opportunities for local employment.

Sea turtle conservation training programmes for forest department personnel, GMB and coast guard could be initiated. Local public awareness campaign is a must. During Nature Education Camps between December to March, "Turtle Walks" were initiated with a view to patrol and protect the nesting beaches. Beach clean ups were organised through camp participants.

Recently in December 1999 there happened to be a major oil spill. Approximately 15,000 tons of crude oil spilt into the Gulf of Kachchh. There were reports of sea turtles and dolphins being affected. Similarly oil slick may have also damaged the fragile coral ecosystem. The overall impact of this spill has yet to be assessed.

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## The Nesting Frequencies of Marine Turtles in Rekawa, Southern Sri Lanka

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Five of the world's seven species of marine turtles come ashore to nest in Sri Lanka. Those are the green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*) and the olive ridley turtle (*Lepidochelys olivacea*). Despite government legislative protection, marine turtles are still being exploited in Sri Lanka for their eggs and their meat. As a result of this and threats to habitats, all marine turtles are considered under threat and the hawksbill turtle is critically endangered in Sri Lanka (Hewavisenthi, 1993).

The Turtle Conservation Project (TCP) is a Sri Lankan NGO, established in 1993, with the aim of devising and facilitating the implementation of sustainable marine turtle conservation strategies through education, protection, research and community participation. Rekawa beach, on the southern coast, is Sri Lanka's most important marine turtle nesting rookery, but was under serious threat from 100% turtle egg collection since the 1970's by local people. In 1996 the TCP established a pioneering community based *in situ* marine turtle nest protection and research program in Rekawa. This program was designed to employ former turtle egg poachers as turtle 'Nest Protectors'. The main aims of the program were: (1) to protect all nests using the *in situ* method and allow for the immediate natural release of all hatchlings to the sea on

emergence; (2) to provide new data on the biology of the nesting marine turtle populations of Sri Lanka; and (3) to provide an alternative sustainable income for the turtle egg collectors in Rekawa.

So far TCP researches have tagged 600 turtles including all five species. Out of 600 nesting females, 541 were green turtles, 28 were olive ridleys, 23 were leatherbacks, three were hawksbills, and five were loggerheads. Two thousand six hundred and sixty nests were laid on Rekawa beach during the period September 1996 to September 1999. There were 2572 green turtle nests (96.7%), 39 leatherback nests (1.47%), 36 olive ridley nests (1.35%), seven loggerhead nests (0.26%) and six hawksbill nests (0.22%).

## Introduction

TCP surveys revealed that Rekawa is the location of one of the most important green turtle rookeries in Sri Lanka (TCP internal reports-unpublished). Leatherback turtles, loggerhead turtles, hawksbill and olive ridley turtles also nest at Rekawa. All of these species are listed as either endangered or vulnerable by the World Conservation Union (IUCN).

For more than 20 years up until 1996, local people from the impoverished Rekawa village had collected all the turtle eggs laid on Rekawa beach for sale or local consumption. This resulted in zero recruitment into the local marine turtle population. Egg collectors from Rekawa interviewed during TCP surveys have said that in the 1970's it was not uncommon to take eggs from as many as 40 nests per night. But today the number of the nests per night rarely exceeds 10. These egg collectors are either dependent or semi-dependent on the sale of marine turtle eggs for income generation. Some nesting female turtles are also occasionally killed for their flesh, which is also sold at local markets (TCP internal reports 1994/95-unpublished).

Marine turtles are believed to reach sexual maturity at about 30 years of age (Mrosovsky, 1983); research has also found that female turtle's return to nest at their natal beach. Therefore, as there'd been no recruitment into the Rekawa populations for more than 20 years-due to egg collection, there would only be a further 10 year period when first-time nesting turtles would arrive at Rekawa (i.e., up to the year 2006). After this time there would be no first time nesters and the nesting population would begin to dwindle due to mortality from natural and human factors (e.g. fishing by-catch, pollution). If egg collection had continued there would have been no further recruitment into the nesting population. The TCP therefore believed that if no action was taken to prevent egg collection, the nesting population of marine turtles at Rekawa would have been so over-exploited as to have been unable to recover, leading to the extinction of this population within 20 years (Richardson, 1996).

## Rekawa: The Project Site

The TCP selected Rekawa, a small village near Tangalle, in the district of Hambantota in southern Sri Lanka, for the implementation of the TCP's *in situ* marine turtle nest protection and research program. Rekawa is located on the border of the intermediate and dry climatic zones of Sri Lanka, and borders a large saline lagoon surrounded by extensive mangrove forests. There are no electricity or telephone lines in the village and the majority of households do not have running water.

The village is divided into two divisions, Rekawa East and Rekawa West, and the numbers of families in these divisions are 121 and 144 respectively (Foerderer, 1996, in press). Income generating activities for the families in the Rekawa area include agriculture (47%), lagoon fishing (10%), sea fishing (18%), coral mining (9%) and others (17%) such as masonry, carpentry, government services and labor (Banda *et al.*, 1994).

The community of Rekawa village has suffered several setbacks in the last decade. During the late 1980's and early 1990s, Rekawa was the location of political violence, which bereaved many families of their skilled men-folk. An irrigation system designed by the government to improve the quality of the agricultural land surrounding nearby Tangalle, drained Rekawa of its groundwater. The groundwater was eventually replenished by saline water from the sea and Rekawa lagoon, which rendered the land unsuitable for agriculture unless there are heavy rains. These events have resulted in low incomes for most of the families in Rekawa with approximately 57% of the families dependent to some degree on government welfare (Foerderer, 1996).

## Rekawa's Natural Resources

Because Rekawa is located on the border of two climatic zones there is a high local biodiversity. As well as the mangrove forests, the local vegetation consists of scrub jungles, medicinal plants, fruit trees and a wide variety of wildlife including 150 resident and migratory birds, 29 species of mammals, 23 species of reptiles, many arthropods and diverse aquatic life (Kapurusinghe,1995).

## Project Objectives

The objectives of the TCP Rekawa community *in situ* marine turtle conservation and research project can be listed as follows: (1) to protect *in situ*, all marine turtle nests located within the project boundaries and ensure that all resulting hatchling turtles reach the sea immediately after emerging from the nest; (2) to incubate the eggs collected from as many nests as possible laid on adjacent beaches outside the project boundaries in a small, scientifically managed hatchery and immediately release

the resulting hatchlings; (3) to collect biological data from the nesting female populations of marine turtles of each species present at the Rekawa turtle rookery. Research topics will include determining number of nests per season (individual and population totals), size of nesting female populations, growth rates of individuals, longevity of individuals beyond tagging, mean breeding frequency, migratory paths and geographical range, nest incubation periods, nest temperatures, and hatching success rates (*in situ* and hatchery comparative studies); (4) to involve local stakeholders in the planning and implementation of the *in situ* nest protection and research program; (5) to provide an alternative and sustainable income to those Rekawa community members currently financially dependent on marine turtle egg gathering by employing them in a system of non-consumptive and sustainable utilisation of local nesting marine turtle populations; (6) to set up a 'Turtle Watch' program for paying tourists to help contribute to the future sustainability of the project; (7) to provide a field study and training site for interested parties, such as university students, government department research officers, and NGO members, to learn about marine turtle conservation and research methodology.

## Methods

*Involvement of Former Egg Collectors*

A series of meetings were held with the egg collectors. During these meetings the regular egg collectors were identified by TCP. Those individuals were requested to stop collecting eggs once the program began. As an alternative they would be provided with the opportunity to take up employment as assistants to the Research Officers (ROs) (see "Research Methodology") of the research program and as in situ protectors of marine turtle nests. The transformation of the local egg collectors to 'Nest Protectors' provided the research team with an invaluable local understanding of turtle behavior in Rekawa.

Twenty four egg collectors were organized into a formally recognized group of 'Nest Protectors' (NPs). Discussions were held on the methodology of the *in situ* nest protection and research program and appropriate alterations made. The TCP also carried out basic training in in situ nest protection methods and data collection skills. The project began on 2 September 1996.

*Research Methodology*

Data sheets were designed to collect biometric data from each turtle and from each nest laid. Key data collection involved an initial mapping of the beach; the weighing, measuring and tagging of nesting female turtles; monitoring nesting behavior; and collecting data on incubation periods, hatchling biometrics, and hatching success rates. Each hind flipper of each turtle was tagged with a Dalton plastic tag, using first a leather punch to make a hole in the flipper and then an applicator for affixing the tags. Flexible measuring tapes were used to turtle curved carapace length and width.

The 2 km stretch of beach within the project boundaries were patrolled 24 hours a day by the NPs in order to prevent poaching of marine turtle eggs. At least two ROs and six NPs were present on the beach from 19:00 hours to 3:00 hours every night. The ROs organized rotation patrols for themselves and the NP's, originating from a central position on the beach. Therefore, each half of the 2 km stretch of beach was patrolled every half hour at night by 2 personnel. The purpose of the patrols was to locate landed turtles and protect nests already laid.

Once a track has been located by a patrol unit of NPs, one of the personnel carefully ascends the track and ascertains the stage of the nesting procedure of the turtle. They then issue a recognized torch signal to the central position to indicate to the rest of the patrolling team that a turtle has been located. A RO based at the central position then returns a recognition torch signal and then makes his way to the nesting site with the necessary research equipment. Meanwhile the NPs observe the turtle's behavior, recording the time at the beginning of each stage of the nesting process. On arrival at the site, the RO manages the patrol unit in the collection of biometric data.

The RO and NPs on daytime duty measure the exact location of the previous night's nests and place a 'nest screen' over the nest. The nest screen is a 1 m square piece of steel cable mesh, the mesh size is small enough to prevent animal predators from excavating the nest, yet large enough to enable emerging hatchlings to escape.

ROs and NPs occasionally patrol the beach outside of the project boundaries. Any recently laid nests found in these areas are relocated and incubated within TCP boundaries, to prevent poaching. Similarly any nests that the TCP staff decides may be threatened within TCP boundaries for various reasons (eg. some nests are laid in areas subject to high tides), are relocated to a safe place. All the data collected by ROs was fed into a database (Microsoft Excel) on a regular basis.

Five full-time ROs were trained in data collection, research methods and nest protection, and were responsible for the coordination and supervision of the beach research and conservation. The posts were occupied as follows: one TCP Senior Research Officer and program co-ordinator; one1 TCP Research Officer; one Post-graduate student, registered with the Department of Zoology at the University of Peradeniya; one Officer from the Department of Wildlife Conservation; one National Aquatics Resources Agency (NARA) officer; and one Post-graduate student registered with the Department of Zoology at the University of Ruhuna.

## Discussion

Setting up and operating the participatory *in situ* nest protection and research program at Rekawa was an

enormous challenge for the TCP. It was Sri Lanka's first genuine marine turtle conservation and research program and one of only a few marine turtle conservation projects in the world operating as either in situ, or community participatory.

The program has not been without its problems and the TCP has had to continually review the program and address problems as they arise, working in cooperation with the NPs. It has been a learning process in both in in situ turtle conservation, and community participation in conservation and development. The TCP staff is now confident in being able to deal with any future difficulties.

During the research period TCP staff observed dogs, crows, water and land monitors, ants and ghost crabs attacking and consuming hatchlings. Ghost crabs are the main night-time predator, while the remainder are daytime predators. One of the most destructive predators on Rekawa beach was a species of red ant attacking a small number of nests, killing and consuming hatchlings still in the sand after hatching.

The hatching success rate has improved through the project's duration as the TCP has adopted better methods in nest protection and nest relocation. Nests and their emergent hatchlings have been successfully protected from predators and environmental threats and it is believed that the nest success rate is significantly higher than it would be in the wild. The TCP expected considerable thefts on nests considering the radical change over from egg collection to egg protection as villagers were depending on eggs for over twenty years. The TCP managed to catch seven nest thieves who were reported to the police and given severe reprimands. Disappointingly, five of these people were 'Nest Protectors' working for the TCP and were subsequently sacked in the early stages of the project, a decision taken by the NPs and TCP management.

The predominance of the green turtle species was expected. We were however pleasantly surprised by the three hawksbill turtles that nested, as these have not been seen nesting in Rekawa for five years! The research has also been extremely successful with ROs and NPs working well as a team to produce a comprehensive and detailed data base on nesting turtles and nests hatched. This information will be extremely important in ensuring an improved understanding of the biology and behavior of Sri Lanka's marine turtles and hence provide for more effective future marine turtle conservation strategies. The research information collected by the TCP will also be an important contribution to the world data base on marine turtles to help produce more effectual regional strategies to protect this long distance migratory species.

The Rekawa project has also been very successful as a site for in-situ training for marine turtle research and conservation methodology: (1) NARA and the DWLC now have a trained officer in in situ marine turtle conservation; (2) ROs are currently undertaking their MSc dissertations based on the *in situ* conservation program, with positive implications for future marine turtle research in the Zoology departments of their respective universities; (3) two hatchery managers have been trained in *in situ* methodology and good hatchery management procedure. It is hoped that hatchery management practice will become more scientific and conservation orientated as a result; and that hatchery managers and interested conservationists may be inspired to set up similar *in situ* programs; (4) marine turtle conservationists from around the world have also visited the project.

The project has provided a valuable source of education and promotion of marine turtle conservation and the principle of conservation as a whole, with visits from local people, Sri Lankans, foreign tourists and schools. A group of students from an International school in Colombo stayed in Rekawa for a week and undertook scientific research on beach geography and chemistry to evaluate impacts on nest success rates.

The project has provided a valuable alternative source of income for community members previously dependent on the destructive exploitation of marine turtles and their eggs at Rekawa. NPs now receive higher and more stable earnings than as egg collectors, thus aiding local development. Local people can now see there is an alternative to destructive exploitation of natural resources. Some NPs have seen hatchlings for the first time and now say they would not collect or eat turtle eggs again.

## Conclusions

According to the results the authors would like to conclude that: (1) all five species nesting in Sri Lanka nest at the Rekawa marine turtle rookery; (2) the most common nesting marine turtle species in Rekawa is the green turtle (*Chelonia mydas*) ; (3) the 2 km stretch of beach at Rekawa can be considered the most important green turtle nesting rookery in Sri Lanka, according to the available data; (4) the least common nesting species at Rekawa is the hawksbill turtle (*Eretmochelys imbricata*); (5) the nesting female population in Rekawa is so far estimated to be 600 and it includes all five species found in Sri Lanka; (6) on average more than 800 nests per year are laid by the nesting turtles in Rekawa; (7) almost a 100,000 eggs are laid annually by the nesting turtles in Rekawa (8) dogs, crows, water and land monitors, ants, and ghost crabs are the main land predators for eggs and hatchlings on Rekawa beach; and (9) a viable alternative has been provided to the previous marine turtle egg collectors of Rekawa who were unsustainably exploiting the local marine turtle population.

## Recommendations

Marine turtles have over 180 million years of evolutionary history. Despite increasing intensity in international marine turtle research, researchers still know very little about marine turtle biology. Therefore, the best

method to conserve marine turtles would be by adopting the *in situ* conservation method, which allows turtles to continue to interact with their natural environment and reproduce naturally as they would in the wild. Where in situ conservation is not possible or economically unfeasible, then ex situ conservation can play an important role in marine turtle conservation, as long as it is carefully managed according to the best scientific protocol available.

Considering the TCP's experience during the Rekawa marine turtle nest protection and research program, the authors would like to make the following recommendations: (1) the Rekawa *in situ* marine turtle conservation and research program should be continued for at least another ten years to ensure a reasonable recovery of the exploited marine turtle population in Rekawa; (2) the strength of the research and management including the administration should be increased by receiving more support from both government and non-government agencies including foreign donor and research agencies; (3) aspects of marine turtle research in the program should be expanded and improved by increasing the areas of research, incorporating more modern research techniques and increasing research staff training; (4) The community should be continuously involved with the program development and participate fully in program activities and benefits, as they do now; and (5) further activities for self-sustainability need to be developed and implemented.

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## Ten Years of Marine Turtle Conservation in the Mediterranean (1989-1999)

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**INTRODUCTION**

From the seven species of marine turtles that occur in the world, three are frequently found in the Mediterranean: the loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) that have nesting beaches and the visiting leatherback (*Dermochelys coriacea*). MEDASSET, the Mediterranean Association to Save Sea Turtles, was set up in 1988 to protect the remaining populations of marine turtles in the Mediterranean.

Since 1989, ten areas have been assessed from Sardinia to the N.E. Aegean Sea and from the Ionian Sea to the shores of Egypt and Libya, covering 7,300 km. Financial support came from various sources, including the EC and international intergovernmental and non-governmental organizations. After ten years of conservation work, it is