scute-codes, and consequently to a higher number of potentially matching profiles. For this reason, the entire profile showing all the scutes near the neck is required for hawksbill turtle photo-ID. Conversely, a wide range of photographs can be used for green turtles as long as post-ocular and bottom-central scutes (i.e. at least the two first rows) are visible. Moreover, results showed that blurred photographs could be used, as long as the separations between the scutes were visible.

Based on the validation of the green and hawksbill turtles photo-ID method, a long term programme for monitoring the marine turtle population recently started around Reunion. This programme mainly uses photographs taken by local Scuba divers in order to identify untagged individuals foraging outside the reef barrier.

The turtle photo-ID programme in Reunion currently includes nearly 150 photographs in the database captured by local Scuba divers since 2005. Based on this, we identified 60 different green turtles and 20 different hawksbill turtles observed foraging between five and 30m depth in commonly frequented diving spots. Of these, 15 green turtles and two hawksbill turtles were re-sighted two or more times in the same location, many months apart. The longest interval between the first and last observation was four years for a juvenile green turtle, encountered twice at the same diving spot located outside the reef barrier at depth of around 20m. Most of the turtles observed were juveniles or sub-adults. Our results seem to indicate foraging site fidelity behaviour in some juvenile turtles found in Reunion but this needs to be confirmed by further photo-ID or by acoustic or satellite telemetry in the future.

Conclusion

Preliminary results of the validation of the method based on 106 profiles of green and 132 profiles of hawksbill turtles, indicate that this method based on a computer-assisted screening is reliable to identify individuals within these species. However, a more robust validation using a larger number of profiles per species and a multi-observer approach to avoid observer bias has to be done in order to finalize the validation of the method. This will be done as the next step in the development of this programme.

From a practical point of view, field experiences have indicated that photo-ID may be more suited for underwater images rather than for images taken on the beach as sand may obscure parts of the head, especially with hawksbill turtles. For photographs taken on beaches, profiles should be clear of sand and washed off with seawater. One advantage for underwater fieldwork is that the entire profile is most often visible, as the head and the neck of the turtle are extended during feeding. In addition, digital technology provides easy acquisition of high-resolution images and enables photography of the turtles without going close and disturbing them.

Analyses of images showing the facial profile of marine turtles at the three study sites (Mayotte, Mahe and Reunion) have shown the effectiveness of the technique for individual identification and site fidelity studies of foraging habitats. The use of this method in Reunion, where marine turtles cannot be conventionally tagged as they stay outside the reef barrier, should considerably increase our knowledge regarding home-range and habitat use of the resident population and, coupled with aerial survey, assessment of the foraging population. On a larger geographic scale, the use of this method should contribute to study the origin of these turtles and their movements between different habitats in complement or in substitution to standard 'capture-mark-recapture' studies.

Photo-ID can become extremely tedious and prone to subjective errors when large catalogues of images are being processed and matched manually, thereby inducing a loss of accuracy. The technique presented here is based on a non-subjective process, with a computer-assisted sorting routine, albeit requiring personal training to assign accurate profile codes to each photograph. It allows streamlining of the search for any particular individual to a maximum of 20 images selected from the database according to the numerical correspondence of the input profile code. Unlike many automated image identification systems, which require standardized photographs with particular inclination and resolution, this method allows the use of a wide range of photographs as long as post-ocular and bottom-central scutes are visible for green turtles, and the entire profile of scutes is visible for hawksbill turtles. Special fieldwork and training for photographers is not required. The participation of scuba divers is a great opportunity to collect images over time and across a broad range of locations, allowing continuous and long-term studies. It is also a good way to increase public awareness for the conservation status of these endangered species.

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First report of *Chelonia mydas* affected by cutaneous fibropapillomatis on the West coast of Madagascar

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Located at 15 to 65 km off the shore of Maintirano, the Barren Archipelago consists of 10 small islands. All these islands are less than one km^2 in size and six of them are covered with vegetation similar to the one found on the mainland. Because of their isolation, these islands are relatively preserved and little is known about their flora and fauna. These islands also provide important reproductive and foraging habitats for marine turtles. Two of the five marine turtle species that frequent the waters around the archipelago nest on the wild beaches of these islands.

Formerly exploited by fisheries and the extraction of guano, these islands are now frequented only by Vezo fishermen, who set up their camps for periods lasting from a few days to several months. The semi-nomadic Vezo community originates from the south-west coast of Madagascar and currently populate most of the littoral zone along Madagascar's west coast between Toliara and Mahajunga.

In October 2005, the Muséum d'histoire naturelle de la ville de Genève, with financial support from the Réseau Universitaire International de Genève

(RUIG) and the World Wide Fund for Nature (WWF) and with technical support from the Institute of Halieutic and Marine Sciences (IHSM), initiated a program called "Melaky miaro ny tontolo andriakany" meaning "The Melaky protects his marine environment".

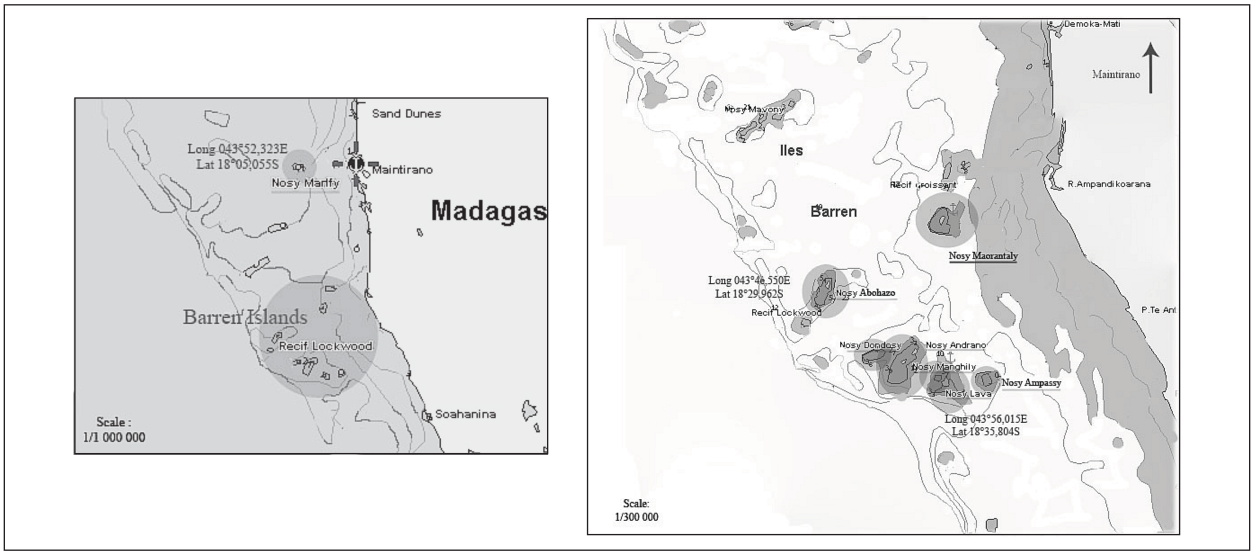

Figure 1: Barren Archipelago (west coast of Madagascar). (Source: S. Hawini, 2009)

The initial objective was to reduce the local consumption of sea turtles and their eggs. Three main axes were developed to conserve local biodiversity: monitoring, raising awareness, and the identification and implementation of development and conservation strategies adapted to the local context.

Turtle monitoring is carried out by a team of four local fishermen, which uses a capture protocol inspired by a Vezo technique. Between 30 March 2006 and July 23 2009, 1288 specimens were captured mostly on their foraging grounds but also during nesting activity. Forty-one fieldtrips were carried out with motorised pirogues that lasted on average about 60 hours (10 days), strongly depending on meteorological conditions. Turtles were tagged with Monel Tag from National Band and Tag Co. (MAL2001 to MAL3603 with the address of WWF BP 738 Antananarivo 101, Madagascar), curved carapace length and width were measured according to standard protocols (IUCN/SSC Marine Turtle Specialist Group), while species, sex, and potential pathologies or marks were also recorded.

Five species were observed during the study (*Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, *Lepidochelys olivacea* and *Dermochelys coriacea*). Capture numbers quite closely followed the relative abundance of the five species around the archipelago (*Chelonia mydas* 95.2%, *Eretmochelys imbricata* 4.5%, *Caretta caretta* 0.2%, *Lepidochelys olivacea* 0% and *Dermochelys coriacea* 0.1%). Only green and hawksbill turtles nest in the Barren archipelago (Rakotonirina, 2008), while loggerhead (*Caretta caretta*), and olive-ridley turtles (*Lepidochelys olivacea*) can be observed near the coast (the latter are sometimes caught in the shrimp fishery). Leatherback turtles (*Dermochelys coriacea*) are only found in deep water off the continental shelf.

The study recorded a high prevalence of tumors on captured turtles (Figure 2), suspected as fibropapillomas (FP). This concerned 16% percent of the 1225 green turtles captured[1].

Tumors were observed only in immature green turtles with a curved carapace length between 40 and 80 cm, with a maximal prevalence in individuals between 50 and 59 cm (Table 1).

[1] During the capture, special care was taken to separate healthy individuals from those which had tumors.

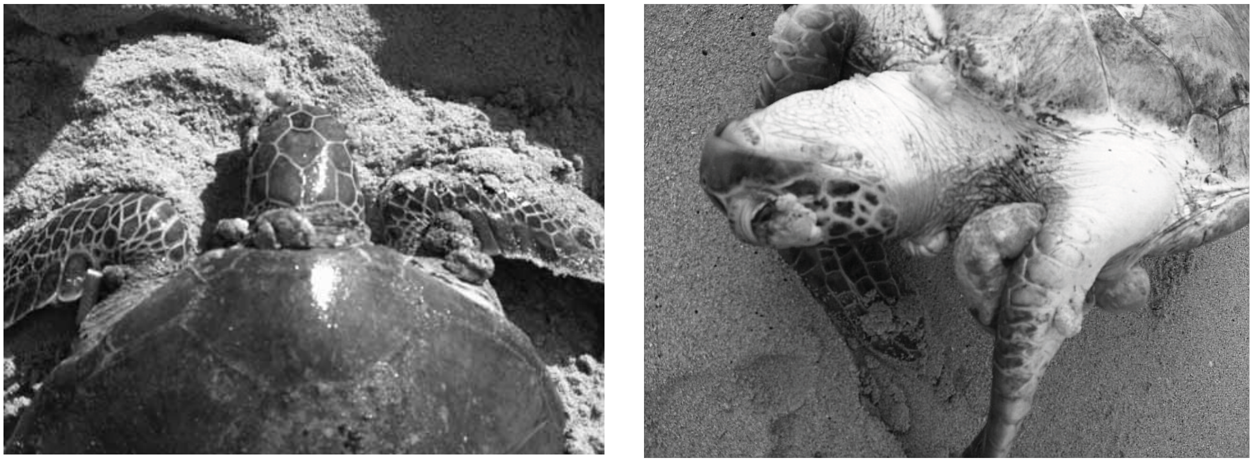

Figure 2: Tumors on immature green turtles (*Chelonia mydas*) of the Barren Archipelago (west coast of Madagascar).
Photos: G. Leroux, 2006

Curved Carapace Length (cm)	30-39	40-49	50-59	60-69	70-79	80-89	90-100	> 100
n (individuals captured)	2	315	349	276	172	42	20	44
Percentage of captured individuals with tumors	0%	15.2%	22.4%	13.8%	16.9%	4.8%	0 %	0 %

Table 1: Tumor prevalence in *Chelonia mydas* of the Barren Archipelago (west coast of Madagascar) according to size class.

These observations are similar to those reported for Australia (Limpus & Miller, 1994), Hawaii (Marakawa *et al.*, 2000) and the east coast of the United States (Foley *et al.*, 2005). Before frequenting coastal areas and remaining within benthic habitats, small immature turtles spend the first stages of their life in pelagic habitats, where FP seem to be absent. Concerning the absence of FP in mature turtles, it would seem that only the healthy individuals survive or those, which managed to overcome this disease (Foley *et al.*, 2005).

In the majority of the turtles recaptured, the progression of the tumors could be observed. However, in nine individuals we observed a regression of the tumors, as indicated in Table 2.

The distribution of the disease within the archipelago is very uneven (Table 3). Turtles captured around the islands near the coast (Nosy Maroantaly and Nosy Marify) had a much higher prevalence of the disease (nearly 25%) than those captured around islands close to the external slope of the continental shelf (Nosy Ampassy, Nosy Lava, Nosy Andrano, Nosy Manghily, Nosy Dondosy and Nosy Abohazo; 0 to 1.5%). However the distance between these groups of islands is less than 20 km.

The water surrounding the islands close to the mainland (Nosy Marify and Nosy Maroantaly) is generally rather turbid. Its visibility - especially during the rainy season - is sometimes less than 2m, because of the significant volume of sediment transported by the rivers. It is possible that there is a link between the presence and quality of this sediment and the observed appearance of tumors in sea turtles.

Tag #	Date of 1st capture	tumor	Date of recapture	tumor	Time interval (in days)
2153	25/08/2006	1	17/10/2008	0	778
2161	26/08/2006	1	12/10/2007	0	414
2222	10/11/2006	1	16/11/2007	0	352
2283	14/11/2006	1	08/04/2008	0	512
2682	06/08/2007	2	01/03/2008	0	207
2806	10/10/2007	1	19/03/2008	0	162
3091	16/03/2008	2	10/04/2008	0	176
2107	22/08/2006	3	21/07/2007	1	203
2734	19/08/2007	3	12/11/2007	1	216

Table 2: Observed cases of tumor regression in *Chelonia mydas* immatures of the Barren Archipelago. 0: no apparent tumor; 1: tumors of less than 1cm in size, generally found around the eyes; 2: many tumors present ranging between 1 and 4cm in size; 3: tumors greater than 5cm in size, present on all soft parts of the body; in the latter case turtles were typically slim and their carapace was covered with algae.

Island name	Abohazo	Ampassy	Dondosy	Lava	Marify	Maroantaly	Andrano	Total
Turtles captured	39	208	65	60	69	738	46	**1225**
Turtles with tumors	0	2	1	0	17	175	0	**195**
Percentage	0	0.9	1.5	0	24.6	23.7	0	**15.9**

Table 3: Geographic distribution of immature *Chelonia mydas* with tumors in the Barren Archipelago.

Various explanations have been put forward for the cause and origin of this disease: infectious agents (Aguirre *et al.*, 1994a), response to a parasitic trematode (Dailey & Morris, 1994; Aguirre & Balazs; 2000), pollution affecting the immune system (Aguirre *et al.*, 1994b; Aguirre & Balazs, 2000), presence of dinoflagellates on the sea-grass bed (Landsberg *et al.*, 1999; Landsberg, 2002), and the presence of Ozobranchus parasites in marine turtles could act as a disease vector (Greenblatt *et al.*, 2004).

Compared with Hawaiian studies that found greater prevalence in heavily urbanised areas (Aguirre, 1994), pollution could be excluded as a cause for the observed disease in the Barren Archipelago because the region of Melaky does not have any industry.

According to local fishermen, this pathological condition has existed since the 1970s, but the number of turtles affected has increased greatly. The recent over exploitation of sharks in the region for the trade with shark fins could be a cause for the observed increase of affected turtles. The larger shark species are important predators of immature turtles. By eliminating individuals that are most affected by the disease, they might play a significant role in controlling the development of the disease. Close to the slope of the continental shelf, these sharks are more abundant and, hence, predation is more frequent. This might explain why the disease is located around the islands near the coast. The spatial attachment of immatures with their foraging habitat (Taquet *et al.*, 2006) might also limit the spread of the disease.

The limited geographical distribution of the disease in the Barren Archipelago, and observed cases of disease regression, mean it is important to develop specific research programs in the Barren Archipelago. In particular, to help better understand the origin of the disease and its evolution, and also to understand tumor regression.

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Monitoring of marine turtles reproductive activities in Juan de Nova, Eparses Islands, South Western Indian Ocean, based on tracks count and width

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Introduction

The Eparses Islands group is composed of four groups of islands (Europa, Juan de Nova, Glorieuses archipelago [main island named Grande Glorieuse] and Tromelin) and one atoll (Bassas de India) scattered across the south-western Indian Ocean. In the 1970s, the Eparses Islands were identified as nesting sites for green turtles in the region (Hughes, 1973; Frazier, 1975). They were poorly known, but interest in monitoring nesting activities grew to supply the green turtles ranching on Reunion in a first place, and then for conservation perspectives (Le Gall, 1986). In fact Tromelin, Glorieuses archipelago and Europa were all stated as 'natural reserve' in 1971, effective in 1975, thus forbidding exploitation of the natural resources. Hence, Grande Glorieuse and Europa's nesting populations have significantly increased, while Tromelin's has remained stable or in a slight annual decrease since the last 20 years (Lauret-Stepler *et al.*, 2007). The monitoring programme established by French Research Institute for Exploitation of the Sea (IFREMER) in the 1980s comprises a 20-year dataset of daily track counts. These data allow an overview on the seasonality and the trend of the population at Tromelin, Grande Glorieuse and Europa (Lauret-Stepler *et al.*, 2007).

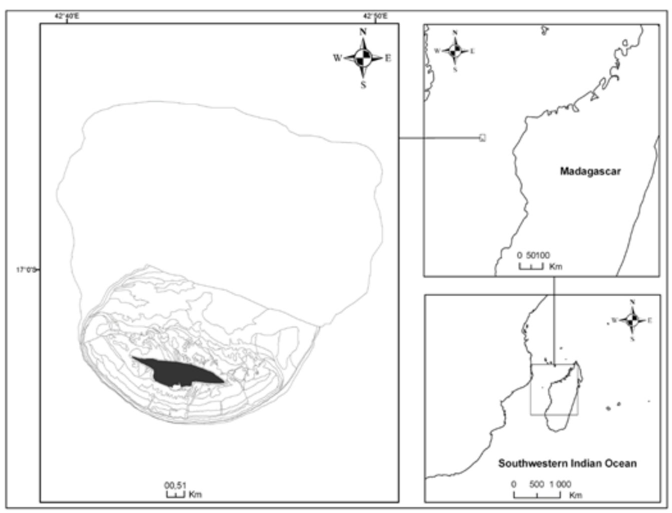

Figure 1: Juan de Nova in the Mozambique Channel. (Source: IFREMER/Kélonia TORSOOI, 2009)

Juan de Nova is located in the middle of the Mozambique Channel (17°03'S, 42°45'E), and is a small island 6 km long with a maximum width of 1.6 km (Figure 1). Its tropical weather has two distinct seasons: a dry season from April to November, and a wet season from December to March (DIREN, 2003) (Figure 2). It had undergone several human colonisation attempts since its discovery in the 16th century (Hoareau, 1993). But most attempts had failed due to the small size, difficulty of access and lack of freshwater. However, Juan de Nova has been the most impacted by human activities of all Eparses Islands. Historical tales report the regular presence of fishermen from mainland Madagascar on Juan de Nova in order to use the natural resources among them marine turtles during the

19th century (DIREN, 2003). At the beginning of the 20th century, guano exploitation based on phosphate extraction offered the possibility for workers to settle on the islands for over six decades. It induced modification on the island with house building, vegetable gardens, and fruit, casuarina and coconut tree planting. In the early 1920s, the guano exploitation could produce up to 50 000 tons of guano (DIREN, 2003). In 1968 the phosphate crash in the Stock Market caused the closure of the guano exploitation on Juan de Nova. In 1973, a weather station was installed as well as a military detachment, like on Glorieuse and Europa. The last workers left the island by 1975.

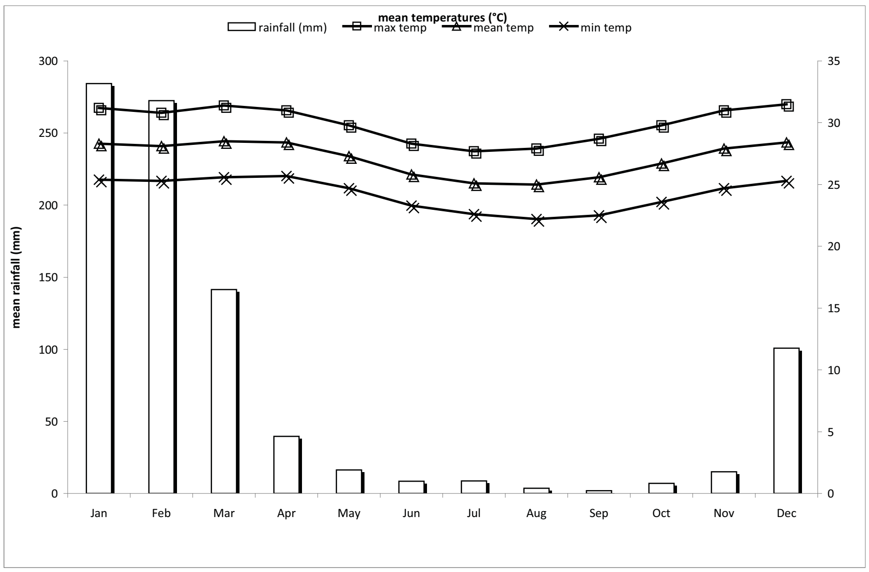

Figure 2: Average rainfall (mm) and temperature, max and min (°C) on Juan de Nova. (Source: Météo France)

Two species of marine turtles (*Chelonia mydas* and *Eretmochelys imbricata*) are known to nest on Juan de Nova, but the abundance of these is not well known due to a lack of data. The daily track count monitoring started in 1987 on Juan de Nova. It follows the same procedure as the other islands (Lauret-Stepler *et al.*, 2007). Every morning, the brigade counts the tracks of the nesting females and marks them with a cross to avoid double-counting. Counts can be missing during detachment rotation, which takes place every 45 days, or when the weather does not allow it. However, sampling effort has been less consistent on Juan de Nova than on the other islands, which created lots of gaps that make analysis sometimes difficult to perform. From 2003, track counts (Figure 3) became more consistent with an effort of more than 80 % of days monitored within a month.

Track width measurement was initiated in December 2006 in order to estimate the abundance of both species nesting on the island. Track width can be used for species differentiation considering the literature on morphology of green and hawksbill turtles (Pritchard & Mortimer, 1999). Data on track width have been continuously collected since December 2006 and 455 tracks were measured from December 2006 to July 2009.

Nesting activity

Because 25.8% of the data from 1987 to nowadays was missing, nesting activity was analysed with complete years of data (N = 10: 1992, 1995, 1996, 1997, 2003 to 2008 included). Average monthly number of tracks is low on Juan de Nova compared to the other islands in the Eparses Islands (Lauret-Stepler *et al.*, 2007). Marine turtles nest year round on Juan de Nova (Figure 3), with a marked peak in summer (October - March) and a less important peak in winter (May – August). Nesting also occurs year round for the other sites of the south-western

Indian Ocean (SWOI), but with one clear peak through the year at different seasons depending on the island: austral summer period for Europa and Tromelin, and austral winter period for Glorieuse and Mayotte (Bourjea *et al.*, 2007; Lauret-Stepler *et al.*, 2007). In fact, it has been shown through the SWIO that seasonality varied among sites genetically or geographically close (Bourjea *et al.*, 2007; Lauret-Stepler *et al.*, 2007). For example, Tromelin and Grande Glorieuse are part of the same genetic stock and yet showed inverse pattern of seasonality (respectively summery and wintry). Europa, the most southern of the islands, has a nesting seasonality similar to Tromelin, and yet they are from different genetic stocks.

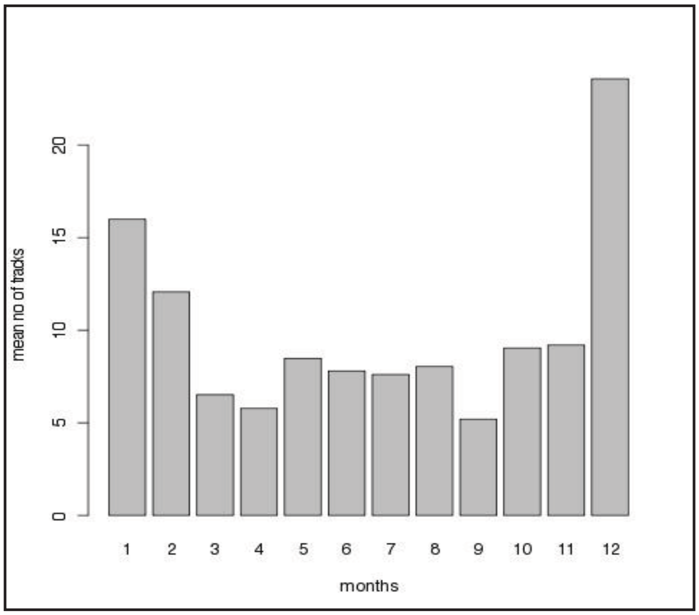

Figure 3: Mean seasonality of marine turtles nesting on Juan de Nova; N = 10 for each month. On the x-axis, month 1 = January, month 12 = December.

The two main genetic stocks of the SWIO were found in equal proportion on Juan de Nova (Bourjea *et al.*, 2007). Bourjea *et al.* (2007) showed how the oceanographic conditions of the Mozambique Channel could have contributed to the constitution of the genetic stocks of the SWIO marine turtle nesting population. In fact, oceanic movements separate the Mozambique Channel in two parts. The two distinct genetic stocks characterising the population of the SWIO, the North Mozambique Channel (NMC) and the South Mozambique Channel (SMC), fit the oceanic pattern of the region. Interestingly, Juan de Nova is located at, what seems the frontier of these two oceanic zones, and has both genetic stocks in equal proportion (Bourjea *et al.*, 2007). Since the presence of two species of marine turtles have been reported, it would be interesting to see how the presence of these two genetic stocks influences the seasonality pattern highlighted here.

Species seasonality

Because on Juan de Nova, track width is measured without species identification, we differentiate between green and hawksbill turtles at this site using width track characteristics. Pritchard and Mortimer (1999) state that hawksbill turtles track width ranges between 60 and 85 cm, while green turtles tend to have wider tracks, usually wider than 100cm - but variable. To confirm this, in May 2007, we measured width of 128 tracks on Itsamia (Moheli – Comoros Union), where only green turtles nest. Our study indicated that width of green tracks range from 88 cm to 131 cm at this location (Figure 4a).

The same study was implemented with tracks and female identification (n=99) on Nosy Iranja, where both hawksbill and green turtles nest. We obtained a comparable result for green turtle tracks: from

91 to 134 cm (Figure 4b). For hawksbill tracks, the result is in conformity with the literature: from 66 to 84 cm (Figure 4b).

Based on these results we assume that at Juan de Nova any track width 85 cm or under is from a hawksbill, and anything over 85 cm is from a green turtle. The observed track width distribution range of 60 to 125 cm, confirms that both hawksbill and green turtles nest on Juan de Nova (Figure 5). Assuming that size species limit is 85 cm, 151 tracks can be considered to be hawksbill, and 304 to be green turtles.

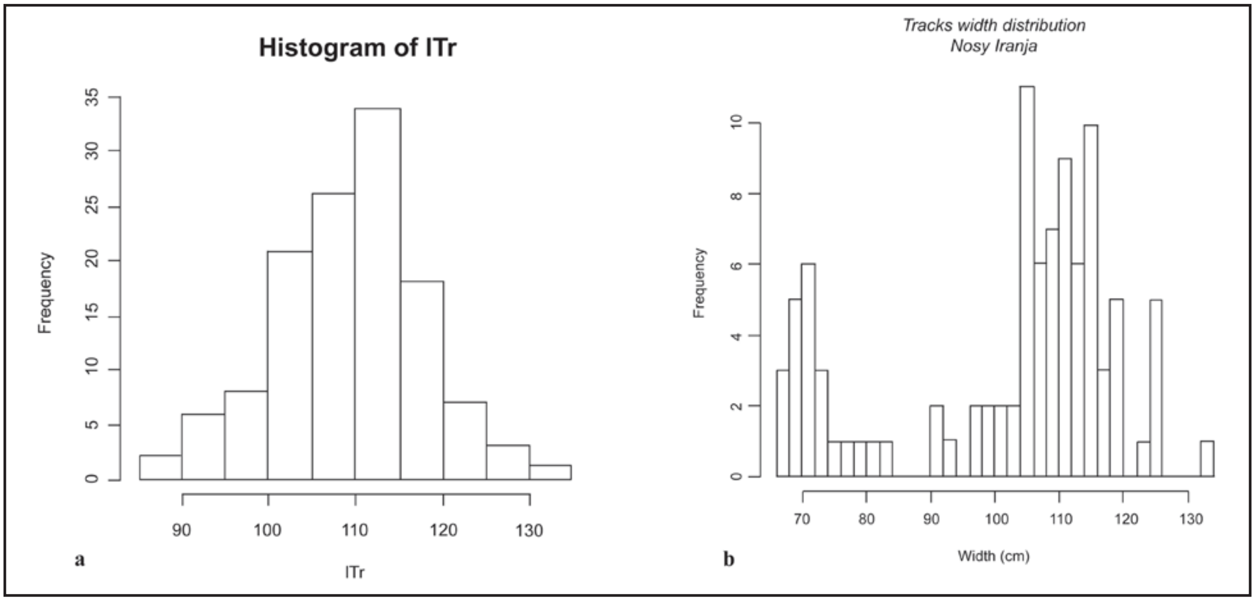

Figure 4 (a & b): Width of sea turtle tracks on a) Itsamia (ITr) Moheli (n=128) from green turtles, and b) Nosy Iranja Madagascar for hawksbill (n=22, range 66 to 84 cm) and green turtles (n=75, range 91 to 134cm).

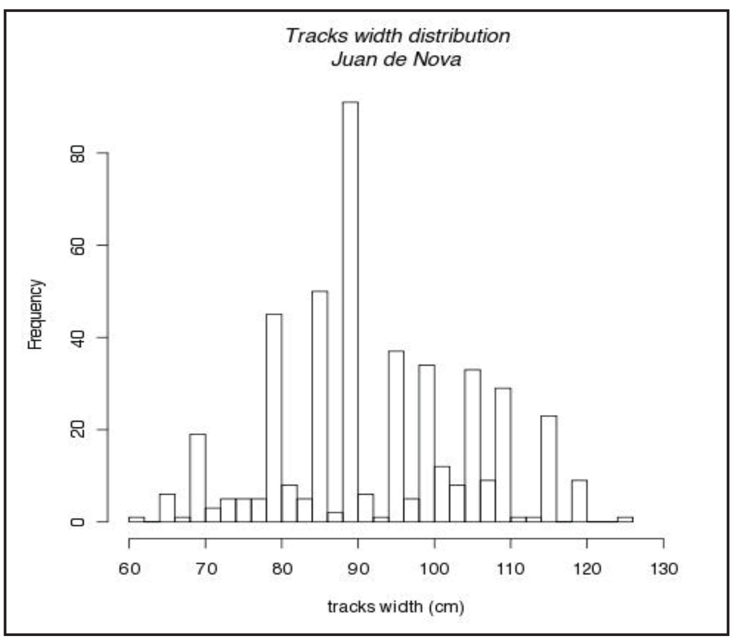

Figure 5: Distribution of marine turtle track width on Juan de Nova – from December 2006 to July 2009 (n=455). On the x-axis, month 1 = January and month 12 = December.

Figure 6 shows that green turtle nesting occurs year round with a slight peak in winter, as it is described for the green turtle nesting sites of the North Mozambique Channel (Bourjea *et al.*, 2007; Lauret -Stepler *et al.*, 2007). Hawksbill nesting is more sporadic, occurring only in summer in 2006/07, and 2007/8. However, continuing through the year 2008, there is a slight nesting activity for this species in winter, and no nesting in summer 2008/09.

Most populations of hawksbill turtles studied through the world exhibit a nesting season in summer (Diamond, 1976; Meylan, 1999; Bourjea *et al.*, 2006), as we found they did at Juan de Nova. However at Nosy Iranja, the 2003 nesting season for hawksbill turtles began as early as September (Bourjea *et al.*, 2006). Exception to the summer dominant pattern has also been found in the Solomon Islands (English overseas territories of the Indian Ocean) (Mortimer, 2002). Within the Solomon Islands, a single genetic stock of hawksbill turtles exhibited a main nesting peak from May to August (SWIO winter) and a smaller peak from November to January (SWIO summer).

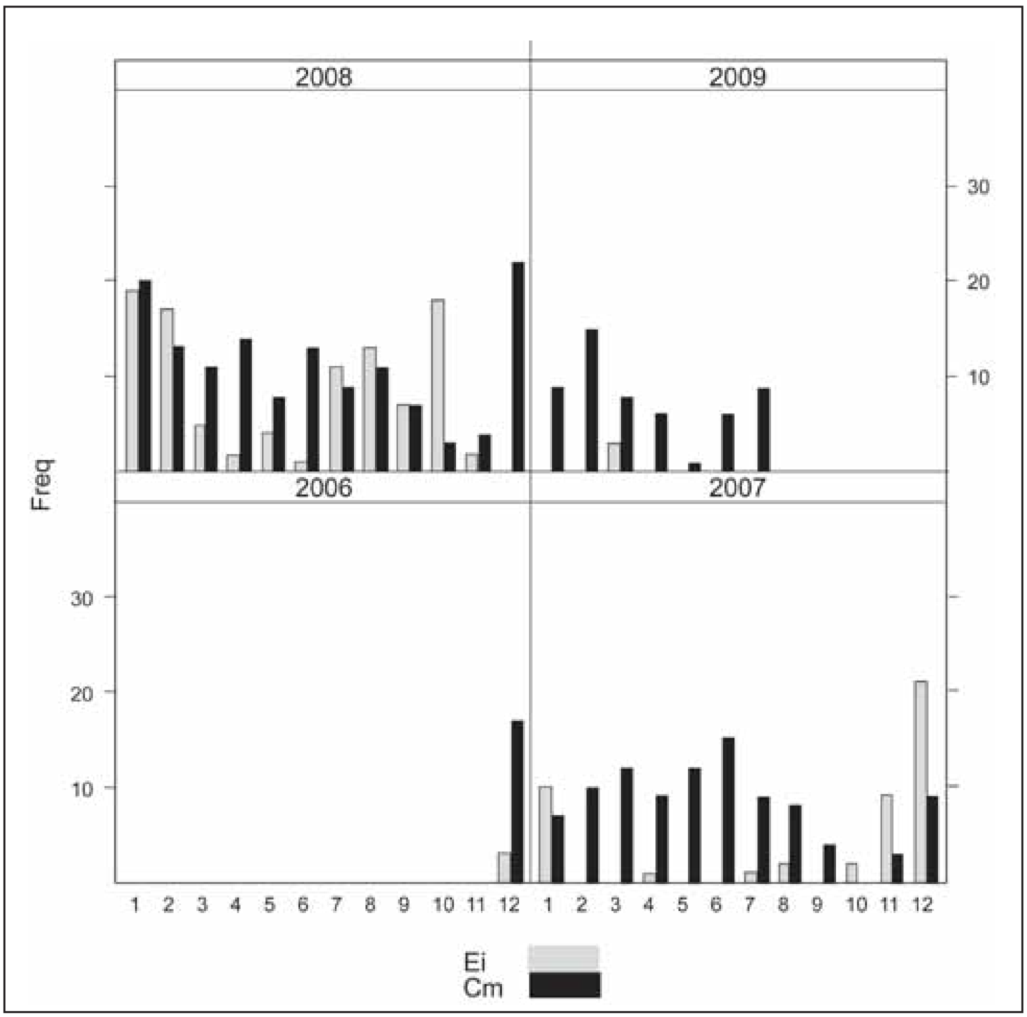

Figure 6: Species seasonality from December 2006 to July 2009, assuming that species tracks width limit is 85 cm. All tracks width less than or equal to 85 cm is considered to be hawksbill turtle, and 86 cm and above it is considered a green turtle. On the x-axis, month 1 = January and month 12 = December.
Ei: *Eretmochelys imbricata*, Cm: *Chelonia mydas*.

Conclusion

This study has examined green and hawksbill turtle nesting on Juan de Nova. The fact that hawksbills nested during both winter and summer in at least one year is an interesting contrast to the strongly summer nesting seen on Nosy Iranja (Bourjea, 2006).

Genetic studies on the Solomon Islands hawksbill turtle population show that they are from a unique genetic stock, which is probably not the case for hawksbill of Juan de Nova. Indeed, Bourjea *et al.* (2007) show how the oceanographic conditions of the Mozambique Channel have contributed to the constitution of the genetic stocks of the SWIO marine turtle nesting population. In fact, oceanic movements separate the Mozambique Channel into two parts. The two distinct genetic stocks characterising the population of the SWIO, the North Mozambique Channel (NMC) and the South Mozambique Channel (SMC), fit the oceanic pattern of the region. Interestingly, Juan de Nova is located at what seems the frontier of these two oceanic zones, and has both genetic stocks in equal proportion.

Lauret-Stepler *et al.* (2007) suggest environmental conditions are more likely to affect nesting seasonality than genetics are and the Solomon Islands are closer to the Equator than Juan de Nova. So perhaps the specific oceanographic conditions in the Mozambique Channel (especially concerning sea surface temperature) can help explain variation in nesting season observed in Juan de Nova (Figure 6), and within the islands of the Mozambique Channel, i.e., Europa versus Glorieuses (Lauret-Stepler *et al.*, 2007) or at a shorter distance Juan de Nova versus Nosy Iranja.

Recommendations to come out of the study so far are that in order to gain better understanding of marine turtle nesting seasonality on Juan de Nova it will be advisable to (1) train the beach monitoring brigade in species identification using track patterns, and (2) collect some associate data on Sea Surface Temperature throughout the study period to see how oceanic movement and environmental variation may affect marine turtle nesting seasonality.

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Loggerheads and leatherbacks in the Western Indian Ocean

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Introduction

This is a rare opportunity for me to provide an overview of loggerhead and leatherback conservation in the Western Indian Ocean. Despite the fact that I was personally an integral part of the conservation effort for some 40 years I was not there at the beginning. All credit must go to the late Peter Potter, a senior officer in the then Natal Parks Board, the provincial conservation authority of the then Natal, South Africa, who, in 1963, responded first to complaints about turtles being killed on the beaches of what was then known as Tongaland (it is now known as Maputaland but I shall refer to Tongaland throughout the paper) just south of the Mozambique border. Peter sent a ranger Hennie van Schoor, and two students John Bass (now Dr.) and Humph McAllister and it was their first publication (McAllister *et al.* 1965) that laid a solid and inspiring foundation to the 45 year old programme on loggerheads and leatherbacks in South Africa.

Formal conservation organisations in South Africa were dominated by large mammal issues for nearly 80 years. There was considerable political strength in the promotion of large mammal conservation and this is clear when you consider that the first four formal protected areas set aside for large mammal conservation in Africa took place in Natal in 1895.

It is thus quite remarkable that one of these early protected areas had a marine component, the St Lucia system which, having been static in size for nearly 70 years suddenly started to attract attention (with the turtle programme providing one of the most important and visible catalysts), and over 35 years was expanded to include two marine reserves, several extensive terrestrial areas and is now known as the iSimangoliso Wetlandf Park, South Africa's first World Heritage Site (Natural) declared in 1998. The park now covers 325000 ha with 220 km of coastline including all the turtle breeding beaches.

The localised lack of enthusiasm for the project in the early Sixties led to my becoming aware of political undercurrents within conservation which have proved both supportive and damaging to turtle conservation. The successful protection of the turtle beaches in South Africa has been achieved firstly by fighting entrenched political conservatism, persisting to successful conservation results and then using the successful turtle story to political advantage to enhance protection.

In 1965 as an ex-Game Ranger recently launched into university studies and willing to take any vacation job offered, I accepted a chance to visit the Tongaland area to take part in what was to become quite famous as "The Turtle Survey". My fellow students were John Bass and Mike Mentis, later to become Professor of Botany at the University of the Witwatersrand. In fact the turtle survey became a sort of testing ground for some of the most capable biologists produced in South Africa in the Sixties. For the most part at that stage they were not an impressive sight but some went on to become acclaimed in such fields as elephant biology, shark biology, botany, ornithology, ichthyology, and large mammal ecology.

As Mike, John and I were the first to find some recoveries of animals tagged in the first two seasons we were inspired with the challenge of learning more and began advocating a much more intensive programme of study with improved equipment (Hughes *et al.*, 1967).

Our recommendations were accepted and the net result was that the survey became one of the longest running programmes involving loggerheads and leatherbacks in the world with some of the most extensive tag returns.

The first meetings of the MTSG in Morges, Switzerland

It was in preparing for an improved effort that contact was first made with the late and much lamented Professor Archie Carr whose early scientific papers and popular books on turtles provided considerable stimulus to our efforts. He was an encouraging and enthusiastic correspondent and he was instrumental in persuading IUCN to establish a Marine Turtle Specialist Group the first Meeting of which was held in March 1969. There were effectively 12 of us gleaned from across the world of which Peter Pritchard and I were the youngest.

The first gathering was memorable for meeting some wonderful and stimulating scientists and it was noteworthy for its open discussions. It would come as a considerable surprise to many of you here that one heated argument revolved around the fact that my pictures (each of us had to produce a slide show and I started first because South Africa was a completely unknown quantity at that time) showed the beautiful clear water normally found off our breeding beaches. I was immediately challenged by Joop Schultz from Surinam who said that turtles only nest in dirty water (which they do in Surinam!). This may sound exceeding strange to turtle biologists today but it does serve to illustrate the very limited knowledge of the group at that time (see IUCN publications).

The first meeting can best be summarised by saying it ended with tremendous enthusiasm and goodwill and we all returned to our regions determined to expand our efforts.

The second meeting held in Morges in 1971 ended somewhat differently despite the fact that there were some outstanding reports submitted and the first serious attempt was made to understand the challenges and potential of turtle farming.

The soon-to-be extremely divisive politics of turtle conservation was experienced almost immediately and the emergence of ego-driven ambition became destructive. The meeting ended badly after there was a shameful misuse of some very senior but naïve members to try to exorcise an office bearer. The process was so distasteful to me that I began to become concerned how easily conservation effort can be severely damaged by individual zealousness and instead of the unified position that was the product of the first meeting we have since suffered from the division of turtle conservation into two camps, those that see sustainable utilisation as a tool of conservation and those to whom the very thought of using sea turtles at all is anathema.

At this time the general philosophy and goal of the Natal Parks Board was to encourage the owners and occupants of land outside of protected areas (roughly 90% vs 10%) to take an interest in the conservation of whatever biodiversity was not inimical to their occupational interests. (It is impossible to get sugar farmers to live in peace with elephants!!). This was long before the term "sustainable use" came into fashion but the philosophy was exactly that. In fact I would suggest that South Africa has created the most successful wildlife industry in the world by pursuing this goal which, whilst recognising the consumptive and economic role played by the hunting industry, is a direct result of the philosophy and determination of the formal nature conservation bodies of South Africa.

Encouraged by the early writings of Archie Carr who described the green turtle as "The Buffalo of the Sea" and later enthused about turtle dishes and considered the future of turtle farming (Carr, 1967) which matched precisely the philosophy of our organisation, it was therefore to me absolutely correct that sea turtles should be regarded as biodiversity elements extremely worthy of conservation effort but with a firm intention of ensuring that they would make a contribution to improving the lot of local people. Especially that of the amaThonga people in whose tribal area the turtles nested.

As with many other species with which we worked, it was agreed that at this stage our primary goal would be to prevent any further killing and restore the nesting populations to a higher level than we found them in 1963. Actual targets were set for total nesting numbers after which the Board would consider giving the local people access to sustainable use programmes. As far as loggerheads are concerned this was a regular nesting population of at least 500 females…a target that we have reached only in the last few years.

Happily, however, the need to kill sea turtles or to eat their eggs appears, for the most part, to have declined and the sea turtles are recognized, even by the local amaThonga, to be a valuable economic resource now benignly used for tourism.

The Cayman turtle farm & sustainable use as a conservation tool

In the early Seventies the Cayman Turtle Farm was struggling to find its feet but was beginning to attract a great deal of negative attention in parallel with an upsurge of protective legislation in the United States which began to take on the characteristics of a crusade. The IUCN was encouraged to investigate the farm, its goals and practices, and had a number of us undertake the task. It was a wonderful experience but I was as equally appalled by the negativity towards the farm by US turtle workers as I was with the impressive work being carried out on the farm. I saw considerable benefits for turtle conservation if the farm proved successful and the recommendations to IUCN although concerned about certain threats did not reject the positive potential of the enterprise.

Regrettably this carried no weight with the US conservation lobby which launched bitter attacks on the farm and indeed have continued to oppose every opportunity of saving sea turtles through sustainable use to emerge over the past thirty years. The Corail turtle farm in Reunion Island was effectively closed down by over zealous anti-sustainable use elements in France and of course the Convention on International Trade in Endangered Species (CITES) has become a convenient tool to nail down the coffin lid on any innovative enterprise involving sea turtles.

In my view this has been a series of golden opportunities missed and quite likely a massive loss of knowledge which might one day have become immensely valuable. It also engendered a degree of complacency in the influential US which is not justified. The human population of this world continues to rise at an alarming rate and we have no justification for believing that sea turtles have been saved forever no matter how many protected populations we may have.

I do believe however that the combined efforts launched throughout the world by the establishment of the Marine Turtle Specialist Group was a remarkable and laudable achievement by IUCN which has greatly improved the global survival prospects of sea turtles and inspired a massive global endeavour embracing many thousands of individuals.

South Africa is very proud to have been a part of that effort.

Highlights of the South African programme

Establishing population trends

It is my firm opinion that important biodiversity programmes should be the responsibility of a state or federal institution. Only by having a long term commitment by an appropriate authority can you confidently expect sound and dependable results.

This in no way decries the efforts of NGOs in the role of conservation awareness, protection and indeed support, as we have had in South Africa from bodies such as the Worldwide Fund for Nature (especially WWF-SA).

It has always been a feature of the Tongaland turtle programme that it never tried to apply mathematical models to establish annual nesting numbers. Annual counts have been based on actual animals handled using standard sampling methods and more recently observed nesting records. The purpose of the method ensured that we did not end up with a series of variable models which changed from year to year. The difficulty is ensuring that your managers adhere to the same sampling methods year by year and to convince them that attaining new tagging records was not the main purpose of the study but having comparable data year after year was.

The trends in Figures 1 and 2 are therefore a fair reflection of the results of this 45 year endeavour.

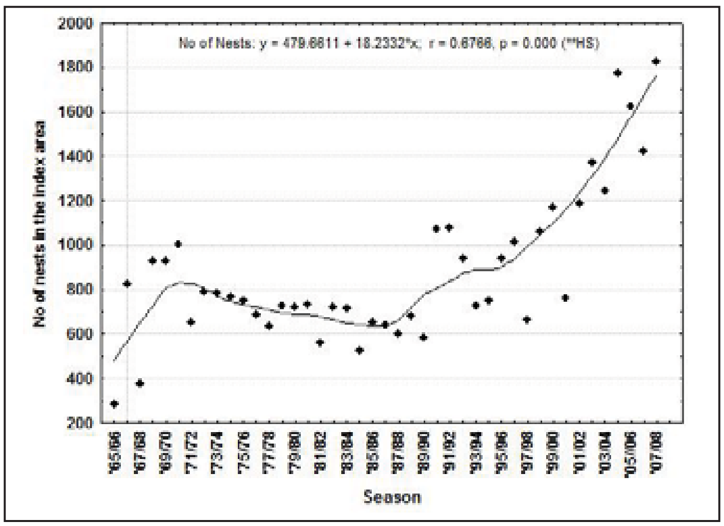

Figure 1: Long term trends in nesting activity of loggerheads in Tongaland survey area 1965 – 2008. (Courtesy Dr Ronel Nel)

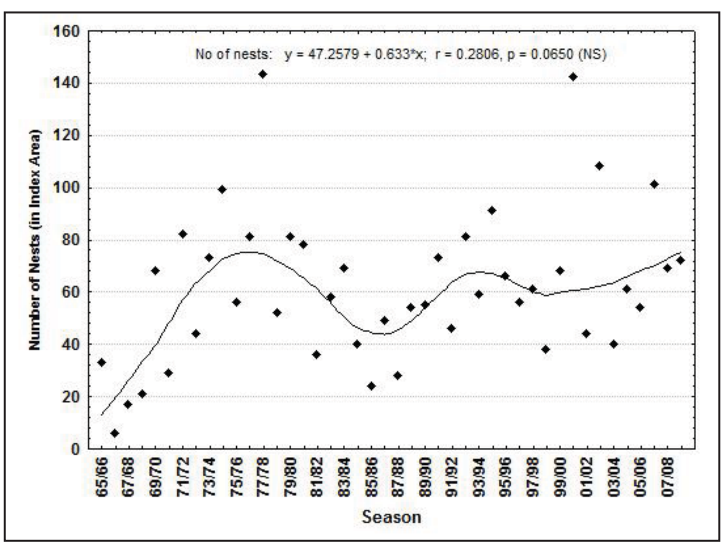

Figure 2: Long term trends in nesting activity of leatherbacks in Tongaland survey area 1965 – 2008. (Courtesy Dr Ronel Nel)

Post nesting movements

Like many programmes we started using tags that were less than ideal but despite the shortcomings of many tags we started to accumulate regular and valuable information on inter-season and intra-seasonal intervals the results of which persuaded us to question the accepted wisdom that all turtles exhibited regular between season nesting intervals (Hughes, 1976, 1981). We also gradually accumulated considerable information on between season migrations demonstrating that Tongaland was the most important nesting site in the Western Indian Ocean for loggerheads and leatherbacks and attracted turtles from great distances. In the case of loggerheads our longest recovery shows a minimum distance from the nesting ground as 3500km. These recoveries involved primarily flipper tags but with the advent of satellite transponders better understanding of the migrations was achieved especially in the case of leatherbacks. Here I must record the splendid cooperation of the University of Pisa, Italy and the South African Department of Marine and Coastal Management, without whose help we would never have known just how extensive an area is covered by leatherbacks. At least one of our leatherbacks has travelled in excess of 20 000 km over a ten month period as well as recording a maximum dive of some 940 metres whilst feeding. It is clear that there is no fixed pattern of post-nesting movement of leatherbacks (see for example Luschi *et al.*, 2006).

In pursuit of the 'lost year'

Archie Carr coined the now famous term 'the Lost Year' to describe the fact that no information was available on the movements and distribution of hatchlings after they left the nesting beaches. In Tongaland, in 1971 we initiated a programme of marking hatchlings using various tags (none of which were successful but we were in good company as even Archie Carr had a failure with magnets (Carr, 1967b)) and eventually settling on mutilation tagging of loggerheads by excising coded pairs of marginal scales each year (Gaustella & Hughes, 1995). This programme ran for 31 years and saw the eventual release of some 327811 marked hatchlings, an average annual effort of 10575 hatchlings notched. Recoveries of marked hatchlings demonstrated that the 'lost year' was driven by the movements of the Agulhas Current and further that there was an annual leak of loggerhead genes into the Atlantic Ocean (Hughes, 1978).

Later DNA studies confirmed these results (Bowen *et al.*, 1994).

Age to maturity studies

As a result of regular sampling of turtles captured in the anti-shark network along the Natal coast it was established that after leaving the shores of South Africa loggerheads returned to the coast only when they reached a carapace length of some 60cm. (Hughes, 1974a). We had no idea, however, as to how long this took nor indeed how old the animals were at nesting maturity. What we were able to demonstrate was that there was a distinct change in feeding ecology at this stage when the animals ceased to feed on surface food alone and started diving (Hughes, 1974b).

The hatchling tagging programme, especially once we had settled on the coding system and could be more certain that an animal could be recognisable on maturity, eventually provided annual samples of females returning at first maturity allowing Jenny Tucek to critically analyse the data to ascertain that Tongaland loggerheads have a mean age at maturity of 21.6 years (Tucek, *pers. comm.*).

If it takes 15 – 25 years to reach nesting maturity it is highly likely that it takes between 7 and 12 years for the turtles to grow to 60 cm in the open ocean.

Economic benefits of the programme

As mentioned earlier one of the primary concerns was see the turtles grow in numbers and then to bring economic benefits as we, in the Natal Parks Board, had achieved from the growth and sale of our large mammal populations and indeed from the sound management of our more popular sport fisheries.

The first direct benefit that flowed from the expanded turtle programme saw the regular employment of some 20 members of the local tribal people for the duration of the programme. This may not sound like much of a benefit but when there is NO other source of employment this was indeed significant. What is more, as the years passed a loyal and supportive cadre of local staff formed an integral and invaluable part of the turtle survey.

As early as 1973 plans were drawn up for the development of the coastline (Hughes, 1973) but this had to be preceded by enhanced protection and better controls over development along the coast where the turtles nested. By 1986 almost the entire coastline was formally protected and the private sector was invited to establish additional tourist facilities and thus create more jobs.

Today there are five full concessions (walks and vehicles) and two walking concessions granted annually for turtle viewing which indirectly and directly provides employment to many local people and indeed both of the walking concessions are drawn from the Tembe Community the members of which are neighbours of the turtle beaches. The total contribution to the park's revenues from these concessions exceeds R 500 000 annually and the total contribution of the tourist industry associated with the turtle nesting season runs into millions of Rands. A significant portion of these funds flows into the local communities through direct employment, the formal Tourism Levy originally started by the Natal Parks Board (and continued by its successor Ezemvelo KZN Wildlife), and some innovative Trust Funds that must be established by tourism operators within the protected area.

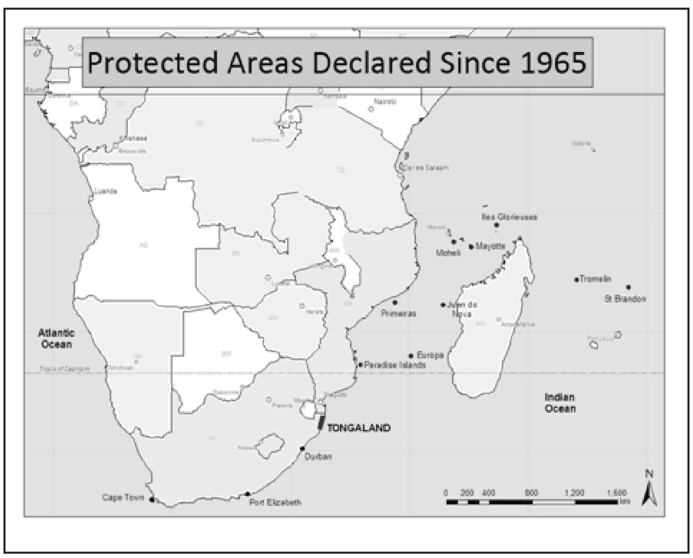

Figure 3: Nesting sites of sea turtles in the region proclaimed as protected areas since 1965.

Cooperative projects

During the past 45 years the turtle conservation programme has become one of the most iconic nature conservation programmes in South Africa. Not only has it attracted a significant measure of pride for the ordinary South African but it is has contributed to programmes in numerous other areas and, I would like to think, has made a positive contribution to conservation efforts elsewhere. It has been directly involved in the establishment of programmes in Mozambique, Mauritius, Kenya, the Islamic Republic of the Comoros (see for example Bruton *et al.*, 1989) Eritrea, Bangladesh, Angola and Reunion Island (France) and its dependencies as well as cooperating (often for our benefit) with sister programmes in Malaysia, Australia, Japan, Surinam and the United States.

In fact we take particular pride in the outstanding community conservation efforts of the people of Itsamia in the Comoros for their work on green turtles and even greater pride in the creation of the Kelonia Institute in Reunion (the successor to the Corail Turtle Farm).

Influence and benefits

The popularity and influence of the turtle programme in Tongaland has been dramatic and, in 1982 certainly contributed to the prevention of the establishment of a deep water harbour in the heart of the turtle nesting grounds in Tongaland (Hughes, 1982). This, as a matter of interest, prompted a ten year programme of translocating 20 000 eggs per year from the threatened northern part of the coast to deep within the proclaimed marine reserve some 100 km further south.

1993 saw the end of a campaign to prevent the mining of heavy minerals in the dunes of what was later to become the iSimangoliso Wetland Park, South Africa's first World Heritage Site. The turtle programme also played a role in the success of this campaign.

Without in any way suggesting that it was the direct result of South African effort I would modestly suggest that the loggerhead and leatherback programme in South Africa since its inception was influential in the establishment of 10 important protected areas in the South Western Indian Ocean (see Figure 3).

Conclusions and acknowledgements

No single achievement described today has come about simply as a result of any single person or group of people. Whatever good has come from the South African turtle protection programme is a product of hundreds of people starting with the local staff, both permanent and temporary, of the Natal Parks Board and its successor Ezemvelo KZN Wildlife, who have walked thousands of kilometres over the years and without whose dedication and enthusiasm the basic data would not have inspired the help, cooperation and support received from so many other bodies. These formal agencies have always carried the lion's share of the financial and logistical costs of the programme.

Additional and invaluable financial help has come from the Worldwide Fund for Nature, both International and, almost without interruption, from South Africa, through the original South African Nature Foundation (starting in 1969) and, more recently, through its successor, WWF – SA. Other funding contributors have been the Gulbenkian Foundation, Lisbon, the Oceanographic Research Institute, Durban, the African Wildlife Society, Richards Bay Minerals and Wilderness Safaris, to name a few of the most prominent contributors.

Scientific support and participation in the programme has come from the University of Natal, the University of Durban-Westville, (now combined as the University of KwaZulu-Natal), Rhodes University, the University of the Witwatersrand, Stellenbosch University, the University of Cape Town, the Nelson Mandela University and the Universities of Pisa, Italy and Swansea in Wales. The contribution made by the Oceanographic Research Institute, Durban and the Department of Marine and Coastal Management, Department of Environmental Affairs and Tourism, South Africa have been substantial and over a long period.

The recognition received from international bodies has made an enormous contribution to the state acceptance of the programme and I should like to record my appreciation of the World Conservation Union (IUCN), the Ramsar Convention, the World Heritage Convention, and the Convention on Migratory Species and especially for its Indian Ocean and South East Asia Memorandum of Understanding (IOSEA).

Two more expressions of emotion are necessary from me. Firstly my thanks to my many colleagues, lay and scientific, local and international, who have enriched my association with the sea turtles. There are just too many to list here but there is not one of you whose contributions will be forgotten. Without you my life would have been so much poorer and the success of the turtle programme so much reduced.

What can one say to thank the sea turtles, these wonderful animals, whose biology, ecology, relationship with man and his culture, and simple endearment have sparked a veritable industry of

passionate support and a flood of scientific results that have added an admirable chapter to the book of knowledge and relations between Humankind and animals.

By the very presence of so many scientists and conservationists here today it is clear that the story is far from ended. There remains much to be learnt and much to be done. Part can be done by direct participation in turtle conservation and part must be done by reducing the speed of human population growth and improving the lot of the poorer people round the globe. There is no such thing as single-issue conservation, the destinies of both humans and turtles are inseparable and success will follow only if everyone involved in turtle conservation addresses problems with an open mind in pursuit of innovative and ultimately successful outcomes. What is needed for any successful conservation endeavour is a sense of balance, for it is all a question of balance.

Finally my thanks to Colin Limpus, firstly for a life-long friendship and for inviting me here, and the Western Pacific Fisheries Management Council, Hawaii for funding my participation.

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Marine turtles in the French Eparses islands

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The islands located in the Mozambique Channel, including the French Eparses (Scattered) islands, are major nesting and feeding sites for green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles (Bourjea, 2005; Taquet, 2007; Bourjea *et al.*, 2008; Bourjea & Benhamou, 2008). Green turtles are present in tropical and subtropical waters worldwide, generally in coastal areas and near islands. In the South-West Indian Ocean (SWIO) around 50% of the turtles present are estimated to be green turtles – compared to 20% on a worldwide scale (Servan, 1977). Unlike many other regions where green turtle populations are increasing thanks to efficient protection measures, the populations in the SWIO are in decline (Taquet, 2007).

Genetic studies on green turtles have revealed the existence of two meta-populations in the world, one Atlantic, the other Indo-Pacific (Bourjea, 2005; Taquet, 2007). Samples taken from adult females in the French Eparses islands of Tromelin, Glorieuses, Juan de Nova and Europa have showed that turtles from the Atlantic population reproduce and nest in the South of the Mozambique Channel (Europa and Juan de Nova), whereas the Indo-Pacific turtles do so in the North (Juan de Nova, Glorieuses, Tromelin) (Bourjea, 2005; Bourjea *et al.*, 2007a; Taquet, 2007) (Table 1). Juan de Nova is the only island where both meta-populations breed.

	Tromelin	**Glorieuses**	**Juan de Nova**	**Bassas da India**	**Europa**
Chelonia mydas **(Green turtle)**					
Nesting site	Yes	Yes	Yes	No	Yes
Feeding site	?	Yes	Yes	?	Yes
Eretmochelys imbricata **(Hawksbill turtle)**					
Nesting site	No	Yes	Yes	No	No
Feeding site	?	Yes	Yes	?	Yes

Table 1: Summary of Eparses islands characteristics concerning nesting and feeding of green and hawksbill turtles

The French territory of the *Terres australes et antarctiques françaises* (Taaf) is composed of five districts: Terre Adélie, in the Antarctic continent, the sub-antarctic archipelagos of Crozet and Kerguelen as well as the Saint-Paul and Amsterdam islands, and the tropical Eparses islands (îles Eparses) composed of Tromelin, Glorieuses, Juan de Nova, Bassas da India and Europa (Figure 1). The Eparses islands have been under the authority of the minister of France's overseas territories and departments since 1960. Their administration was first handled by the prefect of Reunion Island, until it was handed down to the prefect of the Taaf in 2005. In February 2007, these islands officially became the Taaf's fifth district. Although French, they do not belong to the European Union.

The sovereignty over Europa, Juan de Nova and Glorieuses is entrusted to military detachments of the *Forces armées de la zone sud de l'océan Indien* (FAZSOI). On Tromelin, it is carried out by the chief meteorologist and for Bassas da India by the presence of the French Navy in its waters. This permanent presence plays a key role in the conservation of sea turtles, as it dissuades poachers from taking turtle eggs or killing turtles for their meat.

The Eparses islands are scarce remainders of

Figure 1: Location of the Eparses islands in the SWIO. (Source: Taaf, 2007)

practically virgin biodiversity sanctuaries. Their amazing marine diversity has earned them the name of "oceanic sanctuaries of primitive Nature". These islands have been protected over the centuries by their isolated locations and a very limited human occupation, thus giving them an elevated scientific value. They are privileged sites for studying marine flora and fauna, including turtles, and can be used as world wide scientific references.

Geographically isolated from the rest of the Eparses islands, **Tromelin** is the only island not to be located in the Mozambique Channel. It is located to the east of Madagascar and the north-west of Reunion Island. This small remote island is an important site for reproduction and nesting of green turtles (Bourjea, 2005) (Figure 2). Due to its small size and preserved ecosystems, it is also a valuable area for scientific research.

The archipelago of **Glorieuses**, whose two main madreporic islands are Grande Glorieuse and l'île du Lys, stands sentry over the north-east of the Mozambique Channel (Figure 3). Both green and hawksbill turtles can be found in Glorieuses (Ciccione *et al.*, 2005; Bourjea *et al.*, 2008). Whereas the lagoon is a feeding site for both species, only green turtles nest on the island's white beaches (Roos, 2000; Ciccione *et al.*, 2005; Bourjea & Benhamou, 2008).

Juan de Nova is located in the narrowest part of the Mozambique Channel, between Madagascar and Mozambique, and south of Mayotte (Figure 4). It is the only one of the Eparses islands to host nesting hawksbill females as well as nesting females from both green turtle meta-populations (Bourjea *et al.*, 2007a; Bourjea *et al.*, 2007b). Furthermore, its lagoon is an important feeding site for green turtles who find not only food but protection from predators (Bourjea *et al.*, 2007b). Conservation stakes for marine turtles are therefore high in Juan de Nova.

Bassas da India, in the south of the Mozambique Channel, is a recent atoll. It is completely submerged at high tide, thus preventing turtles from nesting (Figure 5). Scientific studies concerning Bassas da India are very scarce, and no seagrass beds favorable to nourishing immature turtles have been reported (R. van der Elst, *pers. comm.*).

Europa, located near Bassas da India, is the most southern of the Scattered islands (Figure 6). It is home to both hawksbill and green immature turtles (Bourjea, 2005; Bourjea *et al.*, 2006; Bourjea *et al.*, 2007b; Bourjea *et al.*, 2008). It is also a regional and world-wide major nesting site for green turtles belonging to the Atlantic meta-population (Hughes, 1970; Quod et Garnier, 2004). These facts make Europa a great asset to sea turtle protection.

The presence of both hawksbill turtles (critically endangered on the IUCN Red List) and Atlantic and Indo-Pacific green turtles (listed as endangered by the IUCN) give the Eparses islands a high natural value. This, and the existence of both feeding and nesting sites, confers particular conservation values to this region. Nevertheless, the Eparses islands are also subjected to certain pressures. Marine turtles are exposed to several threats, mostly anthropogenic. Pollution by oil and gas, which occurred on Juan de Nova in 2006, threatens not only immature turtles living in the lagoons but all turtles swimming in the area as well as nesting beaches.

Purse seine tuna fisheries use Fish Aggregating Devices (FADs). These cause the by-catch of immature green and hawksbill turtles, which eventually drown if they aren't taken out of the nets fast enough. Furthermore, it takes centuries for abandoned FADs and nets to deteriorate, creating a widespread problem of ghost nets, or ghost 'fishing', which is thus far impossible to quantify. In addition to the impacts of legal and ghost fishing, illegal fishing also takes its toll on marine turtles. Although remote, the Eparses islands are visited by small-scale fishermen who are attracted by the abundance of reef fish. These fishermen sometimes eat turtles or their eggs.

Last but not least, climate change doubly pressures marine turtles. On the one hand, the current sea level rise is reducing the surface of available nesting beaches (Taquet, 2007; Hawkes *et al.*, 2009). On the other hand, rising temperatures favor female production, which could lead to a strong sex bias and ultimately the extinction of these animals (Taquet, 2007; Hawkes *et al.*, 2009).

It is very important that we preserve the opportunity and the privilege of working in natural labs such as the Eparses islands. This is the very reason why the Taaf has been supporting scientific programs in these isolated territories, especially those led by organizations such as Kélonia[1] and IFREMER[2] for quite some time now. These studies deal with global warming, nesting characteristics, population genetics, tagging and photo-identification of immature and nesting turtles, etc[3].

Besides supporting research, the Taaf also lead concrete actions to mitigate turtle by-catch under FADs. For instance, the fishery observers placed by the Taaf on tuna purse seiners receive specific training by Kélonia and IFREMER to identify and revive entangled turtles.

[1] Kélonia : Marine turtle observatory of la Réunion island. Not only does Kélonia lead scientific studies on turtles, but it also plays an important role in education and awareness.

[2] IFREMER : Institut Français de Recherche pour l'Exploitation de la Mer. IFREMER collects data and knowledge about marine environments, constitutes data bases and contributes to developing sustainable marine activities.

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Figure 2: One of Tromelin's nesting beaches (Source: Taaf, 2009)

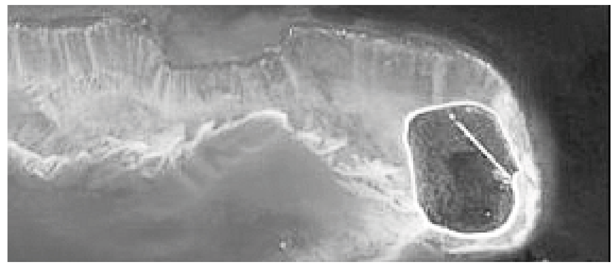

Figure 3: Grande Glorieuse (Source: NASA, 2005)

Figure 4: Juan de Nova's lagoon hosts green and hawksbill turtles (Source: Taaf, 2009)

Figure 5: Bassas da India atoll (Source: Marine Nationale, 2007)

Figure 6: The entrance to Europa's mangroves, where hawksbill turtles may be found (Source: Taaf, 2009)

Scientific research contributes greatly to better knowledge of species and habitats. Furthermore it is essential to orienting management measures and ecosystem preservation. To this end, the *Terres australes et antarctiques françaises* and the *Agence des aires marines protégées*[4] (AAMP) have signed an agreement to carry out an eco-regional analysis of the Eparses islands. The aim of this document is to create a strategy to establish Marine Protected Areas (MPAs) in the Eparses islands by 2011. Two complementary steps are planned: (1) a summary of all scientific data available, and (2) the realization of new research campaigns. The flexibility of the Taaf's administration as well as its know-how in ecological management will likely amount to quick concrete results, thanks to a close co-operation with the AAMP.

Furthermore, the Taaf have made two commitments within France's *Grenelle de la Mer*[5]. The first one is to classify the island of Europa and its territorial waters as a National Natural Reserve (NNR) by the end of 2010. This action should be complemented by the establishment of MPAs in the Eparses islands, which will be done with all relevant administrations. The Taaf's second commitment is to become a reference for scientific research and sustainable marine activities.

Based on their experience in the southern islands and thanks to the management of the NNR of the *Terres australes françaises*[6], the Taaf wish to reach the same type of sustainable management and preservation of the Scattered islands' natural resources.

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[4] Agence des aires marines protégées: state-owned company whose main functions are to support public policies for the creation of MPAs and to coordinate France's MPA network.

[5] Revealed on 27th February 2009, the Grenelle de la Mer is a marine policy that concerns all actions of the Government and formalizes France's ambition concerning the oceans and all related activities. The "blue book" makes an inventory of all 138 commitments made by France on short, medium and long terms. These commitments apply to very various domains, of which marine energies, transportation, biodiversity, fisheries, pollution, governance, aquaculture, education, etc.

[6] Crozet, Kerguelen, Saint Paul and Amsterdam

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Progress and development of a hawksbill turtle (*Eretmochelys imbricata*) monitoring project, Seychelles: 2004-2008

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Introduction

The Seychelles inner islands are home to one of the world's largest hawksbill turtle nesting populations. Since 2004, 10,000s of volunteer hours have been donated by people from all nationalities and walks of life in contribution to the Global Vision International (GVI) Seychelles Marine Expedition. Data has been collected on *E. imbricata* population dynamics, nest site monitoring, and behavioural ecology from multiple locations. Thirty-two hawksbill turtles were tagged for identification from June 2006 to July 2008 as part of a well established mark/recapture program within the Curieuse Island Marine Park; in addition, 45 turtles were recaptured and nine tags replaced for long-term integrity. The results from beach patrol surveys between 2004 and 2008 indicate that marine reserves on Silhouette and Curieuse Island retain higher nesting populations when compared to unprotected areas monitored across North West Mahé Island. GVI has also developed a new focal behavioural study on the foraging ecology of *E. imbricata* with the guidance and advice of regional experts. By collaborating with resource managers and local stakeholders, research conducted by international conservation organisations such as GVI effectively addresses critical gaps in the scientific literature while providing a number of tangible benefits to the wider community.

Marine turtles in the Seychelles

The Republic of Seychelles contains 115 islands and covers one of the largest Exclusive Economic Zones (EEZ) relative to landmass of all countries. This West Indian Ocean archipelago is geographically isolated from other continents and world renowned for its high biodiversity, rich coral reefs, and lucrative fishing industry. Marine turtles have significant cultural and economic importance in the Seychelles and presently images of sea turtles can be found on the logo of the Central Bank of

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Seychelles, the 10 Rupee banknote, and national postage stamps.

Five of the world's seven species of marine turtle enter the Seychelles for nesting or foraging activities. Incidental reports suggest that leatherbacks (*Dermochelys coriacea*) often fall prey to long line fisheries in the region (Hamann *et al.*, 2006) while loggerheads (*Caretta caretta*) and olive-ridley turtles (*Lepidochelys olivacea*) are rarely encountered. Several long-term studies have previously addressed the nesting habits of hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) on numerous high density nesting beaches across inshore (Diamond, 1976; Mortimer & Bresson, 1999) and offshore islands respectively (Mortimer, 1988; Mortimer, 1990; Mortimer *et al.*, 2006). Although over 20 marine turtle conservation and monitoring programs operate within the Seychelles, no published information is currently available for hawksbill nesting sites on Silhouette, Curieuse or Mahé Island.

Baseline information has recently been established on hawksbill foraging preferences throughout marine protected areas of the outer islands (Brandis, 2008) and Haughton *et al.* (2003) has documented energy budgets for juvenile hawksbills across the inner islands albeit over a limited temporal scale (i.e. March-April 2000). These studies have provided the grounds for further investigation into the link between energy allocation and site fidelity across inner island locations.

As hawksbill turtles are easily observed within the coastal areas of the inner islands they have remained the focus of monitoring efforts undertaken by Global Vision International (GVI)'s Seychelles Marine Expedition. GVI has provided trained individuals to assist volunteers with research and environmental monitoring on behalf of local data collection agencies since 2004; they also support a conservation based eco-tourism industry and generate environmental awareness while contributing to a variety of fundraising events and capacity building projects in the wider community.

Threats to *E. imbricata* within the Seychelles

As the Seychelles Republic rises to meet a growing economic demand for the international tourism market, so too does the justification for larger and more numerous coastal developments. The impacts generated by these anthropogenic activities are influencing all phases of the hawksbill's life cycle from incubation success (feral animals, coastal erosion, habitat loss, etc.) to adult mortality (e.g. boat strike, ingestion/entanglement of marine debris and poaching). Other forms of environmental degradation associated with proposed developments include channel dredging and reef blasting, industrial/petrochemical pollution, sand mining and coastal erosion. Furthermore, increased coastal development approvals have necessitated the installation of artificial lighting, wider roads, increased watercraft traffic and coastal armouring, all of which place added pressure on marine turtle nesting sites and coastal habitats.

Hawksbill turtles within the Seychelles are particularly vulnerable to poaching because of their unique daylight nesting behaviour (>85% on Cousin Island), high frequency of nesting emergences, and predictable inter-seasonal patterns of nest site fidelity (Mortimer & Bresson, 1999). The foraging habits of *E. imbricata* render the animal's flesh and adipose tissue unsuitable for consumption due to bioaccumulation and magnification of toxic compounds (Meylan & Whiting, 2008). However as the market price of scutes from the carapace and plastron fetch prices to rival that of ivory the risks involved in illegal harvest are often overshadowed by attractive profit margins (Collie, 1993).

The international trade of 'tortoise shell' or 'bekko' has been a major incentive for continued harvest. Between 1976 and 1979 Japan alone imported more than 40,000 kg of marine turtle by-products (roughly equal to 44,000 animals), and continued to import until 1992 despite the hawksbill's mid-1980 listing under the Convention of International Trade in Endangered Species (CITES) (Collie, 1993). In 1996 *E. imbricata* was officially named on the IUCN Red List as 'Critically Endangered' (Appendix I species) based on global population declines of 80% over the past three generations and sufficient evidence to predict further declines in the future (Meylan & Donnelly, 1999).

Sea turtle policy and protection within the Seychelles

The trade in hawksbill shell has been an important commodity throughout the Seychelles since the 1700's. However no official stock management guidelines were available until The Turtle Act (Chapter 141) was formulated in 1925 (Collie, 1993). Over the past 50 years a number of seasonal closures, taxon specific limitations, and trade restrictions have been trialled in the region with limited success. It was not until 1993 when the Artisan Compensation and Reinstallation programme was passed that a closure of the fishery became possible. This scheme focused on the transition from unsustainable harvest to alternative livelihoods and was supported by a government buy-back strategy of the existing hawksbill product stockpiles (Mortimer & Balazs, 1999).

In 1994 the commercial trade in turtle products was outlawed throughout the republic (see The Wild Animals and Birds Protection Act), and the Fisheries Act was also modified to prevent the capture of sharks using drift nets in an effort to reduce rates of incidental mortality. Irrespective of this progress a loophole in the regulations still allowed existing stockpiles of turtle products to continue being sold legally and it wasn't until 1998 when the government passed an amendment, and publicly burned a large 'bekko' product stockpile, that the market was effectively closed (Mortimer, 1999; Mortimer & Balazs, 2000).

Penalties for breaches of The Wild Animals and Birds Protection Act increased dramatically in 2001. Maximum fines were raised 500 fold, prison sentences escalated 100 %, and authorities reserved the right to confiscate vessels, aircraft, vehicles and gear. Since this legislation was introduced, a number of public awareness campaigns involving television segments, festivals, radio pieces, and newspaper articles have been circulated with the intention of disseminating information on threats, current legislation, and the mitigation of nest depredation.

The present paper provides an overview of hawksbill population management in the Seychelles and a data summary of GVI's marine turtle conservation fieldwork on the Isles of Mahé, Curieuse and Silhouette from 2004-2008.

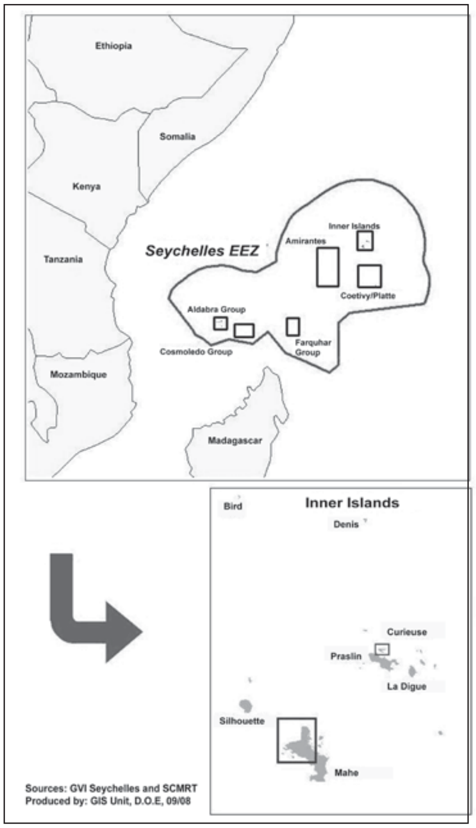
Methods

Site description

GVI is a non-government organisation (NGO) that conducts marine research expeditions across the Seychelles inner islands with the objective of documenting marine ecosystem health in the wake of the 1998 coral bleaching event. A range of local partners are involved in the planning and execution of GVI's activities and all raw data is subsequently forwarded to Seychelles Centre for Marine Research and Technology – Marine Parks Authority (SCMRT-MPA) for quarterly review. Every three months roughly 30 international volunteers join 10 staff members to collect data in the field. From 2004-2008 the primary research station was located on the North West (NW) coast of the Seychelles largest Island Mahé, which covers an area of 455 km2 and contains the nation's capital (Victoria - 04° 36.9' S 55° 28.8' E, Map 1) along with most of the republic's estimated 90,000 inhabitants. Between 2004 and 2007 turtle monitoring was undertaken on Silhouette Island, the third largest island in the republic. This designated marine protected area covers a small but mountainous 20 km^2 and is located approximately twenty kilometres north-west of Mahé. In 2006 a secondary research station was established on Curieuse Island. However due to pending coastal developments on Mahé, all of GVI's operations have since relocated to Curieuse. This small protected granitic isle (2.86km^2) is positioned approximately 45 km north-east of Mahé and adjacent to Praslin Island, the second largest landmass and residential population found within the Seychelles.

Nest monitoring

Several beaches across the Inner Islands of the Seychelles are monitored throughout the hawksbill nesting period (Oct-Mar). Beach selection, and the number of patrols conducted, are usually dictated by volunteer availability, weather constraints, and tidal movements; however on average at least one patrol per



Map 1: Seychelles EEZ and the relative position of Inner Island study locations.

week for Mahé Island, and two per week for Curieuse Island, were undertaken at the time of writing. During each beach walk volunteers are accompanied by trained GVI staff to examine the foreshore and areas above the mean high water mark (MHWM). Nest monitoring began in 2004 on Grand Barbe, Silhouette Island with thrice daily beach patrols; a smaller number of patrols were also conducted across a variety of low density nesting beaches across NW Mahé (Grand Anse, Anse Du Riz, Anse Major, Port Launay and Baie Ternay). Monitoring on Curieuse Island (Anse St Jose, Baie Laraie and Grande Anse) commenced in 2006 when GVI's second marine research station was established.

When a track is discovered GPS coordinates of the nest's location are recorded in addition to any information that can be obtained from the track pattern, or the time frame in which egg deposition occurred. Mean track width (cm) is determined from three separate measurements at distinct points along the track's trajectory. If a turtle is observed emerging, further information on nesting behaviour and clutch size can be obtained, and females may be tagged post nesting if feasible.

Tagging

Tagging to date has been conducted on Curieuse Island in tandem with the local rangers from SCMRT-MPA. Snorkelling surveys, or beach walks during the nesting season are used to locate the turtles. Upon capturing an individual a series of three metric linear measurements are recorded for each variable following the Marine Turtle Specialist Group (MTSG) guidelines (Bolton, 1999). Callipers and measuring tapes are used to obtain mean values for body depth, plastron length, carapace length (SLCL), carapace width (SLCW), head width (OCCW), head length (OCCL), total tail length (from plastron to tip) and post-cloacal tail length (from mid-cloacal opening to the end of the tail). Live weights are obtained by wrapping the turtle within a large-mesh nylon net attached by hand to a 10 kg spring scale. Tag numbers (if present) are visually inspected to ensure long-term integrity (Limpus, 1992) and descriptions of any characteristic marks or scarring on the carapace are also recorded.

Focal behavioural study

Stomach content analysis has shown that Hawksbill turtles across the world feed predominantly upon marine sponges (Family Porifera); secondary elements of dietary composition may include Corallimorphs, Ascidians (sea-squirts), Alcyonaceans (soft corals), shellfish, seagrass, macroalgae and mangrove fruits (Meylan & Whiting, 2008). From June 2006 to July 2008 snorkelling surveys of resident marine turtles were conducted on NW Mahé using stationary point count and u-shaped 25mx5m belt transects; incidental sightings during coral reef research and monitoring activities were also documented. Through these observations and the advice of local experts it was hypothesized that some degree of site fidelity was likely evident within the Baie Ternay marine reserve. This prompted the introduction of a focal behavioural study using SCUBA with the long-term objective of establishing a photo identification database and obtaining previously unknown information on hawksbill turtle foraging ecology for the inner islands. The sampling methodology implemented was a modified version of that employed by von Brandis (2008) and this approach was deemed effective for analysis, and achievable for incorporation, within the framework of GVI's Seychelles marine expedition.

One day per week two teams (am/pm), each consisting of between 2-4 buddy pairs of SCUBA divers, are spread evenly across the reef slope in Baie Ternay to undertake a U-shaped search pattern with a maximum bottom time of 45 minutes. The divers rely on compasses to swim towards the shore but may deviate from their course when a turtle is found. On initial sighting of a turtle the subject is kept at a minimum distance of 4 m or greater while a timed series of information on activity budgets and depth is recorded with a dive computer. Further information on prey selectivity is gathered if the turtle is witnessed foraging, and data recorders are strongly encouraged to photograph prey items for *aposteri* identification.

Results and discussion

Nest monitoring

From 2004-2008 beach patrols across Mahé and Silhouette Island have yielded 794 observations of turtle tracks by GVI staff and volunteers. The mean number of turtle tracks recorded over the breeding season (Oct-Mar) on Silhouette remained consistent throughout 2004/2005 (39.8) and 2005/2006 (40.7) before rising markedly in 2006/2007 (54.2) in response to a greater investment of sampling effort (R^2=0.92). The highest number of tracks (140) documented in any month of sampling occurred on Grande Barbe beach, Silhouette Island during November 2006 (Figure 1a) shortly before GVI's monitoring activities ended in December 2007 due to preparations for the new Curieuse Island research station.

Our initial findings clearly show that Grande Barbe represents one of the highest density sea turtle nesting sites within the Seychelles inner islands and provides encouraging results for an area which has only been protected as a marine reserve since 1987. Moreover, two incidental nesting patrols conducted in July 2005 have resulted in two tracks being recorded (80 cm and 120 cm width respectively) the latter of which is consistent in both the size and seasonality of *C. mydas* in other Seychelles Islands (Miller, 1997; Mortimer *et al.*, 2006).

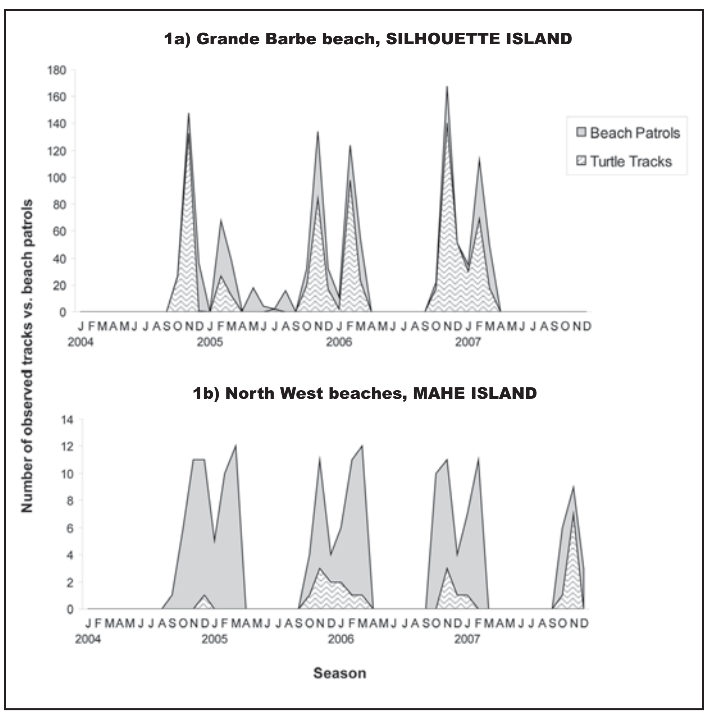


Figure 1 (a&b): Number of tracks observed during volunteer beach patrols across a) Grand Barbe beach, Silhouette Island and b) North West Mahé Island.

Between 2004 and 2007, 165 beach patrols were conducted on beaches across NW Mahé with a total of 24 turtle tracks recorded (Figure 1b). Despite the relatively high level of sampling effort, estimates of the nesting population are difficult to discern due to the small number of tracks recorded and no correlation between the number of patrols and the number of tracks recorded was found to exist (R^2=0.02). Of the five NW Mahé beaches that were monitored, Baie Ternay and Port Launay were both declared marine protected areas (MPA) in 1979, however these were not the locations where turtle tracks were most often encountered (only n=2 and n=3 respectively across the total sampling period). Most of the tracks were found on beaches that included a freshwater source (Grande Anse: n=8, Anse Du Riz: n=4) or were accessible to the open ocean (Anse Major: n=4).

Taking into account the multiple nesting efforts made by a single female during any season (3.6-7), and Mortimer and Bresson's (1999) estimated 1.8 trial emergences to every successful nesting event, it appears that only a handful of female hawksbill turtles are still emerging across NW Mahé to lay eggs.

There was no obvious difference in the mean size of nesting tracks between NW Mahé (n=11, mean=82.73, SD=7.80, range=65-92 cm), Curieuse (n=202, mean=75.53, SD=9.80, range=38-103 cm), or Silhouette Island (n=500, mean=78.26, SD=10.51, range=40-138 cm). Most of the turtle tracks encountered fell within the 70-90cm size range (Figure 2) suggesting that the sample population is comprised primarily of hawksbill turtles (Pritchard & Mortimer, 1999). Substantially fewer tracks were recorded on the heavily populated and predominantly unprotected location of NW Mahé, compared with Silhouette and Curieuse islands where complete coastal marine ecosystem protection is afforded and the impact from anthropogenic activity is limited. Long-term studies from nearby Cousin Island have demonstrated that nesting hawksbills only return to their natal beaches every 2-3 years and so further monitoring over extended temporal scales is required before a biological trend can be validated (Mortimer & Bresson, 1999).

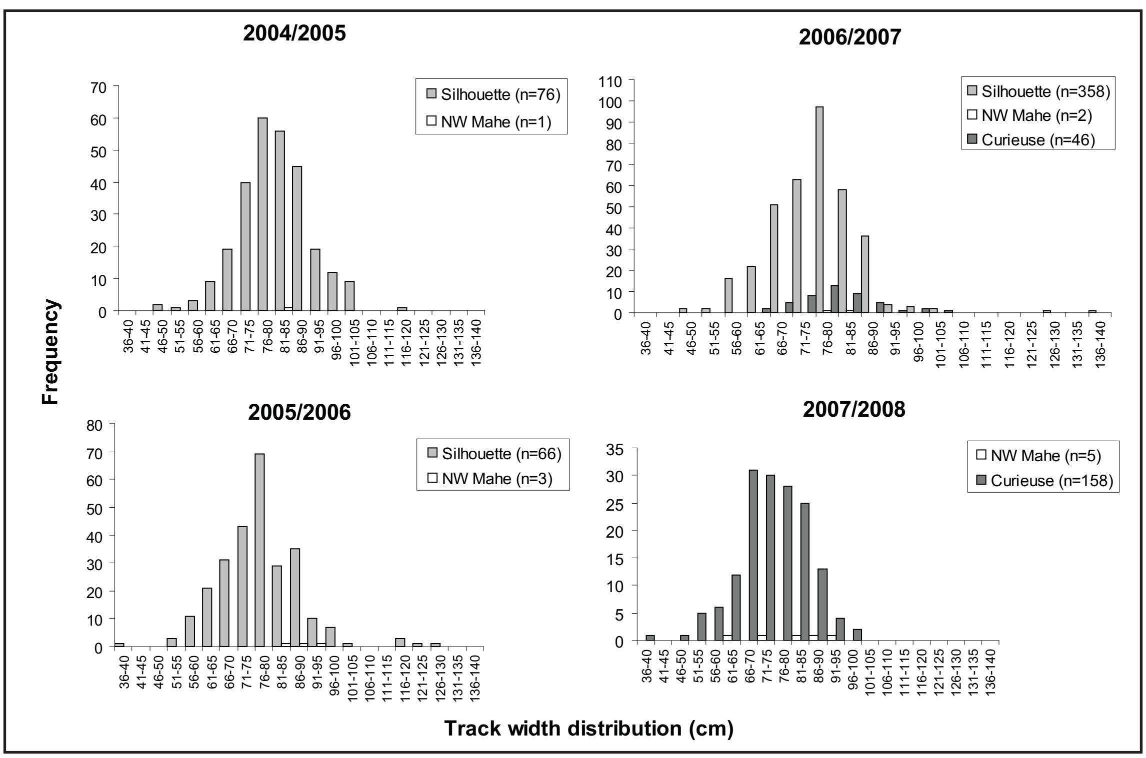


Figure 2: Frequency histogram showing the distribution of track widths left by nesting female sea turtles emerging across the NW beaches of Mahé Island, Grande Barbe beach, Silhouette Island and the Curieuse Island Marine Park from 2004-2008.

The continued monitoring of linear track widths (cm) throughout our study has provided a useful, non-invasive estimate of size for nesting females as well as supporting evidence for species identification in the absence of a live subject. In future this technique should also be cross examined periodically with other nest and track characters such as body pit depth, clutch size, and egg diameter to accurately identify the seasonality and track size variability between *C. mydas* and *E. imbricata* nesting populations. Regardless of the inherent differences in the pattern symmetry, hawksbill and green turtle tracks can be confused and do exhibit an overlap in size ranges between widths of 85-95cm (Pritchard & Mortimer, 1999).

A relatively small number of tracks (>100cm) were observed on Silhouette and Curieuse Island that substantially exceed the maximum expected track width of *E. imbricata*; I have not attempted to separate the data taxonomically as it is likely to become skewed by an unknown amount of heterospecific variability. Nonetheless, the high maximum values recorded on Silhouette Island during each sampling period provides strong evidence that Grand Barbe beach is also utilised as a nesting location by green turtles.

Tagging

Thirty-two hawksbill turtles were tagged by GVI over the 2006/2007 and 2007/2008 breeding seasons (Table 1). The number of individuals tagged each season was roughly even between years, although the rate of recaptured hawksbills did fall substantially from the first to the second sampling period most likely as a result of the disparity between individuals emerging over consecutive seasons (Mortimer & Bresson, 1999). Conservation volunteers played a significant, and valuable, role in collecting data for the Curieuse Marine Park tagging program. GVI's consistent supply of well trained research volunteers also provides an opportunity to obtain descriptive information on the breeding ecology of *E. imbricata* from nesting locations. A mean clutch size of 178.67 was obtained from observations of six laying females between July 16th 2006 and July 15th 2007 (152, 173, 174, 190, 190, 193 eggs each), and while this finding is consistent with surveys of clutch size across Cousin Island over time (Diamond, 1976; Hitchins *et al.*, 2004), we still have little information on incubation success rates for Curieuse Island from year to year and the factors which may be influencing them.

Year	**# Hawksbills tagged**	**# Hawksbills recaptured**	**# Tags replaced**
06th Oct 2006 – 22nd Feb 2007	17	40	8
08th Nov 2007 – 12th Mar 2008	15	5	1
Total	**32**	**45**	**9**

Table 1: Summary of Global Vision International's tagging efforts within the Curieuse Island Marine Park from 2006 - 2008.

Focal behavioural study

To date over 50 hours of timed underwater observations of hawksbill turtles have taken place in the Baie Ternay Marine Park at various depths and positions on the reef. Preliminary findings made outside the breeding season (July-September 2008) have noted a conspicuous absence of foraging observations in the Baie Ternay marine reserve. However the theft of notebooks containing data collected by the Mahé Island research station has meant that a more descriptive appraisal of preliminary results is not possible. GVI is currently revaluating its monitoring project to accompany their newly developed base of operations; further investigation of ontogenetic shifts in habitat utilisation and prey preference across inner island reserves is recommended.

Conclusion

Our results have highlighted the important role that NGOs play in monitoring both protected and non-protected areas over long temporal scales, and reinforced the need for independent turtle monitoring groups to work cooperatively and employ consistent data collection methods for the elucidation of biological trends. Recent studies have demonstrated that marine reserves are the most effective tool to slow population decline and mitigate the deleterious effects of extraction in the absence of comprehensive biological data for the species (Mortimer, 1988; Mortimer & Balaza, 1999; Mortimer *et al.*, 2000). In spite of the sustained and heavy extractive pressure which has taken place in the Seychelles over previous decades, this region represents one of just five nations in the world with >1000 females nesting annually (Meylan & Donnelly, 1999). Informed management decisions and pro-active intervention from government and non-government sources in recent times has made substantial progress in the reduction of unsustainable environmental practices across the outer Islands. However the cumulative effect of industries such as sand mining, commercial fishing, coastal development and poaching continue to take their toll. Every effort must be made in the future to ensure that management strategies involve coastal development operators in the task of habitat preservation or remediation efforts, and that the emphasis on enhancing natural systems through responsible tourism practices is maintained.

Acknowledgements

Local government, para-statal and NGO partners are instrumental in achieving GVI's research and monitoring objectives within the Seychelles. We would like to thank Rodney Quatre and Daig Romain of the SCMRT-MPA for their input into current research and monitoring techniques, while Dr. Jeanne Mortimer and Dr. Rainer von Brandis have given their time and expertise without hesitation throughout the development of our hawksbill focal behavioural study. The Marine Conservation Society of Seychelles (MCSS), the Seychelles Fishing Authority (SFA), and Nature Protection Trust of the Seychelles (NPTS) deserve special mention for their continued support and I'd also like to extend my respect and gratitude to country director Tim Kirkpatrick for his innovative approach to expedition management and his unwavering support of staff members in the field.

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A multi-stakeholder approach to the challenges of turtle conservation in the United Republic of Tanzania

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Introduction

Tanzania, located in tropical East Africa, has a coastline of 900km, supporting a diverse array of marine habitats including coral reefs, mangroves, sea grass beds, lagoons and offshore islands. Many of these habitats provide important foraging and breeding grounds for endangered marine turtles (Muir, 2005). Five species of turtle are present in Tanzanian waters: green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*) but only green and hawksbill turtles are known to nest on Tanzania's beaches (Howell & Mbindo, 1996). Sea Sense monitors nesting activity in eight coastal districts which represents approximately one–third of Tanzania's coastline. Nesting density is relatively low across these districts with an average of 350 - 400 nests recorded per year (Sea Sense, unpublished data). Although afforded complete protection under national fisheries legislation, turtle populations in mainland Tanzania continue to face threats from subsistence harvesting for meat, poaching of eggs, incidental capture in gill nets and habitat disturbance (Bourjea *et al.*, 2008). Inshore commercial prawn trawlers also pose a significant threat (Joynson-Hicks & Ngatunga, 2009). Tourism development leading to destruction of nesting beaches is a major concern for turtle populations in Zanzibar (Bourjea *et al.*, 2008).

Challenges

There are many challenges facing turtle conservation in Tanzania. Although Tanzania has ratified several international treaties which pertain to marine turtle protection including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973 and the Convention on the Conservation of Migratory Species of Wild Animals

(CMS), 1979, turtles continue to face major threats from anthropogenic activities in the coastal zone.

Key turtle foraging and breeding habitat in Tanzania is under threat from destructive fishing practices including industrial prawn trawling and seine nets (Muir, 2005). Poorly regulated coastal development threatens nesting beaches and disturbance from seasonal fisher camps has had an impact on turtle behaviour and nesting frequency (Muir & Abdallah, 2002). Despite clear conservation measures in Tanzanian legislation to protect turtles, there is little enforcement by relevant government authorities. Those who deliberately hunt or poach eggs, trade in turtle products or who use illegal fishing practices such as dynamite fishing are rarely apprehended or penalised.

A multi-stakeholder approach

Tanzania is a signatory state of the Indian Ocean South East Asia Marine Turtle Memorandum of Understanding (MoU). In recognition of the importance of a coordinated, multi-stakeholder approach to turtle conservation, Sea Sense is working closely with national and regional partners to implement priority actions and strategies of the MoU. The MoU has directed many of the collaborative efforts that Sea Sense has implemented and continues to be a valuable tool for guiding Sea Sense research and monitoring activities and community participation, capacity building and public education and awareness strategies.

Sea Sense is engaging with coastal communities, government authorities, academic institutions, the private sector and law enforcement agencies to address the challenges of turtle conservation in Tanzania. A community based turtle nest monitoring and protection programme was established in 2001 and now operates in eight coastal districts. Over 60 community members (mostly fishers) have been trained in data collection and practical field conservation techniques including identification of turtle species and their tracks, tagging of nesting females, egg translocation protocols, nest monitoring and hatchling release.

Sea Sense has elicited the support of District staff (Fisheries, Natural Resources and Education Officers) who contributes to training, awareness and education activities. Tanzania Fisheries Research Institute (TAFIRI) and the University of Dar es Salaam (UDSM) have collaborated with Sea Sense to conduct surveys into turtle bycatch and trade in turtle products. Hoteliers are participating in a turtle ecotourism initiative and supporting Sea Sense turtle conservation activities through donations and turtle viewing fees. Several meetings have been held with Tanzania Marine Police to lobby for action against dynamite fishing which is having a devastating effect on turtle foraging and breeding habitat (*pers. obs.*). Funds are currently being sought to conduct a marine conservation awareness seminar for law enforcement agencies and the judiciary.

A broad, participatory approach to turtle conservation has proven to be an effective method of protecting turtles in neighbouring Kenya (Okemwa *et al.*, 2004) where similar challenges are faced. In Tanzania, significant progress has been made in engaging a range of stakeholders who are now participating in Sea Sense turtle conservation activities. There is improved understanding of the major threats to turtle survival although addressing the issue of law enforcement remains the greatest challenge at both a local and national level.

Community nest monitoring

In 2001, community based nest monitoring commenced in Mafia Island, a small island 120km south of Dar es Salaam. Beach surveys were undertaken and interviews were held with local fishers to help identify turtle nesting beaches (Muir & Abdallah, 2001). Since then, six community members have been conducting early morning foot patrols throughout the year, at five key nesting beaches. Data is collected on nesting species, nest location and frequency of nesting activity. Nests are located and identified by day track counts. Threats to nesting females and incubating eggs are also recorded and any nest under threat from poaching, predation or tidal inundation is translocated to a safer area. All nests are monitored until hatching and then excavated to assess hatching success. Standard protocols are used for all monitoring and protection techniques as described in Eckert *et al.* (1999).

In addition, opportunistic day and night patrols have been undertaken to nearby islands in the Mafia archipelago where turtle nesting has been reported by local fishers. Results indicate that Shungi-mbili is an important nesting site, particularly for critically endangered hawksbill turtles (Muir & Abdallah, 2002). However, seasonal fisher camps on the island have disturbed nesting females and those that do come ashore to nest are either slaughtered, or their eggs are poached (Muir & Abdallah, 2002).

Monitoring of turtle nesting beaches was scaled up in 2004. Monitoring protocols used in Mafia Island since 2001 are now being implemented in eight coastal districts (approximately one–third of the Tanzanian coastline, Figure 1). Data is being collected by a network of 45 community Conservation Officers throughout the year.

Figure 1: Sea Sense turtle nest monitoring sites. (Source: L. West, 2009)

Over 95% of turtle nests recorded in Tanzania are laid by green turtles. Mafia Island is the most important nesting site. In 2008, 252 nests were recorded from day track counts (West, 2009). Less than 10 hawksbill nests are recorded each year and are all recorded on offshore islands (Muir, 2005). However, it is likely that some hawksbill nests go unrecorded due to the inaccessibility of some of these islands at certain times of the year.

There are seasonal patterns in nesting activity with peak nesting for green turtles occurring in March, April and May at all monitored mainland sites (Figure 2). Peak nesting activity for hawksbill turtles appears to be in January and February although this data is taken from a sample of only 28 nests in Mafia Island. A total of 2,135 turtle nests have been identified and monitored since the implementation of the Sea Sense nest monitoring programme in 2001. Of these, 1,741 (82%) have been successfully protected and 146,713 hatchlings have reached the sea. Clutch size and hatching success rates were calculated according to Miller (1999), means are presented with standard deviations. Mean clutch size for green turtles was 117 ± 25 cm. Mean clutch size for hawksbills was greater at 143 ± 24 cm. A mean hatching success rate of 67 ± 29 % was recorded for green turtles and 73 ± 25% for hawksbill turtles.

In the mid 1970's, olive ridley turtles were known to nest on Maziwe Island in Pangani District (Muir, 2005). The island has since submerged and no further olive ridley nests have been recorded. However, there have been repeated reports of turtle tracks when the island is exposed at low tide. In April 2009, Sea Sense, in collaboration with local fisher associations, commenced regular patrols of the island. Ten green turtle nests have so far been translocated to the mainland to prevent inundation by the tide. No olive ridley nests have been recorded.

Nest poaching and predation

Nest poaching has occurred in Tanzania for generations and is not generally perceived to be contravening the law. However, at sites where effective monitoring and conservation education are underway, the threat of egg harvesting has been significantly reduced. During the first year of monitoring in Mafia Island, 33 out of 70 recorded nests (47%) were poached by local fishers. In 2002, the incidence of poaching fell with eight out of 162 nests (5%) poached (Muir & Abdallah, 2002). This can most likely be attributed to the implementation of a community nest protection incentive scheme and a public awareness campaign. Poaching in Mafia remains at approximately 2% with four out of 252 nests poached in 2008 (West, 2009). The frequency of poaching at other key mainland sites (Temeke District) has also reduced over the past four years of monitoring. In 2005, three out of 68 nests (4%) were poached compared with two out of 143 nests (1%) in 2008 (Sea Sense, unpublished data). Anecdotal reports from Tanga Region in the north of Tanzania indicate that nest poaching is more widespread although these reports have not been verified.

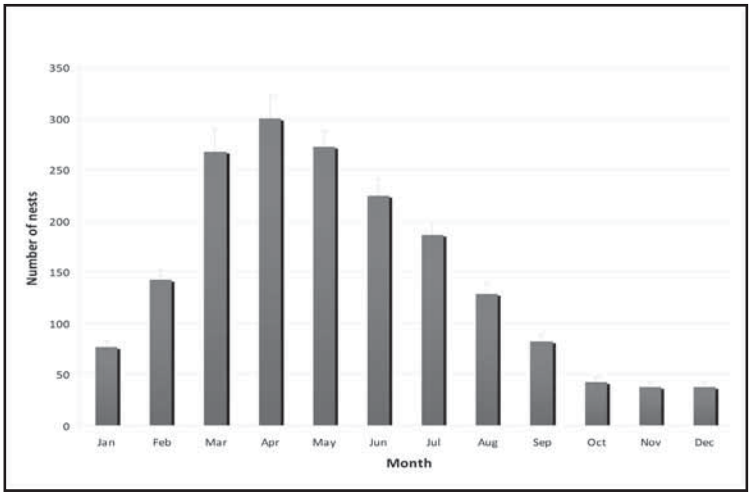

Figure 2: Nesting seasonality in green turtles (*Chelonia mydas*) in Tanzania, 2001 - 2008

Development and survival of turtle hatchlings are threatened by natural predators such as monitor lizards (*Varanus spp*), mongoose (*Herpestes javanicus*), honey badgers (*Mellivora capensis*), termites (Isoptera) and feral dogs (*Canis spp*). Ghost crabs (*Ocypode spp*), Indian house crows (*Corvus splendens*) and other birds prey on hatchlings as they emerge from the nest. In 2008, due to high levels of predation by mongoose, honey badgers and monitor lizards in Temeke District, Sea Sense placed protective nets over several nests using techniques described in Boulon, Jr, 1999. Such strategies have proven reasonably effective in deterring some predators. Twenty-six out of 428 nests (6%) were predated in 2008 (West, 2009) compared with 39 out of 305 nests (13%) in 2007 (Muir, 2007). However, predation by ants (Solenopsis spp) remains an ongoing problem due to the ants' ability to establish underground trails to turtle nests (Buhlmann & Coffman, 2001).

Mortality

Sea Sense began recording turtle strandings in 2004. On average, 230 – 250 mortalities are recorded each year. Many dead turtles are washed up on beaches and show evidence of net entanglement. There is also a high incidence of turtle slaughter in Tanzania and discarded carapaces are often found close to villages or fisher camps. Based on carapace determination, most mortalities (79%) are attributed to green turtles. Hawksbill turtles represent 12% of all recorded mortalities, olive ridley, 4%, loggerhead, 2% and the remaining 3% are unidentified.

Industrial prawn trawlers are considered to be responsible for more sea turtle deaths than any other human-related activity (Muir & Ngatunga, 2009). A two year ban on trawling in Tanzania was implemented in January 2008 due to reduced prawn stocks, high levels of bycatch and commercial non-viability of the fishery (Bourjea *et al.*, 2008). In 2007, Sea Sense and TAFIRI conducted a survey of turtle bycatch in the Tanzanian industrial prawn trawl fishery. The survey was conducted over a three month period and data was gathered from three licensed vessels in three fishing zones. Each month, vessels trawled for 20-26 days, with 4-5 hauls per day. During the survey, a total of 16 turtles were captured, most of which were green turtles (62.5%).

Both male and female turtles were captured and all but one was captured live. Based on these results, it is estimated that over a trawl season of seven months and a fleet of 10 vessels conducting 4-5 hauls per day (number for 2007), the turtle catch rate is estimated to be 54 turtles a year (season). The use of Turtle Excluder Devices (TEDs) in prawn trawl vessels is not mandatory under current Tanzanian fisheries legislation. However, Sea Sense continues to lobby for the incorporation of TEDs into Tanzanian fisheries law.

Trade in turtle products

In 2008, as a result of several unverified reports indicating that trade in turtle products (meat, shells and live specimens) in Tanzania is commonplace, Sea Sense and UDSM conducted a survey of the trade in the Dar es Salaam area (Sea Sense & Mwangi, 2008). Forty-eight people were informally interviewed over a period of seven weeks by an undercover investigator to avoid suspicion. The survey revealed that turtle products (meat, shells, oil) are sold both openly and in secret at the main landing sites in the Dar es Salaam area.

Turtles are reported to be caught daily in fishing nets and with hand lines. The turtles are brought in to landing sites live for sale, normally early in the morning or late in the evening, to avoid detection. Many of the turtles come from other coastal districts as well as local fishing grounds. Turtle meat is sold regularly at six of the survey markets and is believed to improve the immune system. Turtle scutes are ground down and used to treat pregnant women and turtle oil is used to cure ear ache in children. Turtle carapaces are sold for between TSh 4,000 and 15,000 (USD3 – USD12) depending on the size. The shells are usually varnished and then sold for decoration to Tanzanians.

Fishers and traders are aware that trade in turtle products is illegal but due to the lack of enforcement there is no deterrent. Sea Sense has been working with District Fisheries Officers and law enforcement agencies to ensure those responsible for the illegal turtle trade are apprehended. At present three cases are being heard at a court in Kilwa for the illegal sale of turtle meat.

Turtle ecotourism

Turtle ecotourism, if well managed, has been identified as a valuable way to conserve endangered marine turtles and their habitats as it encourages communities to place a high value on live turtles. Sea Sense has been working with hoteliers and local communities to initiate turtle-based tourism activities in the vicinity of key turtle nesting sites. There are currently nine hotels participating. Visitors who witness a turtle hatching event are encouraged to make a donation to Sea Sense or for a modest fee, adopt a turtle nest, receiving an adoption certificate, details of their adopted nest and photos of the hatchlings. Half of monies raised from visitor donations and nest adoptions are used to support Sea Sense turtle conservation work. The remaining revenue is used to fund local community development projects. Sea Sense has established Village Environment Funds in two villages adjacent to turtle nesting beaches. In 2008, US$3,600 was raised through turtle ecotourism activities and has been used to refurbish a local primary school, install a clean water supply and improve health care services.

Awareness and education

Sea Sense conducts regular awareness and education programmes. Primary and secondary school art, drama and song competitions have been held in several coastal districts and 'Village Olympics' were recently held, targeting local fishers. The competitions are organised in partnership with District Education Officers and marine park authorities and have proven to be an effective method of raising awareness of endangered marine species conservation and the importance of sustainable marine resource use. Educational materials have also been distributed including leaflets, posters, t-shirts and DVDs. An annual 'Day of the Turtle', similar to that held in other countries in the Western Indian Ocean region (Comoros and Mayotte) is currently being considered.

Law enforcement

Some progress has been made with law enforcement at a local level following the development of Beach Management Units (BMUs) in several coastal districts. BMUs are at various stages of developing and implementing their own fisheries related by-laws in accordance with Village Resource Use Management Plans (VRMPs) and in support of existing fisheries laws and regulations. Sea Sense has participated in consultations on draft BMU guidelines to ensure appropriate turtle protection measures are designed and incorporated. Frequent meetings have been held with village councils and BMU leaders to elicit support for the measures and promote full participation in decision making processes. This continued collaboration will ensure any future policy measures are fully supported by the local community and will facilitate identification of training and resource needs in order to strengthen capacity for effective implementation and enforcement of local bylaws.

Conclusion

The participation of a range of stakeholders has made a significant contribution to turtle conservation in Tanzania over recent years. In particular, a community based nest protection and monitoring scheme has provided employment, training and education opportunities for coastal communities and empowered them to take ownership of their natural resources. It has also generated a small but sustainable source of income through turtle ecotourism.

However, there remain many challenges to address. There is an urgent need to strengthen capacity of government authorities and law enforcement agencies through training and provision of resources (vehicles, boats, communication equipment). Without adequate capacity within these sectors, the development and implementation of appropriate policy measures will be ineffective and there will be no long term commitment to enforcement.

There are also large spatial and temporal gaps in information on turtles in Tanzania. Important foraging and developmental areas remain unidentified and there is limited information on turtle migratory routes and areas of high risk, particularly from fisheries bycatch. This information is fundamental to the conservation and management of different breeding populations and to ensuring resources are focused effectively.

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Discovering behaviour of open sea stages of sea turtles: working flipper on hand with fishermen in Réunion

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Sea turtles are under pressure from a number of natural and anthropogenic factors, both in the terrestrial phase of their life as well as in marine environment. Conservation efforts will only succeed if the major threats can be managed, and fisheries interactions constitute one of these. The small offshore longline fishery of the French islands of the Indian Ocean (30 offshore longliners) seems to have a limited impact on sea turtles (Bourjea *et al.*, 2008). In 1999, a three-year study showed that less than 0.004 turtles per 1000 hooks were by-caught by this fishery (Miossec & Bourjea, 2003). Trawling and gillnets are not used in Réunion. However, in order to be able to further reduce current and future interactions between sea turtles and fisheries, it is necessary to gain as much understanding of the biology of turtle species during the pelagic stages of their lifecycle as possible.

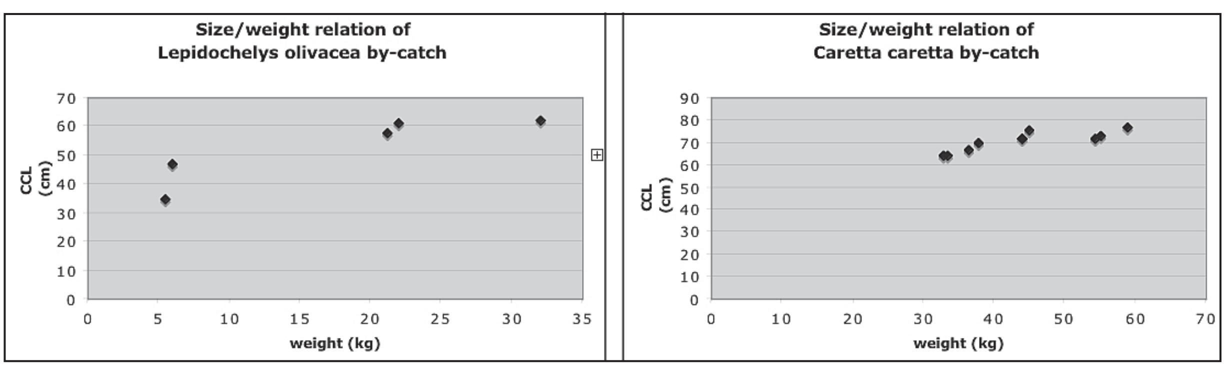

Figure 1: Size and weight of marine turtles in by-catch from 2004 to 2008 by longliners in the waters of Réunion.

2a 2b 2c

Figure 2 (a, b &c): Surgical operation, under anaesthesia, to withdraw a fishing hook from a sea turtle found in Réunion longlining bycatch. Photos: S.Ciccione, 2009

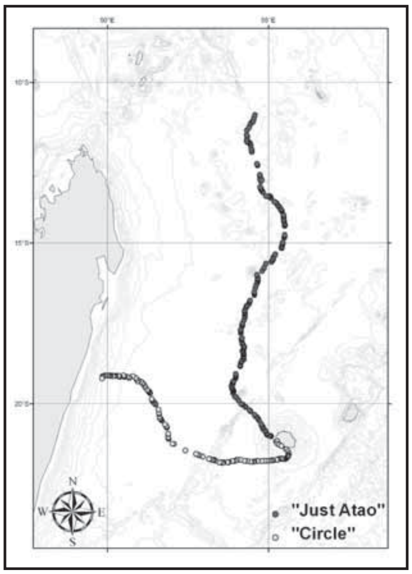

Figure 3: One month long travel of two *Caretta caretta*, in October 2008 (red) and March 2009 (green), from Réunion longlining bycatch.
(Source: J. Bourjea, 2009)

Cooperation with fishers for research and best practice

By working together, scientists and open sea fishers can work towards reducing sea turtle by-catch and mitigating its impacts. For example, fishers can remove hooks from turtle esophaguses before they release them, or keep the turtle alive on board until assumption of responsibility for them by a health center. Additionally, data collected when turtle by-catch occurs (e.g. boat position, time and date, turtle weight and length, and genetic sample) or after the release (e.g. movement and diving behavior of turtles fitted with satellite tags) can help increase understanding of the biology of sea turtles and their interaction with open sea fisheries.

To this end, in 2004 a cooperative program was established by Kelonia, IFREMER and Reunionese volunteer fishers to monitor by-catch of sea turtles in the Réunion longline fishery and to reduce by-catch mortality. By-catch turtles (Figure 1) are kept onboard by fishers, and given to the Kelonia health centre to recover after hook removal. Modern surgical techniques and anaesthesia sees more than 60% of turtles recovering (Figure 2). In September 2008, this program was included as part of the French sea turtle component of the South West Indian Ocean Fisheries Project (SWIOFP) supported by the Global Environment Facility (GEF). The issue is to study the open sea behaviour of marine turtles and the interactions with fisheries within an ecosystem approach. The program is led from Réunion and works together with volunteer Réunionese drifting longliners. Turtles are released with a location/depth recorder satellite tag, in order to study their open sea behavior.

The partnership with the fishermen is a long-term job, but the partnership is going well and has continued to involve the same four boats since 2004.

In October 2009, two *Caretta caretta* were fitted with satellite transmitters (Figure 3), and three other turtles will be released with satellite tags in the next six months.

In the framework of the SWIOFP, 80 satellite tags will be deployed in the French Exclusive Economic Zone of the West Indian Ocean to have a regional vision of the oceanic displacements of the sea turtle. Results will be taken into account in fisheries management.

Acknowledgements: Thanks to the Local Initiative Fund of Credit Agricole Bank and the Regional Council of Réunion for their financial support, and to Dc Francis Schneider for his surgical expertise.

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Project Profile

Blue Ventures Conservation
Community marine turtle conservation in Southwest Madagascar

Background

Southwest Madagascar's remote Toliara region contains some of the most biodiverse coral habitats in the Indian Ocean, but also supports Madagascar's largest traditional fishery, with 20,000 fishers operating in the province. Artisanal fishing is one of the primary causes of direct reef damage (Nadon *et al.*, 2007; Ahamada *et al.*, 2008) and unsustainable biomass removal but is also the principal source of income for the indigenous Vezo coastal communities. Protecting the region's biodiversity is therefore inextricably linked to promoting more sustainable resource use. Blue Ventures Conservation and the local community are currently leading efforts to protect and manage marine turtle fisheries in the region.

The traditional marine turtle fishery in Madagascar

Five species of marine turtle inhabit Madagascar's coastal waters, green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys coriacea*) turtles. The Vezo population of southwest Madagascar actively fish for and consume all five. Decline in turtle populations in this region has been documented previously by Rakotonirina (1987), who reports declines in numbers of nesting green, loggerhead and hawksbill turtles. The fishers exploit both the nesting populations as well as the foraging aggregations.

Turtle hunting is considered an important cultural Vezo activity and has several associated ancestral rituals. Traditionally turtle fishing had several restrictions that had to be observed by the hunters in order to catch turtles, although many of the rituals related to the preparation of the meat. Whilst some still observe the traditions or parts of them, there has also been a relaxation of traditions and restrictions, especially where new methods have been used. There are also currently no conservation strategies in place to monitor or manage the traditional subsistence turtle fishery.

Project Objectives

In October 2006 the first phase of turtle research and conservation programme was initiated in Andavadoaka region, 200 km north of Toliara.

The project objectives are to:

1. Profile the regional turtle fishery;
2. Locate and monitor any nesting sites in the region;
3. Increase awareness of marine turtle conservation issues;

1a 1b 1c

Figure 1:
a. A community meeting with the village of Lamboara, near Andavadoaka, to discuss the protection of the nesting beach.
b. The community marks the nesting beach with a flag and performs traditional rituals to their ancestors.
c. Sign constructed to inform other fishers that the beach is protected and that overnight camping is no longer permitted.
Photos: Blue Ventures Conservation, 2008

4. Evaluate current awareness of turtle protection legislation;
5. Determine the importance of the turtle fishery to the community;
6. Develop community-led management strategies for turtle conservation.

Project results and future objectives

The research programme has seen widespread support and now monitors the turtle fisheries in 24 villages in Andavadoaka and expanded to the Morondava region, a further 200 km north of Andavadoaka. Turtle fishermen voluntarily report their catch to local fishermen that act as data collectors for the project. The first two years of the project has yielded significant achievements in accurately profiling the extent of the turtle fishery within the region and in starting to promote the idea of management of the traditional fishery. As a result of awareness-raising work, two green turtle nests were protected and successfully hatched – the first known to have done so in the region since 2003 - and led to the community-led protection of the nesting beach.

Blue Ventures is also working to coordinate the implementation of a community-run network of marine protected areas in the Andavadoaka (Velondriake community marine protected area) and Morondava regions (Kirindy Mite National Park) and this project aims to integrate a local framework for turtle fisheries conservation and management into both. The success of this project will contribute to several themes of the IUCN Global Strategy for the Conservation of Marine Turtles, as well as enhancing understanding of the marine turtle populations in southwest Madagascar feeding into regional and global conservation strategies. However, the most substantial and long lasting contribution that the project will make to nature conservation is through a shift in the attitudes towards the marine turtle fishery amongst the Vezo people. There has already been the first step in community-led management strategies through the protection of a nesting beach and the next steps must now be taken to promote sustainable exploitation.

Information

Blue Ventures Conservation (www.blueventures.org) is a UK-based NGO dedicated to facilitating marine conservation and research. Based in southwest Madagascar, Blue Ventures Conservation aims to establish a sustainable and community-led approach to marine conservation by steering ecological research towards goals that aid the socio-economic development of the region. Blue Ventures collaborates with the Marine Turtle Research Group (www.seaturtle.org/mtrg) at the University of Exeter on its turtle research and conservation program.

For more information please contact Frances Humber (frances@blueventures.org).

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NGO Profile

Marine Conservation Society, Seychelles (MCSS): An integrated approach to marine turtle management in the inner islands, Seychelles

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Introduction to the Marine Conservation Society, Seychelles (MCSS)

The Marine Conservation Society, Seychelles (MCSS) is a Non-Governmental Organisation (NGO) that was registered in 1997 in Seychelles, Western Indian Ocean. MCSS was formed by a group of local marine experts to meet the lack of capacity in Seychelles and to address matters of marine biodiversity, conservation and sustainable use. MCSS remains to this day the only Seychelles based NGO dedicated exclusively to the conservation and sustainable use of marine biodiversity.

In 2000, the MCSS successfully obtained funding from the Global Environment Facility for a three year project focused primarily on the management of coral reefs, whale sharks and marine turtles following the severe bleaching event of 1998.

The MCSS has pioneered conservation actions in Seychelles through a number of highly successful projects including monitoring the whale shark (*Rhincodon typus*), management of the Crown-of-thorns-starfish (*Acanthaster planci*), the installation and maintenance of environmentally friendly moorings systems, a strategic approach to marine turtle management, the development of marine eco-tourism activities and the sustainable use of marine biodiversity in general.

MCSS bases its work on a policy of open engagement of actors in the domain of marine conservation, sustainable use and development. It works closely with local partners, such as the Ministry of Environment, Natural Resources and Transport (MENRT), the Seychelles Fishing Authority (SFA) and the Seychelles National Parks Authority (SNPA), without compromising its role as an independent NGO.

Background on the MCSS integrated approach to marine turtle management in the inner islands, Seychelles

Seychelles hosts the fifth largest population of the Critically Endangered hawksbill turtle (*Eretmochelys imbricata*) (Meylan & Donnelly, 1999) and a significant population of the Endangered green turtle (*Chelonia mydas*). Historically, turtle populations around the islands of Mahé and Praslin were probably as prolific as any other in Seychelles, but exploitation and loss of nesting habitats over many years has decimated these populations (Mortimer, 2004). While much has been done in recent years to protect these remnant populations and educate the population of Seychelles on turtle conservation, there is still much that can be achieved, especially with targeted and cooperative actions.

With this is mind, MCSS has launched a number of complementary and mutually supportive turtle projects that address the strategic, tactical and local scenarios in an attempt to address turtle conservation in an integrated manner. Given the integrated nature of these projects, turtle monitoring and awareness efforts are ongoing, even though funding from the original donors may have ended.

Strategic management of turtle populations

MCSS launched its first turtle project in June 2003 with funding from the Foreign and Commonwealth Office through the British High Commission in Victoria, Seychelles. The project on *Strategic Management of Turtle Populations* brought together stakeholders from throughout Seychelles, who currently manage turtle rookeries, into a partnership through which they can share data through an on-line database. This partnership informed the development of a Strategy and Action Plan, adopted by the partners in April 2005, and now supports implementation of the Plan. This should improve the survival status of the Seychelles turtle populations by a clear strategic overview of the status of turtle rookeries and habitat and by better coordination of communications and activities between the various stakeholders. A Memorandum of Understanding between the partners was developed by open and equitable consultation which clearly sets out the terms and conditions of information provision, sharing and use.

This project instigates long term strategic action to conserve and where possible rehabilitate key marine turtle populations. The strategy will elaborate conservation and eco-tourism plans and thereby develop a real value for the living animal, as well as enhancing their conservation status.

In addition to the e-turtle database, one of the main outputs of this project was the formation of the Turtle Action Group of Seychelles (TAGS) and the web site www.seychellesturtles.org.

Integrated turtle beach management project on Intendance beach, South Mahé

In September 2003, MCSS in partnership with the Banyan Tree Resort, Seychelles, launched an *Integrated Turtle Beach Management Project on Intendance beach, South Mahé*. This project aims to manage the beach, its dune structure and associated vegetation to enhance turtle nesting and mitigate the impacts of tourism activities.

The project functions at various levels: it records turtle nesting activity, manages beach front vegetation and resort activities in a turtle–friendly manner; it incorporates local community involvement particularly through the inclusion of educational activities for school children; and it monitors the dynamics of sand movement on the beach through seasonal change. The project also further incorporates the Resort clients with educational talks, provision of information on turtles in the rooms and in particular information on how tourists should act if they encounter a turtle on the beach.

Over the six years since its inception, this project has expanded to cover neighbouring beaches as turtle tagging by MCSS and Resort staff, has indicated inter-beach nesting.

Conservation of priority turtle rookeries on the Developed Islands

The *Conservation of Priority Turtle Rookeries on the Developed Islands Project* was launched in January 2004 and is funded through voluntary donations from the general public and business community. It focuses on the hawksbill turtle rookeries on the three main islands of Mahé, Praslin and La Digue, which were once the largest rookeries in the Central Seychelles but are now in serious decline (Mortimer, 2004). This project aims to target priority beaches for management intervention which offer the best potential to maintain turtle populations, through community support and participation. From one beach being monitored in 2003, MCSS now monitors twenty turtle nesting beaches on Mahé and manages another three on Praslin.

Integrated turtle beach management project on Lemuria beaches, North Praslin

Constance Lemuria Resort on Praslin has been monitoring turtles since 1999 (Mortimer, 2004) and began working closely with MCSS in November 2006, to implement the *Integrated Turtle Beach Management Project on Lemuria beaches, North Praslin* with the ultimate aim of harmonising the needs of tourism and turtles on the three Lemuria beaches, thus making each beneficial to the other.

As with Banyan Tree Resort project, this project functions at various levels and employs a full time Turtle Manager under MCSS supervision to: record turtle nesting activity, manage beach front vegetation and Resort activities in a turtle–friendly manner; and monitor the dynamics of sand movement on the Lemuria beaches through the seasons.

Movement patterns of nesting and inter-nesting hawksbill turtles on the developed islands of Seychelles

This project was launched in January 2008 with funding from Barclays Bank, Seychelles. It is being implemented by MCSS in association with the Ministry of Environment and Natural Resources and Transport (MENRT), the Wildlife Clubs of Seychelles and various other local and international sponsors. The aim of the project was to track two nesting hawksbill turtles with satellite relayed GPS tags, so as to expand the limited scientific knowledge available on the movement patterns of the nesting populations on the developed islands of Seychelles and determine where these animals go to forage between nesting seasons. Unfortunately, one turtle was killed by a poacher ten days after tag deployment. The second turtle was named ‘Carol’ by Jessica Marengo, a local school girl and winner of the ‘name-the-turtle’ competition; Carol has surprised researchers by swimming all the way to Madagascar. Her tag, which was expected to last three months, is still transmitting some twenty one months after deployment.

The location data from Carol’s tag was used as an awareness tool and shared with teachers at local schools via the Wildlife Clubs and through the internet via the facilities of www.seaturtle.org. The Seaturtle.org Satellite Tracking Program provides a unique opportunity to engage students in a fun and exciting way. Satellite tracks were used to develop lesson plans covering a number of subject areas, including biology, mathematics and geography. Special interest groups, such as the Wildlife Clubs, were also able to focus on a specific ‘projects’ competition which was judged in October 2008. This is the first time that this sort of high-tech co-operative educational project has been tried in Seychelles and it is hoped that the teachers will use this opportunity to motivate youngsters to the needs of turtles.

A further two tags funded by private donations and the local business community, will be deployed during the 2009-2010 nesting season.

Tracking turtles within the Western Indian Ocean through photo-identification

This project was launched in May 2009 in collaboration with Kelonia Marine Turtle Observatory, Reunion, following an agreement between Seychelles and Reunion for Regional Corporation in turtle research and conservation. The aim of the project, as described by Jean *et al.* (2010) and Ciccione *et al.* (2009), is to use photo-identification to track tagged and untagged turtles at their foraging sites.

Individual animals are identified using photographs of their left and right facial profiles, with scales being coded based on their location and number of sides. MCSS submitted over 80 images of nesting and foraging turtles in the waters around Seychelles, allowing researchers at Kelonia to validate this new photo-ID method on Hawksbill turtles (Jean *et al.*, 2010). MCSS has since started a national campaign to encourage SCUBA divers, as well as other turtle researchers in Seychelles, to contribute to this project.

Conservation of turtle rookeries on the developed island of Mahé

This is the most recent of the MCSS turtle projects, which started in September 2009 with funding from Mangroves For the Future (MFF). The primary objective of this project is the conservation and rehabilitation of the few remaining viable nesting colonies on Mahé and the overall reduction in anthropogenic disturbance to turtles on nesting beaches. This will be achieved through the identification, monitoring and rehabilitation of priority turtle nesting beaches on Mahé under collaborative programmes with local communities and stakeholders and by raising public awareness in both residents and tourists about turtle conservation in Seychelles.

Project outputs and public awareness about turtle conservation in Seychelles

Nesting data from all of these projects is being submitted to the State of the Worlds Turtles (SWOT) to help to generate a Global Hawksbill Nesting Map (Hutchinson *et al.*, 2007).

MCSS has produced a number of documents during the implementation of these projects, aimed at raising awareness about turtles within the general population, as well as with visitors to our shores. This includes newsletters, codes of conducts for watching turtles and guidelines for turtle friendly beach development. MCSS recently set up a turtle blog (http://seychelles-turtles.blogspot.com) and also contributes to http://www.ioseaturtles.org/ and http://www.seaturtle.org.

Several activities have also been organised with school children and local community groups aimed at rehabilitating nesting beaches through beach clean-ups and replanting of dune vegetation.

For more information on MCSS activities: Tel/Fax: (00248) 261511 or write to *info@mcss.sc* or visit www.mcss.sc. Contact MCSS at P.O. Box 1299, Victoria, Mahé, Seychelles.

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New Resources

Relevant news from IOSEA

http://www.ioseaturtles.org

The following summary text is drawn from www.ioseaturtles.org, modified with permission.

Western Indian Ocean country profile

The IOSEA website focused its September 2009 monthly profile on the Western Indian Ocean (WIO) region, following the Sixth WIOMSA Scientific Symposium in La Réunion, France. In compiling the profile, they drew on the national reports of the respective IOSEA Signatory States. Almost all of the country reports had been updated recently in preparation for the second meeting of the WIO-Marine Turtle Task Force. The profile (http://www.ioseaturtles.org/pom_detail.php?id=90) takes the reader on a tour of the WIO region beginning in South Africa and continuing northward along the mainland coast to Kenya, before heading east to take in a half dozen island States and territories.

Projects database

About 50 projects (mostly from the Western Indian Ocean) have recently been added to the IOSEA Projects Database, see http://www.ioseaturtles.org/projectdb.php

Bibliographic resource

A new IOSEA Bibliography Resource launched in November 2009 makes available to interested practitioners essential information about marine turtle conservation and research, with an initial focus on the Western Indian Ocean region. It has been developed especially to support the work of the Western Indian Ocean - Marine Turtle Task Force, a technical committee established under the CMS/IOSEA Marine Turtle MoU and the Nairobi Convention. The IOSEA Bibliography Resource aims to overcome the paucity of current and readily available information on marine turtles in the region by compiling the most comprehensive collection of reference material ever on marine turtles of the Western Indian Ocean.

The basic bibliography is available for general public viewing, querying and printing. However, the actual collection of documents that have been converted to electronic format (PDF) may be consulted only by colleagues associated with the WIO-MTTF and other concerned individuals who have been granted exclusive password access to the system. The strict conditions for non-commercial research and educational use of the IOSEA collection are described during the login process. Over time, it is envisaged that some of the documents in the collection will be made publicly available, to the extent that any applicable copyrights are respected. As a general rule, however, journal articles will not be made publicly available.

Satellite tracking metadatabase

IOSEA launched its new Satellite Tracking Metadatabase (http://www.ioseaturtles.org/satellite_tracking.php) in August 2009. The database aims to compile existing metadata relating to satellite tracking in order to facilitate a more coordinated approach to future work, and to maximise the usefulness of what is still a relatively expensive research tool. Having an overview of what tracking studies have already been done may help to pinpoint complementary data sources never before compiled in a single reference. Equally important, the database can be used to identify strengths and gaps in coverage in satellite tracking, in terms of geographic area, species, sex, age class, etc.

Altogether the IOSEA metadatabase contains information on nearly 550 satellite-tracked turtles from about 20 countries of the IOSEA region (as of November 2009). The database includes details of 50 IOSEA-region projects (concerning nearly 300 animals) that have published their results in the literature, as well as a similar number of projects described in seaturtle.org/tracking - which provide information on the movements of about 200 animals fitted with satellite transmitters. Adult female green turtles have been extensively tracked in the IOSEA region (well over 200 animals in more than 15 countries), whereas leatherback and olive ridley studies have been limited to just a handful of countries. While relatively few hawksbills have been tracked, many countries have been involved. Satellite tracking of male turtles and juveniles (of any species) is relatively uncommon. Historically, Australia, India, Indonesia, Japan, Malaysia, Oman, South Africa and Thailand top the charts when it comes to satellite tracking studies in the IOSEA region.

The metadatabase aims to capture 95% or more of all satellite tracking studies ever conducted in the Indian Ocean - South East Asia region. Known gaps in coverage include France (Southwest Indian Ocean), India (deployments in 2002 and 2007) and Thailand (about 20 animals).

3rd Announcement: 30th Annual Symposium on Sea Turtle Biology & Conservation 27 – 29 April, 2010 Goa, India

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Symposium website: http: india.seaturtle.org/symposium2010

Only three months remain until the symposium in Goa. Preparations are in full swing, and we currently have over 700 registrations! Thank you all for your enthusiasm and support.

Programme Schedule:

The main symposium will be held between the 27th and 29th of April at the Kala Academy in Panaji, Goa. We have scheduled about 400 abstracts distributed over several oral, speed and poster sessions.

Workshops and regional meetings

A host of workshops and regional meetings are scheduled for the 24th – 26th and 30th of April. The workshops lined up include: Stable Isotopes, Marine Invasive Species, Satellite Telemetry and Turtle Rehabilitation. A statistics workshop is also planned. Regional meetings include: Africa regional meeting, Indian Ocean and Southeast Asia regional meeting, Latin America meeting (Retomala) and Mediterranean meeting. In addition, the IUCN / MSTG will hold its annual meeting on the 30th of April.

Special this year

Special to the Goa symposium is a Fisheries Forum, scheduled for the 25th of April, which seeks to provide a platform for discussion of fisheries, livelihoods, natural resource management and conservation. Also planned as part of the Fisheries Forum is an photographic exhibition of communities, craft and gear.

A special South Asia Mini-Symposium is scheduled for the 26th of April. This regional meeting will bring together conservation groups and others from within the region to help strengthen networks and address issues that are of common interest to the region.

Social events

Don’t miss out on the exciting social events planned for this year's symposium. You can sign up for the Welcome Event and Farewell Banquet on the registration website (http://iconferences.seaturtle.org).

Auction

The auction is an exciting symposium tradition that provides endless entertainment each year, but also helps us raise money towards travel for next year's symposium. Do bring all things turtle and turtle-like that can be sold at ridiculous prices for a good cause.

To know more about these events, log on to our website.

Travel related information:

For those of you who are traveling from outside India, do make sure that you have applied for a visa well in advance. To help easy processing of visas for participants, we are collecting details which will be forwarded to the Embassy / Indian mission in your country. Do write to us if you have not already been contacted by our coordinators. More details about visa related procedures and travel is available on our website.

You can book rooms online through our appointed travel agency ICE-India. Details are available on the website. A list of low budget accommodation is also now available on our website. Book now to avail of the early bird rates that are on offer to symposium participants.

You may also use the discussion forum on seaturtle.org to find room partners if you are traveling alone, and other information that you may need.

If you are a travel grant applicant and have not heard with regard to your travel grant, please contact you regional travel chair immediately. Travel grant recipients will be intimated about the mode of payment and related details in a separate email in April, 2010.

Group tours

Group tours are currently being planned by the symposium travel and tour partners. Information on this will be shortly available on our website. You may also use the discussion forum on seaturtle.org to find travel partners, and other information that you may need.

Registration:

If you have not already registered for the symposium, you may do so online at http://iconferences.seaturtle.org. The early bird registration fee is no longer available; the current registration fees are:

High income: $ 230
Regular income: $ 160
Student / low income / participants from developing countries: $ 60

Vendor and Exhibition tables:

If you would like to purchase a vendor table, please make sure you register online and indicate the number of tables you would like to purchase. Our vendor coordinator will be in touch with you for further details. In case of any queries or information needed, do feel free to write to Vijitha Pereira at vijitha@hostindiaevents.com.

Support for the symposium

Support for the symposium has been received from many donors and individuals, but we still have a long way to go. We encourage individuals and donors to contribute to the symposium. Please contact us for further details.

More information

Do remember to visit the website
http://iconferences.seaturtle.org and
http://india.seaturtle.org/symposium2010 for the latest news and updates about the symposium.

For general queries and inputs, write to our symposium coordinator, Seema Shenoy at seemashenoy83@gmail.com.

I look forward to seeing you all in Goa!

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Cover photograph: Mangrove fringes of Europa, the southern most island of the French Espares islands in the Southwest Indian Ocean, where hawksbill turtles are found. (Source: Taaf, 2009)

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