
Frontier Madagascar Environmental Research

REPORT 2

Artisanal and traditional turtle resource utilisation in South West Madagascar



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Artisanal and traditional turtle resource utilisation in South West Madagascar

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Madagascar, the fourth largest Island on the planet is renowned for its high biological and ecological diversity, characterised by its high abundance of endemic species. Madagascar is one of the poorest nations in the world and very dependent on the resources the natural environment provides. As a result conservation and development work is of paramount importance as efforts are made to preserve an environment under pressure from non-sustainable exploitation. Frontier Madagascar is in the process of carrying out baseline survey work in the southwest coastal region of Madagascar in an effort to provide biological and resource utilisation data for the preparation of sustainable management initiatives for the region.

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The Society for Environmental Exploration and The Institute Halieutique et des Sciences Marines (IHSM), part of the University of Toliara have been conducting collaborative research into environmental issues since 2000 under the title of Frontier Madagascar. Frontier Madagascar conducts research into biological diversity and resource utilisation of both marine and coastal terrestrial environments, of which one component is the Frontier Madagascar/Darwin Initiative: Madagascar Marine Biodiversity Training Program. Since October 2001 the initiative has been working with local stakeholders within the marine environment to promote sustainable resource use through training and education.

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EXECUTIVE SUMMARY

Five species of turtle are utilised by the fishers of southwest Madagascar, all species showing severe declines globally in recent decades. Turtles have historically held cultural significance to those that exploit them in this region of Madagascar, legally protected domestically and internationally, these laws are seldom adhered to in the region.

Data on annual catch levels and resource utilisation of the five species of turtle was collected through logbooks and interviews with those involved in the local trade. During the study 47% of the catch was harvested from the same area, with green turtles (*Chelonia mydas*) comprising 65% of the catch. Catch rates were very environmentally dependent with seasonal trends evident but an annual catch rate for the region was estimated at 3,656 turtles in total, with an annual capture rate of 20 to 25 animals per fisher. During the Austral winter Anakao acts as a sink for turtles captured in the region with most animals passing through four dealers. During the warmer months capture rates are greater and most fishers supply the dealers of Toliara where the animals are processed, and the meat sold locally.

Turtles are deemed economically unimportant for most of the fishing communities concerned due to the scarcity of the animals only making up a small portion of the catch, of what is regarded as a multi species fishery. Fishers and dealers in Anakao regard turtles as economically important to the community due to the revenue generated by the dealers concerned. Cultural dependence on turtles is diminishing due to the increasingly low catch levels of recent years resulting in the abandonment of traditional turtle fishing gears and the fishers that solely target turtles. The reporting of continued low catch levels over a number of years suggests the fishery to be non sustainable, with annual capture rates halving in the last 10 years, nesting of green turtles has reduced three fold due to nest raiding by local communities, fishers appear to also be impacting on the protected populations of Europa and other regions of the western Indian Ocean, due to the consistent capture of tagged individuals.

Conservation efforts have been made by The Society for Exploration (SEE) and the Darwin Initiative Madagascar Marine Biodiversity Training Program (MMBTP), by running small scale community based education programs in Anakao and training local fishers in basic marine ecology and the ideas behind sustainability and conservation of the local marine environment. The MMBTP has also aided in the training of local marine science students and fisheries officers regarding ideas and current thinking behind sustainable fishery management. The authors have suggested integrated local coastal management ideas for the region with the aim of turtle conservation. Low tech, sustainable alternative livelihoods have been suggested along with the integration of marine protected areas of zones within the region that hold significance for turtle populations.

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1. INTRODUCTION

Madagascar, the fourth largest island in the world supports a coastline of approximately 6,000km (McClanahan, 2000). With a high proportion of its population close to its shores, heavy dependence on the resources they supply are evident by the levels of fishing activities, principally based on non motorised traditional boats (Macia and Hernroth, 1995, Cooke *et al*, 2000). Artisanal and traditional fisheries are ubiquitous throughout the western Indian Ocean, targeting a full range of exploitable resources in coastal waters, including a wide range of fish species but also elasmobranchs, dolphins, dugongs, turtles, crustaceans and even sea birds and eggs (Cooke *et al*, 2000). Fisheries and aquaculture in Madagascar provide protein for the large part of the population as well as foreign currency. In 1994, the production of marine products nationally was estimated at 117,500 tonnes of which 55% was captured by small scale, artisanal fisheries and traditional (McClanahan, 2000).

1.1 TURTLE CONSERVATION

The conservation of marine turtles is of global importance, due to significant declines of all species over the past three decades (Mayland and Ehrenfeld, 2000). A number of anthropogenic causes such as fisheries by-catch (Ehrenfeld, 1982), habitat destruction or disruption (Rakotonirina & Cooke, 1994), pollution, disease, and over-exploitation of adults and eggs (Rakotonirina & Cooke, 1994., Kar and Bhaskar, 1982) have contributed to the decline. All seven species of turtles are listed as Endangered, Critically Endangered, or Vulnerable by The World Conservation Union (IUCN) (Appendix 2), with all listed on Annexe 1 of The Convention on International Trade in Endangered Species of wild flora and fauna (CITES). International trade in turtle products is therefore prohibited by CITES but continues, particularly in Japan and other South East Asian countries. South West Madagascar supports a strong tradition of subsistence turtle resource utilisation, but the country has no effective conservation strategies for marine turtles, unlike many countries in the Southern African region (Hughes, 1974). WWF (2000), states the importance of development of regional programmes of protection, and the sensitisation of coastal communities in turtle conservation in developing nations such as Madagascar.

1.2 TURTLE BIOLOGY

Marine turtles belong to the families Cheloniidae and Dermochelyidae. Five species of marine turtle inhabit Madagascar's coastal waters, green turtle *Chelonia mydas*, hawksbill turtle *Eretmochelys imbricata*, loggerhead turtle *Caretta caretta*, olive ridley turtle *Lepidochelys olivacea* and leatherback turtle *Dermochelys coriacea* (Rakotonirina & Cooke, 1994). The first four species are known to nest on Madagascar and the ranges of all five have been estimated by Hughes (1974). Hughes (1974) reports that the greatest concentration of turtles appears to be in the southern end of Madagascar, with Rakotonirina & Cooke (1994), stating that the barrier reefs of Toliara are important feeding grounds for green turtles, and probably support the largest populations of this species in Madagascar.

All species of turtles become sexually mature after 20-30 years of age, and exhibit high fecundity. Fisheries modellers would consider turtles as k strategists, therefore not suitable for

intensive harvest, making poor species to base a fishery on, even back as far as 1930 Petit (1930) reported the importance of turtles to Malagasy fisheries and that population declines were already evident. Hughes (1974) pointed to the apparent decline in numbers of the hawksbill turtle and the disappearance of its nesting sites. Rakotonirina (1987) reported declines in numbers and nesting occurrences for green, loggerhead and hawksbill turtles. Groombridge & Luxmoore (1989) carried out a comprehensive review of the available literature on green and hawksbill turtles and observed the virtual lack of data on nesting sites for each species. Ratotonirina & Cooke (1994), state that the raiding of nests and hunting for meat and shells are believed to be the fundamental causes of declines for four of the five species in the region, but utilisation of habitat, especially nesting beaches and feeding and resting areas, is likely to have influenced green turtles to a greater extent. Low level of capture through artisanal¹ and traditional² fisheries to supply traditional customs has occurred worldwide for hundreds of years (Suarez & Starburst, 1996., Suae, 2000). The collection of eggs is also practised, often to excessive proportions. Green turtles show a strong fidelity to nest sites (WWF, 2000., Mayland & Ehrenfeld, 2000), it is possible that egg collection may continue for 20 – 30 years before a population collapse occurs due to long term lack of recruitment not always being apparent until it is too late.

An investigation of turtle nesting activities in the Southwest of Madagascar was undertaken by Durbin & Rakotonirina, (1991) with work carried out between 1989 and 1991, this data has been summarised in Table 1.

Table 1. Turtle nest sites, SW Madagascar (adapted from Durbin & Rakotonirina, 1991)

Locality	Green turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley turtle
Itampolo	✓			
Beheloka	✓			
Anakao	✓	✓	✓	
Nosy Satrana	✓			

During this time it was also reported that a green turtle nesting site had been used on Nosy Ve (Fig 1) up till 1987, and observations of nesting hawksbill and loggerhead turtles on the beaches to the south of Anakao occurred vary rarely. Durbin & Rakotonirina, (1991) were of the opinion that nesting rates for all species observed in the area were declining. For all species Rakotonirina & Cooke (1994) state that the nesting season is during the austral summer (October to January).

1.3 LOCAL STATUS

Marine turtles in Madagascar do enjoy some protection legally, but these laws are rarely if ever enforced. As early as 1923 laws were passed to protect green and hawksbill turtles. Decree 23 May 1923 prohibited the capture of nesting females and individuals with carapace diameters of less than 50 cm, measured beneath the plastron. Decree 24, October 1923 declared protected nesting sites on five islands around the country including Nosy Ve (Fig 1), and the French controlled island of Europa (the only area to enforce the ruling). Madagascar ratified CITES in 1975 (Decree 75-014) and a decree of 1988 (88-243), while specifically naming only the

¹ For the purpose of this report artisanal fishers are those fishers operating spear guns from traditional sailing vessels, targeting turtles amongst other species within a multi species fishery.

² Traditional fishers are all other fishers included in this report.

leatherback, appears to grant all marine turtles absolute protection from exploitation. Rakotonirina & Cooke (1994) claim that this law is not enforced for domestic exploitation and is inconsistent with the granting in some areas of licences to sell turtle meat. Rakotonirina & Cooke, (1994) are the most recent authors to have reported on turtle resource use in south west Madagascar, no co-ordinated approach to management has yet been attempted in the region.

Rakotonirina & Cooke, (1994) report during the 1992 study carried out in the coastal zone between Toliara and Beheloka (Fig 1), that the hunting of marine turtles is a long established economic activity in the region. Rakotonirina (1989) describes in detail the rituals and practices the Vezo³ employ accompanying turtle hunting. Traditionally, turtle meat was eaten only by the hunters family and selected villages. Imprecations were made to ancestors and to god before the animal was slaughtered and choice cuts were reserved for elders or “amulet bearers”. Failure to observe these rites was considered to bring bad luck. Rakotonirina (1989) states the rituals are still practised by older fishermen and in remote areas, but are largely ignored by younger fishermen close to major population centres, particularly where capture is incidental to fishing. Turtle fishing still has economic importance, while egg collection has virtually ceased with the decline in nesting (Rakotonirina & Cooke, 1994).

During 1992, Rakotonirina & Cooke, (1994) reported that fishers near Toliara claimed that the cooked meat of an adult green turtle of over 100kg could fetch as much as 200,000 FMG (over \$US30.00)⁴, double the price quoted by the same authors during a 1989 study. The meat is considered a delicacy and sold fried in Toliara. The carapaces of larger animals maybe kept for domestic use. The meat of smaller turtles is home consumed, while the carapaces are sold as ornaments for around \$US1.00. The price for shell from the rarer hawksbill ranges from \$US2.00, to as much as \$US20.00 per kg dependent on the quality and locality (Rakotonirina & Cooke, 1994). Interestingly, Rakotonirina & Cooke, (1994) report that in the Mahajanga region of north west Madagascar green turtle excrement added chicken to feed is used to eliminate intestinal parasites of stock.

1.4 AIMS

Anakao acts as landing and distribution site for the turtle catch in the region. This report centres on the small-scale artisanal and traditional turtle fishery operational in the south west of Madagascar, with Anakao (Fig. 1) being the focal point of the fishery. The aim of this report is to document the findings of a study into the resource use of marine turtle in south west Madagascar. The work documents cultural and economic significance, suggesting appropriate and documenting existing conservation and management tools.

³ semi nomadic, marine resource dependent sea faring ethnic group, indigenous to SW Madagascar.

⁴ All currency conversions are based on the prevailing exchange rate as of the time of interview (6th May 2002, US\$1=6722FMg).

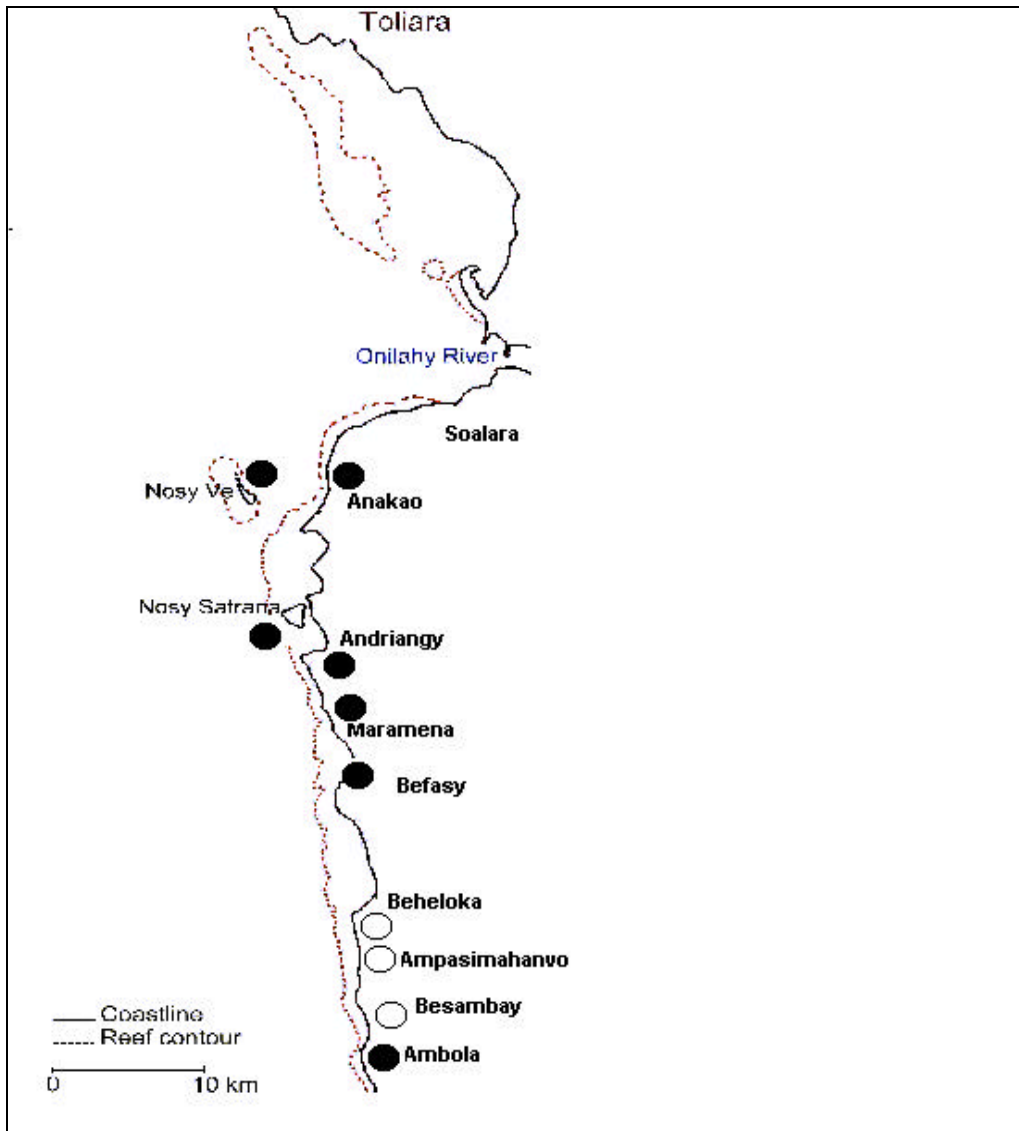


Figure 1. South west Madagascar region from Toliara to Ambola. Former known turtle nesting sites are shaded, with existing known nesting sites unshaded.

2. METHODS

2.1 STUDY SITE

Over 50% of Madagascar's sea fishers operate in the Tulear province (Laroche & Ramananarivo, 1995), with most of the effort concentrated in the near shore environment. Coral reefs and lagoonal areas extend over 600km along the southwest coast of Madagascar (Laroche & Ramananarivo, 1995).

The study area is bordered by the Onilahy River estuary in the north (Fig 1) and consists of the near shore waters dominated by the Anakao fringing reef system and the two small islands of Nosy Ve and Nosy Satrana. This study centres on marine turtle fishing effort of the 8 communities south of Soalara as far as Ambola encompassing a stretch of coastline approximately 50km long.

2.2 DATA COLLECTION TECHNIQUES

All data was collected through semi structured interviews with fishers, village leaders and reprehensive, turtle dealers and traders in Anakao and Toliara, Food and Agriculture organisation (FAO) representatives, based in Toliara and members of Fikambanana Miaro sy Mampandros an' l Nosy Ve (FIMIMANO)⁵. Catch data was collected through log books filled out by dealers in Anakao.

2.3 DATA COLLECTION IN ANAKAO

The willingness of participants to share information was of fundamental importance, with success achieved through allowing time for people to absorb ideas. It was of equal significance that efforts were made to respect local opinion and tradition. This facilitated the gaining of trust on a potentially controversial subject. There is some degree of comprehension locally that turtle killing is forbidden, and therefore it is a sensitive issue to broach without prior sensitisation. The sensitisation work in Anakao carried out by SEE has been taking place for 2 years, since January 2000. Enquiries regarding turtle resource use began in March 2001. Families dealing in turtles were then approached 9 months later.

With the help of FIMIMANO the four families in Anakao responsible for the purchases of turtles were identified and contact made by the researcher. Catch data was recorded for a period of 19 weeks between February and June 2002 by the use of logbooks issued to each family, in addition to a measuring tape and pen. With the aim of gathering the data listed in Table 2, for each turtle purchased by the dealer

Table 2. Data collected through logbooks completed by the turtle dealers of Anakao

Information Gathered by Logbook
• Carapace length (cm)
• Carapace width (cm)
• Carapace curved length (cm)
• Carapace height (cm)
• Catch date (dd/mm/yr)
• Fisher (name)
• Catch location (ie Nosy Ve reef etc)
• Species (local name)
• Sex
• Purchase price (FMg)
• Selling price (of individual parts)

The logbook contained diagrams of each turtle species, and basic ecological facts concerning them. This complimented what had already been explained to the participants regarding the

⁵ A group of delegates based in Anakao, responsible for the guardianship of Nosy Ve and its surrounding waters.

nature of the research. As well as verbal instructions the logbooks contained diagrams of the measurements needed. A demonstration of how to make each measurement was also given, all instructions were given in either written or spoken Malagasy.

2.4 TRADE NETWORK INVESTIGATION BETWEEN ANAKAO AND AMBOLA

Seven villages south of Anakao, as far as Ambola (Fig. 1) were visited by a small team of researchers. Participants in Anakao had given contact names of people who catch or deal in turtles in these villages. Semi-structured interviews (Appendix 1) were used to gain information on the turtle catch levels and trade network with the village.

The team of researchers visited the villages of Beheloka, Ampasimahonoro, Besambay, Befasy, Maromena, Andriangy and Ambola, for between 2 and 24 hours, making initial contact with each President to gain his consent. The interviews, conducted in Malagasy, were recorded on dictaphone and in notebooks, and transcribed

2.5 TRADE IN TOLIARA

The sale of turtle meat in Toliara was investigated. Price and locations of outlets were sought through semi-structured interviews with FIMIMANO members and the individuals selling turtle meat or other products i.e. carapaces.

2.6 ANALYSES OF METHODS

The translator, who has worked with SEE for over 2 years, has lifelong knowledge of the region and its traditional activities. The presence of several fishermen to contribute to discussions also consolidated local knowledge to create a consensus of opinion. Factors such as number of people present and number of years of experience of interviewees were also considered when analysing the responses.

Species names were consistent, turtles being a regular feature of the marine environment most people are familiar with the five species encountered and their identification. This was backed up by reference to diagrams and drawings of the turtle species.

One participant provided details of turtles that were fictional, otherwise all data was considered credible. Where possible direct measurements of turtles caught were made. One participant was found to be measuring in inches and this was rectified. The data was analysed using descriptive statistics, direct reporting of anecdotal evidence derived from informal discussions and information derived from semi-structured interviews.

3. RESULTS

3.1 FISHING METHODS

The turtle fishery in the region is operated from 8 villages listed above (Fig 1). Turtle fishers in Madagascar fall into two categories, occasional or occupational hunters (Rakotonirina & Cooke, 1994). Animals captured during this study are the a result of occasional hunting, being the incidental catch of fishers targeting other species, or turtles making up a portion of a multi species fishery. Gear types used were reported as spears guns and shark gill nets. Traditional fishing practices involve harpoons (Rakotonirina & Cooke, 1994), but more commonly in recent years gear has changed to the use of large gill nets 4m wide and between 60 and 200m long, locally referred to as Jarifa, used to target sharks as well as turtles. The Jarifa were first introduced in 1957 to the region. In 1996 the FAO provided the fishers of Beheloka with the materials to make Jarifa. Jarifa gears have been purchased from Toliara by all other fishers operating from other villages. FAO policy has changed in order to recognise the contribution of Jarifa to turtle fishing, no longer providing such gears, encouraging line fishing instead.

Six of the 8 villages had between 1 and 10 Jarifa used for between 4 and 11 years. The exception was fishers from Maromena, who claimed to operate 30 Jarifa, operational for 45 years. This high number of gear is probably due to Maromena operating an active shark fishery (Frontier, 2002), with the majority of the catch being elasmobranches rather than turtles. Turtles were often captured in Maromena when driven into waiting nets by the slapping of ores on the lagoon surface after they enter the inter tidal area behind a reef to feed at night. In Anakao 10 Jarifa were operated, spear guns were also used by a family of 7 fishers, who target large reef fish but perceive turtles as welcomed incidental catch, fishers in Ampasimahonoro also claimed to use spear guns as well as Jarifa.

3.2 CATCH RATE AND COMPOSITION OF THE TURTLE FISHERY.

3.2.1 CATCH RATE

A total of 28 turtles were captured by 14 fishers within the fishery, and sold to the dealers in Anakao during the study period. The modal fishing site for turtles traded in Anakao were the reefs of Nosy Ve, with 47% of the catch, comprising of 9 green turtles (Fig. 2) captured by 4 fishers. The least productive fishing sites were Soalara and Itampolo with 1 female loggerhead and hawksbill captured respectively, both sites contributing 4% of the catch produced by the fishery (Fig. 2).

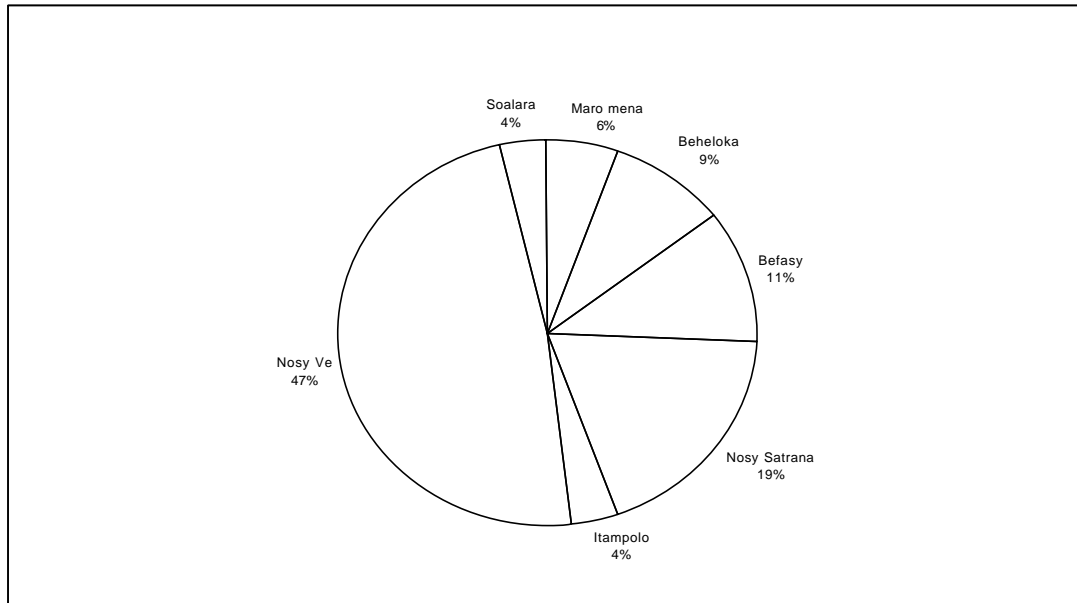


Figure 2. Turtles traded in Anakao by catch location

Interviews with village leaders and fishers from Anakao and the 7 communities south of Anakao revealed estimated catch levels during peak fishing seasons (October to March, Table 2), and low seasons (April to September). From interviews it was established that generally if fishers had 1, 2 or 3 individuals to sell then the turtles were normally taken to Anakao. If greater than 3 or 4 individuals were harvested then the catch would be sold in Toliara. During the study period most turtles would have been sold in Anakao, due to the low numbers collected as the study fell during the low fishing season. Maromena contributes to the largest catch levels, with an annual catch of over 2000 animals (Table 2). It has been claimed that when favourable weather conditions persist the 30 operational Jarifa could yield up to 3 or 4 turtles each, each time they are set. During December Befasy harvested 30 turtles, some communities reported long periods of time where no turtles were captured during the low season, such as Ambola reporting not catching any turtles for 3 months during the winter, and Andriangy only reporting an annual capture rate of 3. The fishers of Ampasimahonoro were not planning on fishing at all with Jarifa till the warmer months. From the above information and other information gained through interviews, it was possible to establish the number of active fishers and gear in the region and therefore an estimate of annual turtle harvest rates. The coastal zone between Soalara and Ambola yielded an annual harvest of 3,656 turtles. This figure is going by the lowest figures given by the interviewees for daily, weekly and monthly capture rates of their respective communities, and therefore a conservative estimate, with the actual figure probably being significantly greater, possibly in the range of 4,000 –5,000 individuals per annum.

Consistent with most traditional fishing practices, it appears from interviews that turtle catch levels are very environmentally dependent, making it difficult to extract precise figures on annual turtle capture over such a wide area. Fishers tend not to attempt to fish during the winter (April to September) with much consistency when rough sea conditions persist, making it difficult to operate their pirogues⁶. Jarifa require 3 to 5 fishers to operate the gear, as opposed

⁶ Hand made, single hulled traditional sailing boats constructed from the tree *Givotia madagascariensis*, by the Vezo ethnic group of south west Madagascar.

to spear guns operated by individuals. It can be calculated that each fisher in region has a mean annual yield of 20 to 25 turtles (Table 2).

Table 3. Turtle catch and fishing data for the 8 villages in the region.

Village	Capture Rate (peek season)	Estimated Annual Rate	Species Represented	Number of Turtle Fishers
Anakao	2 to 3 per month	20	1, 2, 3,	27
Ambola	2 to 3 per day	475	1, 2, 3, 4, 5	*
Ampasimahanvo	2 to 3 per fortnight	49	1, 2, 3, 4, 5	6
Besambay	2 to 3 per day	475	1, 2, 3, 4, 5	16
Befasy	8 per week	169	1, 3, 4	*
Maramena	20 per day	2000	1, 2, 3, 4, 5	120
Andriangy	3 per year	3	1, 3, 4	4
Beheloka	2 to 3 per day	475	1, 2, 3, 4, 5	10

* = data unavailable, 1=green, 2=olive ridley, 3=loggerhead, 4=hawksbill, 5=leatherback

3.2.2 CATCH COMPOSITION.

Each of the 8 communities report the capture of green, hawksbill and loggerhead turtles, with olive ridley also caught in Anakao and leatherbacks caught by the fishers of Beheloka, Maramena, Ambola, Besambay and Ampasimahanvo (Table 2). Of the 28 individuals captured and sold in Anakao during the study period 65% (n=18) were green turtles (Fig 3). Hawksbill and loggerhead 14% (n=4) and olive ridley 7% (n=2) made up the remainder of the catch with no leatherbacks being reported or recorded as being caught. Fishers claim that green turtles are the most abundant species caught in the region, consistent with the above results. Leatherbacks are reported as the least common species captured, but when encountered are normally of considerable size, for example fishers in Ambola report animals of 400 to 500 kg. The species can reach weights in excess of 900kg (Mayland & Ehrenfeld, 2000).



Plate 1. Fishers delivering their catch of a green turtle (*Chelonia mydas*) to dealers in Anakao (photo: Frontier Madagascar).

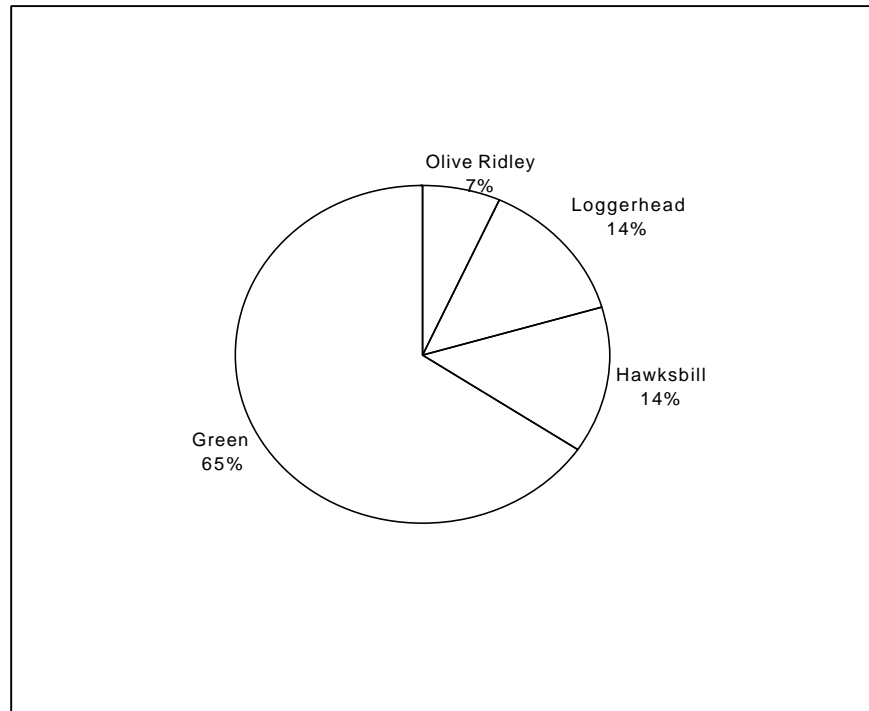


Figure 3. Turtle catch composition sold in Anakao, February to June 2002.

Fishers in the village of Besambay claim to have caught a species referred to as *lavatanapoty*. Another species referred to as *sarara* is also claimed to be captured by fishers in the villages of Maramen, Befasy and Besambay.

Table 4. Species composition and number of individuals sold in Anakao during the study period

Month	Species	Number of Individuals	Total number of individuals captured	Mean curved carapace length (cm)
February	Hawksbill	3 (female)	9	52 (s.d. 21.6)
	Green	3 (female)		97 (s.d. 36.7)
	Olive ridley	1 (female)		49
	Loggerhead	2 (female)		106 (s.d. 17.6)
March	Green	1 (female)	2	73
	Olive ridley	1 (male)		122
April	Hawksbill	1 (female)	4	70
	Green	3 (male)		106 (s.d. 2.0)
May	Green	1 (male)	1	61
June	*Green	9 (female)	12	87 (s.d. 24.5)
	Green	3 (male)		71 (s.d. 28.0)

* 2 female green turtles caught this month were reported to be containing eggs.

Table 4 shows that of the 28 individuals captured 75% (n=21) were female with only 25% (n=7) males caught during the study. All of the hawksbill and loggerheads, including 70% (n=14) of green turtles captured were female, including 2 individuals that contained eggs. Capture rates were low between March and May probably due to unfavourable weather and sea conditions during these months. Catch rates improved during June when the seas were

generally calmer, confirming the information reported by most fishers who were interviewed, stating that catch levels increased during periods of calm weather. Mean carapace length for the total catch varied between 49cm for the loggerhead caught in February to 122cm for the olive ridley captured during March.

3.3 ECONOMIC VALUE OF TURTLE TRADE

Interviews with the 7 communities south of Anakao, revealed Anakao to be a sink for turtles captured in the region normally during the winter months. When catch levels were greater during the austral summer fishers' transport their catch to Toliara for sale. Most small animals captured were consumed within the respective communities. A trade network between fishers, dealers and traders exists in the region. Dealers were based in Anakao and Toliara and supplied by the fishers who brought the catch to them. The dealers processed the catch then sell the processed turtle products (meat and occasionally the carapace) on to traders or members of the community. Four turtle dealers were active in Anakao.

3.3.1 TURTLE MEAT

A live adult turtle was worth a maximum of 500,000 FMg (US\$ 74.00) to the fisher, the price was normally governed by size rather than weight with the lowest price being quoted by the fishers of Ambola who stated that 150,000 FMg (US\$ 22.00) was received for very small specimens. The mean buying price by the dealer during the study was 205,000FMg (US\$ 30.00) (Table 4). There was no difference in value between green, hawksbill, olive ridley or loggerheads, all receiving the same price from the dealers. During the study none of the more scarce leatherback turtles were reported caught, but fishers claimed that despite their general greater size they received less when trying to sell them, as the meat is considered less palatable.

Fishers claimed that turtles sold in Mahavatse (Toliara) generally received a greater price, often in the region of 20-25% of the price obtained from a sale to a dealer in Anakao. Dealers in Anakao recorded the total revenue from each turtle. This averaged 282,000FMg (US\$ 39.00) (SD144,120), making the mean profit 47,000FMg (US\$ 7.00) (SD 43,786) per animal (Table 4). If the meat is sold per kilo, it may then be cooked and resold in small local eateries. Otherwise, the only people in the community to earn from the trade are the fishers were the dealers.

The dealers sold cooked portions of the meat, uncooked meat by the kilo, or occasionally the carapace. The dealer may then in turn sell meat on to small scale traders operating in Anakao or Toliara, vending it cooked on street stalls and small eateries. The cost of turtle meat in Toliara was approximately twice that of Anakao, 15,000FMg (US\$ 2.20) compared to 6,525 FMg (US\$ 0.97) (mean) per kilo. For the majority of the population, turtle meat was consumed through the purchase of small cooked lumps. These were priced at 500FMg (US\$ 0.07) or 750FMg (US\$ 0.11) in Anakao and 500FMg (US\$ 0.07) and 2500 FMg (US\$ 0.37) from the stalls in Mahavatse (Toliara), depending on the size of the portion and the part of the animal.

Table 5. Number, size and profit of the turtles passing through the 4 dealers of Anakao between May and June 2002.

Dealer	Number of turtles	Mean curved carapace length (cm)	Mean profit per turtle FMg/US\$	Total profit FMg/US\$
A	15	82 (s.d. 28.1)	51,066 / 7.60	766,000 / 114.00
Z	3	61 (s.d. 13.0)	25,000 / 3.66	75,000 / 11.00
C	2	32 (s.d. 3.5)	35,000 / 5.00	70,000 / 10.00
R	8	90 (s.d. 28.2)	32,500 / 4.75	260,000 / 38.00
Total	28			1,171,000 / 174.00

Anakao was the only of the eight villages in the study to rate turtles as economically important. During the study, a profit of between 5,000 (US\$ 7.40) and 200,000 FMg (US\$ 30.00) per turtle was made by the dealers trading in Anakao, a profit of between 3 and 67% per animal. A mean profit of 22% per turtle was made by the 4 dealers in Anakao during the study, with a total profit of 1,171,000FMg (US\$ 174.00) being generated by the 4 dealers between them over a period of 19 weeks. Table 4 shows total profit made by the four dealers in the village, with dealer A making a total profit of 766, 000FMg (US\$ 114.00) during the 19 week study.

3.3.2 TURTLE CARAPACE

Compared to the meat, the carapace of the turtle has relatively little value, dealers rarely sell the carapaces. The Anakao dealers were aware that tourists don't tend to buy turtle carapaces now, and the Toliara curio dealer stated that he only sells to Malagasy people or to tourists leaving by boat, as he perceives it as forbidden to fly out of the country with them. Even fishers in Besambay tended not to attempt to sell carapaces anymore, in recognition of the lack of market for them.

Of the 28 turtles captured and sold to dealers on Anakao during the study only 7 of the carapaces were sold (5 green, 1 hawksbill and 1 loggerhead) all were sold on for between 10,000 and 25,000 each FMg (1.50 and US\$ 3.70) with the exception of 58cm long green turtle shell that was only sold for 1,000 FMg (US\$ 0.14). It was probable that the carapaces were sold on for local domestic use (carrying receptacles and child's toy sleds are the most common uses in the area), rather than curios sold to tourists as national political instability had put the tourist industry in the country at the time of the study on hold. Also only 1 of the 7 carapaces sold were hawksbill, the favoured species of the curio trade. Curio traders in Toliara claim that 40cm hawksbill carapaces are favoured by tourists, and they can expect to sell them for 50,000 FMg (US\$ 7.40). Other species can command between 15,000 and 25,000 FMg (2.20 and US\$ 3.70) dependent on the carapace size.

3.4 CULTURAL VALUE

As described by Rakotonirina (1989) (*Section 1.3*), the Vezo people of southwest Madagascar have a strong history of turtle exploitation and associated cultural traditions. The practices involved in turtle fishing include offerings and ceremonies to the ancestors, blessing the hunting spear, and dictating whom may eat the meat. These have begun to fade, with only 3 out of 8 villages (Ambola, Maromena and Beheloka) claiming to support fishers who use Ombiasy⁷

⁷ Spiritual leader and healer, held in high regard present in most Vezo communities.

to bring them luck when fishing. Although the traditions are still known there is little adherence by the younger generations, evident by fishers claims that the number of turtles caught is down to the to the methods used, rather than luck derived by spiritual means. The use of traditional turtle harpoons has been replaced by spear guns probably due to Vezo beliefs prohibiting the use of harpoons for the targeting of any other species other than turtles, and therefore resulting in bad luck. The cultural traditions associated with the local Vezo population with regards to the fishing of turtles is one that appears to be associated to a greater extent with the occupational hunters, described by Rakotonirina & Cooke, (1994) and are no longer practiced by the occasional fishers (*Section 2.1*) active in the region. Fishers claimed that as turtles have become less abundant over time, gear use had switched from spear guns to Jarifa, resulting in a greater catch per unit effort. Whereas spear fishing by free diving is a difficult activity requiring much skill, similar to traditional practices using a harpoon, gill net fishing will trap any turtles present.

3.5 POPULATION BIOLOGY

Fishers and representatives from all 8 communities involved in the study stated that turtle catch levels and general abundance had decreased progressively over the last 10 to 15 years. The fishers in Anakao stated a four-fold decrease in the number of turtles captured over the last 10 years.

Casual turtle observations were recorded by researchers undertaking underwater visual census (UVC) of reef fish, on the fringing reef of Beheloka bay, over a period of 8 weeks. Twelve individuals were observed (11 green and 1 loggerhead). This data is very hard to quantify, but can indicate that green turtles are in relative abundance in this rather concentrated area, but fishers in Befasy and Anakao claim that it is now impossible to catch turtles on the reefs around the village, where they were once abundant. Fishing effort needs to be directed in deeper oceanic areas or reefs of uninhabited or areas of low population density, such as Nosy Ve for turtles to be captured, suggesting the complete fishing out of turtles in some areas where animals were once abundant.

3.5.1 NESTING BEHAVIOUR

Table 6. Reported turtle nesting sites SW Madagascar, pre 1991 and present day (2002), data taken from Durban & Rakotonirina (1991) and interviews.

Locality	Green turtle		Hawksbill turtle		Loggerhead turtle		Olive ridley turtle	
	>1991	2002	>1991	2002	>1991	2002	>1991	2002
Itampolo	✓							
Beheloka	✓	✓						
Anakao	✓		✓		✓			
Ambola	✓							
Andriany	✓							
Ampasimahonoro	✓	✓						
Besambay	✓	✓	✓	✓	✓	✓		
Maromena							✓	
Nosy Ve	✓							
Befasy	✓							
Nosy Satrana	✓							

Table 5 shows the present and former nesting sites of the four species of turtle most commonly exploited in the region. A single green turtle was reported to have nested on the beach at Ampasimahonoro during 2001, the result of a gradual decline of nesting in the vicinity of the village over a period of 15 years. Nesting turtles are rarely seen in the Anakao area now, with Hawksbills last seen on Nosy Ve in 1997. Encouragingly fishers in Besambay report seeing green turtles and loggerheads nesting to the south of the village and Hawksbills to the north, every year between October and December. But appear to be unsuccessful in harvesting the eggs, claiming that all the young have normally hatched when the nests are dug up. Villagers in Maromena report the nesting of loggerheads in December, raiding the nests for eggs each year. Villagers in Ampasimahonoro reported seeing a single green turtle laying to the north of the village in 2001. No turtles have nested near Befasy since the last loggerheads to the north and south of the village in 2000.

3.5.2 TAG RECOVERIES

South west Madagascar acts as a sink for turtles tagged in other regions of the western Indian Ocean, fishers from 3 of the 8 villages claimed that themselves or other fishers from the community had caught tagged turtles. Besambay has captured 10 tagged animals at a rate of 1 or 2 per year returning them all to the sea believing they were poisoned. Fishers claimed that the tagged animals were from La Reunion. Befasy captured two green turtles, one claimed to be tagged in France (probably Europa or La Reunion) and one from South Africa. Fishers from Maromena caught one tagged animal 6 years ago. When questioned on the health of turtles caught within the fishery fishers in Ambola, Besambay and Befasy report animals with limbs missing, a possible result of attacks from sharks. Only on one occasion one fisher from Maromena stated the capture of a green turtle with abnormal growths, consistent with cutaneous fibropapillomatosis (George, 1997) often a result of poor water quality.

3.6 LOCAL EVALUATION OF TURTLE STATUS

Some aspects of turtle biology are generally well understood by those exploiting them, for example the nesting patterns of those species that are exploited regularly appear to be understood and as a result of nest sites and seasons being common knowledge to the local communities nests are often raided on an annual basis. The only exception being the village of Besambay where the population seem unable to time the nesting of the turtles with the harvesting of the eggs. Fishers from Befasy now claim that individuals that used to be seen nesting on the land close to the village have a fear of people which cause them to nest in the sea. When questioned about the local abundance and status of leatherbacks the fishers in Beheloka claimed that the species was never seen locally due to them nesting in the sea as opposed to other species which nest on the beaches.

Even though all fishers have recognised a reduction in the abundance of turtles over a period of 10 to 15 years very few questioned stated that a possible cause could be over fishing or egg harvesting. The only suggested connection was made by fishers in Beheloka who commented on how they have realised that a particularly good year will often be followed by a poor years catch. Only two old fishers in Befasy and Maromena respectively associated the decline in turtles with increased use of Jarifa, and increased fishing effort.

3.7 CONSERVATION AND MANAGEMENT INITIATIVES

The legal protection of turtles in Madagascar has been ignored by both the authorities and fishers. It has been recognised that small scale, community based environmental education programs are the most effective and necessary forms of conservation in rural subsistence communities heavily reliant on natural resources (Ratotonirina & Cooke, 1994., Durbin & Ralabo, 1994., Kapurusinghe, 2000).

Frontier Madagascar, and the Darwin initiative funded Frontier Madagascar Marine Biodiversity training Program (MMBTP) has been working with its partner organisation Institut Halieutique et des Science Marine (IHSM), to initiate sound marine environmental education programs directed at multiple sectors of the community, the projects are based in Anakao. Due to the integrated nature of the marine environment and the traditional and subsistence resource utilisation within it, marine turtle conservation has to be included as part of a well balanced and subtle education programme encompassing all spheres of the marine environment and the resources it provides. Frontier Madagascar has been active in the Anakao region for over 2 years. Quarterly, an education program is run in the village for one or two days targeting a particular demographic sector and tailoring it to the audience. Recent activities have included.

- March 2002, Chinese shadow puppets show highlighting the message of sustainability in resource use. Show was performed twice with audiences including school children (5-15 years) and fishers, turtle dealers and other village representatives. Adaptations were made appropriately for each audience.
- June 2002, visual, verbal and musical presentation concerning marine mega fauna (inc turtles), life cycles, migration and tagging. The audience was general including all sectors of the village.
- Notes on turtle biology and ecology have been passed on in both spoken and written Malagasy to the four turtle dealers in Anakao and their families.

Additionally during August 2002 an education workshop was run in the village of Beheloka on turtle ecology and biology, the workshop was aimed at multiple sectors and was attended by school children, fishers and other members of the community.

The Darwin Initiative funded MMBTP has been in full time operation, managed by individuals of Frontier Madagascar for a period of 12 months, from October 2001. The aim of the program was to educate different sectors of the local population on sustainable resource management. Turtle resource utilisation is considered a component of the local traditional fishery and is centred on for parts of the program. The program has taken a three tiered approach, including training programs and workshops aimed at three different groups;

- *Marine Science students, IHSM.* A continuing education program centring on the practical aspects of marine resource management and surveying and monitoring including, Business and Training and Education Council level 3 (BTEC) qualification in tropical habitat conservation. 12 students are undertaking the course.
- *Regional Fisheries Officers.* Introducing current thinking and ideas on fisheries management through workshops to the regions fisheries officers based in Toliara, who often only have access to outdated and inappropriate fisheries management techniques. 6 officers attended the workshop and seminar run during June.
- *Local Fishers, Community and FIMIMANO Representatives.* Practically based workshops and a three-day training course, introducing ideas on sustainable resource

management and basic marine ecology. 12 fishers completed the course, with numerous others attending the workshops.

4. DISCUSSION

4.1 CATCH COMPOSITION

Historically Rakotonirina & Cooke (1994) recorded green turtles as the most common species exploited, consistent with our results. There appears to have been a shift in species composition of catches, with hawksbills now making up a greater percentage of the catch, loggerheads consisted of a smaller percentage of the catch in 2002. Olive ridleys were captured occasionally, but were never recorded between 1989 and 1992.

Interestingly the mean length of hawksbill, green and loggerhead turtles increased since measurements taken by Rakotonirina & Cooke (1994) of 58 animals captured over a two day period in 1989 and sold in Anakao. The change in size over time could be coincidental or that both studies were carried out at different times of the year, with most of the adults caught between October and March (Rakotonirina and Cooke, 1994), when they presumably come into the coastal waters to breed. During February and March when the study began it would have been expected for populations of adult females to be present in the region. Another plausible explanation could be that during the 1989 study all animals caught by the fishers were measured, whereas in 2002 only animals passing through the dealers have been measured. Smaller animals were normally consumed by the fishers or members of their respective communities and not supplied to the dealers, thus not being recorded.

In 1989 most of the green and all of the hawksbill turtles caught in Anakao were juveniles, in 2002 the mean size of all 4 species probably suggests that most individuals caught had reached sexual maturity (Table 6). The loggerhead turtles captured in 1989 were adults as reported by Rakotonirina & Cooke (1994). Possibly 2 of the 4 hawksbills caught in 2002 were still immature (49cm and 32cm carapace respectively), 5 of the 19 green turtles only had a carapace measurement of 50cm to 60cm suggesting them to be immature individuals of a species that attains sizes of up to 130cm (den Haring and Renshoff, 1999). All of the hawksbill turtles taken in 2002 were females along with 70% of the green turtles captured, consistent with findings by Rakotonirina & Cooke (1994), suggesting possible negative implications for reproduction.

Table 7. Mean carapace length of individuals captured and sold in Anakao during 2002 and previous studies by Rakotonirina and Cooke, (1994) in 1989.

Species	Mean Carapace Length of Individuals Captured 200 2	Mean Carapace Length of Individuals Captured 1989 (Rakotonirina and Cooke, 1994)
Hawksbill	87cm	40 cm
Green	84cm	57 cm
Loggerhead	106cm	82 cm
Olive ridley	86cm	*

*= data unavailable.

There has been a decline in turtle catch levels over the last 10-15 years, an opinion consistent in some respects with Rakotonirina & Cooke's (1994) questioning. Between 1989 and 1992 fishers still claimed that green turtles were abundant in the Toliara region, although a decline was recognised with more females caught than males (consistent with our findings). Rakotonirina &

Cooke, (1994) claim that during their study occasional fishers in the Toliara region were capturing approximately 50 animals per year in 1989, in comparison to present annual capture rate of approximately 25 animals per year. This study and previous work highlights the general decline in turtle abundance, a worrying trend over a substantial period of time.

4.2 ECONOMIC VALUE

There are two levels of value on turtle products, the value to the fisherman, and the value to the dealer and trader. The fisherman makes the main profit, having virtually no outlay of costs, and expending only time and energy to catch, transport and sell the animal. The dealer and trader must have enough capital to buy the animal, and then makes a profit on the resale. During the time of the study dealers made a profit of between 5,000 FMg (US\$ 1.30) and 200,000 FMg (US\$ 30.00) per animal, with a mean profit of 22% for every turtle sold. No distinction was made between species, as the meat from all 4 species was able to command roughly the same price.

The cost of turtle meat has increased over time, due to inflation and the fact that turtle meats a delicacy. For example an adult green turtle over 100kg could fetch as much as 200,000 FMg (US\$ 33.00), in 1992 (Rakotonirina & Cooke, 1994) double the price of 1989. Today a similar animal could command twice the price it would have been sold for in 1992, in Toliara (300,000 to 500,000 FMg, US\$ 22.00 to US\$ 74.00).

Rakotonirina & Cooke (1994) failed to mention any trade network operating in Anakao during the time of their research. Several shifts were evident in the commerce of turtle products in the region over the last 10 years. As the fishing population has increased in the Toliara region by a factor of five over a period of 17 years (DRH/FAO, 1992), and increased pressure has been put on the diminishing, over exploited local marine resources, more people try to create niches in the local economy. This is probably the case of the turtle dealers in Anakao. As turtles have become an increasingly scarce resource, commanding higher prices, entrepreneurial individuals have started buying turtles from fishers with the intention of selling them on at a profit. The shift from occupational hunting to incidental or occasional hunting means that less importance has been placed on turtles by the fishers who now target multiple marine species, and are unable to generate high enough turtle catches to sustain a consistent supply to traders. This position in the local economy has been taken over by the dealers who tend to deal with the catch from multiple sources (fishers) thus being able to maintain a consistent supply of turtle products.

The sale of turtle products as curio has diminished in the area, Rakotonirina & Cooke (1994) stated that in 1992 small green and hawksbill carapaces were sold for about \$US 1.00 and sales of stuffed specimens were rare with approximately 2 small green turtles per month being sold for US\$ 20.00 each. During the study, 7 carapaces were sold by the dealers of Anakao for local domestic use. The trade in stuffed specimens seems to have ceased in Toliara, and very few carapaces seem to be sold in the curio trade, even compared to the diminishing number 10 years ago. There is a general perception of those involved in the trade, from the fishers to the traders, that tourists now refuse in general to buy turtle curio, a positive indication that campaigns by global organisations such as WWF have worked in educating the travelling public at large regarding the conservation implications of supporting such trades, and exploitation of endangered species. In reality this gesture by those that once supported this aspect of turtle resource utilisation probably has very little impact on reducing the number of turtles caught each year. There is still a ready market for turtle meat in the region, and to a fisher a 100kg

green turtle is far more valuable than the fish he may catch whilst investing the same time and effort, and at present there is no incentive placed on him to stop.

Turtles have been stated as only being economically important to the village of Anakao, due to the presents of the dealers. Catch levels are so low in the other 7 villages, with other marine species being more regularly harvested, with greater consistency (ie reef fish, cephalopods and elasmobranches) than turtles, now that turtles have become increasingly scarce in the south west of Madagascar, occupational turtle hunters no longer operate in the region.

4.3 CULTURAL VALUE

Turtles are regarded as culturally significant to the Vezo (Rakotonirina, 1989, Rakotonirina & Cooke, 1994), with a strong history of turtle exploitation and associated cultural traditions. But evidence suggests that while some older fishers still observe these traditions in the villages south of Anakao, in general traditions are at best becoming diluted and at worst ignored completely by the younger generation of fishers. The most overwhelming evidence for this is the replacement of traditional turtle fishing harpoons with spear guns. As marine resources utilisation grows at an alarming rate in the region (DRH/FAO, 1992), due to migration to coastal areas (324% population increase in the Toliara region between 1975 and 1993, Cooke *et al*, 2000), high unemployment and low agricultural production due to the aridity of the climate (Laroche and Ramanarivo, 1995), the cultural value of resources and the traditions that are ubiquitous with them are often disregarded in favour of scratching out a living.

4.4 POPULATION BIOLOGY

The barrier reefs of Toliara are an important feeding ground for green turtles, and probably support the largest populations of this species in Madagascar (Rakotonirina & Cooke, 1994). Reduction in catch levels is most certainly an indication that local populations of all species have been impacted by the turtle fishery in the region. Turtles in the region have declined generally and consistently over time as proved by claims made by fishers during this and previous (Rakotonirina & Cooke, 1994., Durban & Rakotonirina, 1991) studies. A reduction in nesting activity, was reported for all species, with marked declines in some areas between 1989 and 1992 reported by Rakotonirina & Cooke (1994). This decline is still evident, with almost yearly reports by fishers of nesting sites becoming abandoned due to exploitation and continued disturbance. Only 3 of the former 9 known nesting sites of green turtles in the region are utilised to date. Only 1 hawksbill nest site is known to exist near Besambay and 2 sites are still utilised by loggerheads near Besambay and Maromena respectively (Table 5). In the Mahajanga region on the north west coast *fady*⁵ dictates that collectors must leave between 1-20 eggs in the nest (Durban & Rakotoniaina, 1991., Durban & Ralambo, 1994), unfortunately this token gesture of sustainable resource management is not practiced by the turtle egg collectors in the south west. The predominance of female turtles being captured, reported by both this and previous studies, the high numbers of sexually mature animals and even the capture of gravid female green turtles (Table 3) combined with the high rates of nest raiding, suggests that a severe population crash is imminent, of at least the three species that are known to nest in the region (green, hawksbill and loggerhead, Table 3).

⁵ Traditional cultural beliefs the local population must adhere to.

As hypothesised by Rakotonirina & Cooke, (1994), Hughes (1982) states that many hundreds of green turtles tagged in the French colonies such as Europa, 200 km west north west of Toliara, are harvested by traditional fishers in Madagascar. Rakotonirina & Cooke, (1994) stated it possible that the adult turtles arriving in large numbers along the Toliara barrier reef after the nesting season are believed locally to come from Europa. But up to 1992 no tagged animals had been reported, where as two loggerhead and one green turtle all tagged around Durban South Africa, were reported to the marine station in Toliara prior to 1987. When questioned, fishers in Beheloka, Besambay, Befasy and Maromena claimed to capture tagged and numbered turtles, confirming the data presented by Hughes (1982) and ideas suggested by Rakotonirina & Cooke, (1994). The results of the study show quite conclusively the tagged individuals of protected colonies from marine reserves and parks of Tongaland (South Africa) and the French colonies of the south west Indian Ocean (Europa, Tromlin and La Reunion) are consistently recovered by the fishers in the region. These protected colonies could be seen as a great benefit to the turtle fishers of south west Madagascar, and an example of how well a meaning conservation efforts is rendered partly ineffective due to marine fauna migration.

4.5 LOCAL EVALUATION OF TURTLE STATUS.

General naivety of the reasons behind turtle population declines can only be rectified through appropriately directed environmental education programs. It is the experience of Frontier Madagascar that some people in the region find the low reproductive potential of turtles difficult to grasp, when they clearly lay so many eggs. Interestingly Rakotonirina & Cooke, (1994) states that fishers in Fitsitike and Anakao during there study reported green turtle females releasing eggs into the sea where beaches were plentiful. Similar to the claims made by the fishers in Beheloka that leatherbacks laid their eggs in the sea, Siegel (1991) reports similar observations by fishers from Itampolo, stating that this phenomenon could be a due to the females being unable to find a suitable nest site possibly due to continued disturbance by egg collectors and local human communities. Fishers in Morondava area report female hawksbill turtles releasing eggs off rocky shores (Rakotonirina & Cooke, 1994), which might be explained by the failure to find a suitable beach.

4.6 CONSERVATION AND MANAGEMENT INITIATIVES.

It has been shown repeatedly that exploitation of turtles can proceed for many years with little or moderate impact, then numbers rapidly collapsing because of a long term lack of recruitment. Examples of such crashes for numerous species include leatherback populations in Sri Lanka, Malaysia, Indonesia, Thailand, and Pacific Mexico (Limpus, 1994., 1995, Sarto *et al.*, 1996., Spotila *et al.*, 1996) have been recently documented, its possible that such crashes have already occurred in Madagascar due to the relentless exploitation that has seemed to have taken place since human habitation of island 2000 years ago (Cook *et al.*, 2000), and its uncontrollable growth on an almost yearly basis. Clearly a management strategy needs to be put in place. Traditionally most fisheries can be managed sustainable by the application of fisheries management models and applying the maximum sustainable yield (MSY) concept. The danger of any fisheries management models applied to turtles is that the long lag time between turtle hatching and maturity will prevent managers from seeing the effects of there miscalculations during there tenure in the job, or during their lifetimes. Turtle biology dictates that what happens now to a “managed” turtle population is largely the result of past history, not current management practices, and is very misleading. Three main factors listed below are believed to be necessary (IUCN, 1995, WWF, 2000) in the successful application of a turtle management

strategy for a rural developing region such as the coastal communities of south west Madagascar.

4.6.1 ENVIRONMENTAL EDUCATION

It is the belief of the authors that the only means of controlling non sustainable resource exploitation in rural developing communities is through well managed environmental education programs and development of sustainable, alternative livelihood options. Efforts have been made with education programs funded by SEE and the Darwin Initiative and managed by Frontier Madagascar targeting those involved in the turtle trade, amongst others, in the community of Anakao and to some extent Toliara. The dilution and reduction in the cultural status of turtles amongst the Vezo communities in the region will make fishers more willing to except change and respect the conservation issues surrounding turtle fishing.

Already positive results can be seen by the sensitisation, education and training work undertaken in the area. Village presentations have been encouragingly received; evoking thought and changes over a period of 18 months in some people's perceptions regarding certain species and ecological issues in Anakao. Children have shown the most encouraging results by reciting stories and songs with ecological messages, that they have been told, some times months previously.

The 12 fishers who volunteered to take part in the MMBTP training and workshop all expressed gratitude for what has been an enlightening experience enabling them to appreciate to some degree the importance of sustainability and conservation of certain species such as turtles. The training of the local students from IHSM has been beneficial enabling them to be trained in the more practical aspects of survey and monitoring work, and putting into practice the theoretical knowledge they have already gained. The program should help to train the decision makers of years to come, effecting the management and conservation of the regions coastal and marine environment. But education takes time for people to except ideas and modify their lifestyles accordingly, and suitable sustainable alternatives need to be available. At present only Anakao, and more recently Beheloka have been targeted. The less developed communities south of Anakao could also benefit form similar programs.

4.6.2 ALTERNATIVE LIVELIHOODS

Due to the massive population growth in the region as mentioned above, near shore artisanal and traditional fisheries are massively over exploited (Laroche & Ramananarivo, 1995., Cooke *et al.*, 2000) by the Vezo who consider the sea as a commons (Koechlin, 1975). Suggesting the need for low impact, sustainable alternative livelihood development, and possible exploitation of untapped marine resource for fishers involved in the multi species fishery occasionally targeting turtles, and other fisheries, such as intertidal collecting of marine invertebrates and the elasmobranch fishery active in the region.

A fine example can be seen in Beheloka, where algae (*Eucheuma*) aquiculture has recently been developed in the intertidal lagoon in front of the village, supplying a dealer in Toliara who in tern supplies the cosmetics industry. This form of aquaculture could be developed in other communities in the region quite effectively with a small amount of initial investment, as the trade net work already exists. Tourism has been growing in Anakao since the opening of the first hotel in 1986, but it appears that the industry fuels the local fishery to some extent. As wealth in the community increases more expensive fishing gears are invested in such as spear

guns, it only seems a matter of time before the spear gun fishers start investing in wet suits and weights making them more efficient, particularly as Anakao has a small but developing self contained underwater breathing apparatus (SCUBA) industry. Thus having even greater detrimental effects on local turtle populations.

Fishers should be encouraged to exploit unexploited larger pelagic offshore species more efficiently by introducing low cost and fast handling new fishing technologies suitable for small boats. For example surface and midwater longlines with 20 to 30 hooks trolled with multiple lures for tuna, marlin and mackerel. Anchored fish aggregating devices (FADS) were tested in Toliara in 1992 and produced catch levels far in excess of that normally produced by near shore fishers (mean catch per unit effort of 50kg/trip, Rakotoarinivo, 1994), there potential warrants further investigation.

4.6.3 MARINE PROTECTED AREAS

The establishment of marine protected areas (MPAs) needs to be investigated if as sound turtle conservation initiative is to be successful in the region. Turtles tagged on Europa and Tromelin, are caught by fishers in the region highlighting the need for integrated conservation initiative that centres on the population or colony as opposed to the geographical location. At present there is no coastal or marine reserve in the region of south west Madagascar where turtles can use nesting sites, feeding grounds or resting areas unmolested. The coastal zone south of the Onilahy river is presently under consideration for United Nations Educational, Scientific and Cultural (UNESCO) Man and Biosphere designation, which in its self brings no enforced protection but can encourage protection of core zones within the region for example turtle nesting sites. To date there is only one example in the region of a controlled conservation effort directed at turtles being made. In Ifaty (north of Toliara) during 1992 1 hawksbill nest was fortuitously discovered on a private stretch of beach from which 102 hatchlings emerged and were subsequently realised at sea (Rakotonirina & Cooke, 1994).

At present the only area under protection is the region in the island of Nosy Ve. The island is under the jurisdiction of a *Dina*⁶, protecting the island and everything on it through *fadys* preventing the destruction or removal of anything from the island. Fishing is still permitted on the fringing reefs of the island, except for a small area (approx. 4 ha.) of patch reef to the north east of the island. At present the *Dina* encompassing Nosy Ve serves little purpose to turtle protection, except in the event of the animals using the island again as a nest site. But the fact that the reefs of the island yielded 47% of the turtle catch during the study period certainly warrants the reefs of Nosy Ve for careful consideration if protected areas are gazetted.

5. CONCLUSIONS

There is clearly a marked reduction in the catch levels of all four species of turtle that inhabit the waters of south west of Madagascar. Indication that the local fishery is having a detrimental effect on the green, hawksbill, loggerhead and olive ridley turtle populations in the south west Indian Ocean. Catching turtles is a lucrative occupation for the fishers concerned, with catch levels almost certainly to be maintained till such a population crash is to arise making it impossible to harvest any turtles form the coastal waters of the region. Clearly a management strategy needs to be put in place, even though this may mean trying to introduce policies that cause cultural dilution to some extent, but the continued non sustainable harvest of turtles has

⁶ A traditional social community convention, often the basis for local coastal management schemes legally recognised under laws on declaration.

almost certainly aided this reduction in the cultural identity of turtles to the Vezo anyway. On the positive side large stretches of Madagascar's south western and southern coastline is sparsely inhabited due to lack of fresh water and may support unknown nesting populations.

Possible integrated solutions have been put forward, all of which are based at the community level of integrated coastal zone management (ICZM). Bille and Mermet (2002) state that the principles of local community based management initiatives are starting to be well known, countless case studies have been documented, and ICZM policies in Madagascar have proved to be of greater success when operated on the local level, than regional and national policies. More work needs to be done in terms of turtle research in the region. Uninhabited stretches of coastline need to be surveyed for evidence of unknown nest sites. A greater co-ordinated research program needs to be undertaken in the region to try and ascertain the population size of the 4 species of turtle that inhabit the region and which areas (such as the fringing reefs of Nosy Ve) are important sites for turtle populations and warrant protection. The management plan for turtles needs to learn from similar conservation successes in the region. For example through management by FIMIMANO and the integration of *fadys* the *Dina* that protects Nosy Ve has been a note worthy success in protecting the only nesting colony of red tailed tropic birds (*Phaeton rubricauda*) in Madagascar on the island. The colony has remained undisturbed and as a result almost doubled in size over the last 15 years (FIMIMANO, pers coms), due to *fady* dictating that disturbance to the birds will bring bad luck. Through the integration of education and local public awareness, and by providing the fishers of the region with a sustainable alternative, a turtle management program can work for the region.

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7. APPENDICES

7.1 APPENDIX 1

1. what species do you catch (numbers, seasonal trends)
2. what gears do you employ (number of each gear per community, number of fishers).
3. what is the fate of the catch (who buys it or consumes it)
4. where is the catch sold
5. how many turtles (total and species) have you caught in the last 2 weeks / 1 month
6. where were they sold
7. how long have you fished turtles
8. are they important to you
9. in what way (economically/ culturally)
10. how have catch levels changed over time (last 10-15 years)
11. have you ever seen turtles with growths on their limbs, head or insides
12. have you ever seen any with tags / colour signs / numbers
13. size and location of nest sites
14. have you seen any Sasara
15. have you seen turtles mating / nesting / hatchlings

Questions included in semi structured interviews of turtle fishers in the villages of Anakao, Beheloka, Ampasimhanoro, Besambay, Befasy, Maromena, Andrrangy and Ambola,

7.2 APPENDIX 2

Species		IUCN Red list category
loggerhead turtle	<i>Caretta caretta</i>	Endangered
green turtle	<i>Chelonia mydas</i>	Endangered
hawksbill turtle	<i>Eretochelys imbricata</i>	Critically endangered
leatherback turtle	<i>Dermochelys coriacea</i>	Endangered
olive ridley	<i>Lepidochely olivacea</i>	Endangered

IUCN red list category for each species of turtle exploited by the Vezo.