

Investigating marine turtle nesting sites, local perceptions and conservation strategies in Northern Madagascar



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Investigating marine turtle nesting sites, local perceptions and conservation strategies in Northern Madagascar

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ABSTRACT: Sea turtles are under serious threat worldwide due to many anthropogenic and natural impacts hence their conservation is vital to ensure their survival. The aim of this study is to contribute up to date information regarding sea turtles by mapping the location of important nesting sites in Northern Madagascar and evaluating nesting activity through body pit numbers and influencing factors. An assessment of local perception and awareness of sea turtles status and legislation was also done. This study confirmed 7 out of 11 important nesting sites in Northern Madagascar identified using key informant interviews conducted by C3 in 2009-2010. A significant correlation was seen between body pit numbers and the presence or absence of disturbances in addition to nesting position. Results showed that the majority of fishermen did not catch turtles whilst a very small number said they did. Most of these catches proved to be accidental rather than intentional. However, the majority stated that they would eat the turtles and only a small percentage would release them. All the respondents gave different reasons for their actions which are presented in this paper. Catch rates influenced by turtle protection awareness proved to be significant. From this study, I confirmed the identity of 7 important nesting sites in Northern Madagascar and concluded that human disturbance is an important factor which influences nesting beach selection. Exploring local perceptions has revealed that turtles are not targeted, as a high proportion of fishermen are aware of their protection by law even though its endangered status is not well known.

Keywords: Body pits; Conservation; Local perceptions; Madagascar; Nesting sites; Sea turtles.

Word Count: 7987

1. Introduction

Marine environments and the biodiversity they host are under increasing pressures and threats due to environmental change caused by anthropogenic and natural changes. In our rapidly changing world, habitat and diversity loss are terms that are becoming increasingly applied to describe marine systems (Gray, 1997; Airoidi et al., 2008). Human population growth is contributing to the increasing pressure and overexploitation of marine natural resources. Globally, overfishing for large pelagic species at the top of the food webs is resulting in their decline (Jackson et al., 2001; Myers and Worm, 2003; Heithaus et al., 2008; Baum and Worm, 2009; Firth and Hawkins, 2011). There is widely accepted evidence that climate change is being caused by greenhouse gas emission from anthropogenic activities and other contributing factors (Mitchell et al., 1995; Lee et al., 2006; IPCC, 2007; Firth and Hawkins, 2011). Increased concentrations of carbon dioxide are hence causing acidification of the oceans (Caldeira and Wickett, 2003; The Royal Society, 2005; Doney et al., 2009; Firth and Hawkins, 2011). Global warming is also of primary concern for wild species and their ecosystems (Harris, 1993; Root et al., 2003) despite species having responded to climatic changes throughout their evolutionary history (Houghton et al. 2001; Root et al., 2003).

Sea turtles have been swimming the world's oceans for over 100 millions of years. They are one of the incredibly few species on earth to have lived relatively unchanged through mass extinctions with some fossil records dating back to 230 million years ago similar to species that still persist today (Kemf et al., 2000; Spotila, 2004). There are widespread concerns regarding sea turtles' survival that is being threatened by natural and anthropogenic phenomena's. One is the decreasing number of male hatchlings in some areas due to disruption caused by global warming as turtles exhibit temperature-dependent sex determination (TSD) (Hays et al., 2001; Hawkes et al., 2007; Saladin, 2007). A key stage in sea turtles life cycle and one of the threats affecting their populations is nesting, which depends on the availability of suitable beaches. Beach selection is influenced by a number of abiotic and biotic factors such as easy accessibility from the sea with a high beach platform as to not get flooded by tides or the water table (Mortimer, 1982; Whitmore and Dutton, 1985) in addition to relative low abundance of predators and competition from other species of sea turtles (Mortimer, 1982; Blamires and Guinea, 1998). Human alternation of beaches have hugely influenced the selection of nesting beaches as sea

turtles were observed preferring unlighted beaches (Mortimer, 1982). Moreover, destruction of beaches where sea turtle nesting occurs is expected to have an impact on sea turtles' ability to maintain their population (Coston-Clements and Hoss, 1983; Nima, 2007). Adding to the equation all previously mentioned threats, sea turtle populations are unfortunately heavily threatened worldwide. Despite our knowledge of the threats they face on a large scale, little is known about the extent of human impacts on sea turtles on a small scale, especially in tropical regions and the reasons behind their declining population.

Madagascar is one of the largest islands in the South Western Indian Ocean (SWIO) ranking as the 4th largest island in the world (OCHA, 2011). It has a distinct history and culture due to its rich assemblages of marine resources which includes coral reefs and mangroves. However, its once rich marine resources are being depleted at an alarming rate due to the rapid development of small artisanal and traditional fisheries, in addition to the exploitation from both industrial and artisanal fisheries (Iida, 2005; Nadon, 2005; Gough et al., 2009).

Madagascar is known to host both foraging and nesting grounds for sea turtles all over its coasts of which five species of sea turtles are reported to occur (Hughes, 1973; Frazier, 1975; Rakotonirina and Cooke, 1994; Metcalf et al., 2007). These are namely: the Green turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricate*), Olive Ridley (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*) and Leatherback turtle (*Dermochelys coriacea*). All of these are known to nest along the coasts of Madagascar except for the leatherback turtle (Marquez, 1990; Ratsimbazafy, 2003; Seminoff, 2004; Bourjea et al., 2006). Evidence of declining sea turtle nesting sites were reported based on surveys conducted in 1991 and 2003 in the south-west of Madagascar (Durbin and Rakotoniaina, 1991; Walker et al., 2003). However, not much is known about important nesting sites in Northern Madagascar and the status of turtles in this region of the country remains limited.

The range of distribution of these sea turtles around Madagascar was summarized by Hughes (1974). All five species are sparse or absent along the mid-eastern coast of Madagascar whilst the green and hawksbill turtles are widely distributed and nest in Northern Madagascar throughout the year (Hughes, 1974; Humphrey and Salm, 1996; Metcalf et al., 2007), with the hawksbill extending down the north-east coast to Masoala peninsula (Hughes, 1974; Rakotonirina and Cooke, 1994).

In this study, I investigate important sea turtle nesting sites of two species of sea turtles in Northern Madagascar whilst assessing local perceptions towards sea turtles. I will also be proposing conservation strategies to aid conservation management plans in order to combat the declining numbers in Malagasy sea turtle populations.

Chelonia mydas (green turtle) is a highly migratory long-lived species which is usually found in sub-tropical waters (Bowen et al., 1992). It gets its name from its green meat which is due to its strict herbivores diet which consists of sea grass and rooted algae. Like most turtles it goes through delayed sexual maturity with low hatchling survival but high adult survival (Spotila, 2004). The green turtle has for long been the target of human exploitation worldwide for its meat, eggs and cultural significance. This has led to the extinction of some stocks and major decline in others (Frazier, 1980; Witzell, 1994; Bourjea et al., 2007). Despite their history of overexploitation some populations are showing significant restoration as a result of dedicated conservation efforts (Balazs and Chaloupka, 2004; Bourjea et al., 2007), this proves that human aid is vital for their conservation. Due to their delayed sexual maturity, turtles are under constant pressure to maintain their population and if a decline in population is caused by human intervention recovery is a difficult road to pursue without human input.

Similarly *Eretmochelys imbricate* (hawksbill turtle) is also highly migratory between its feeding and nesting grounds. It is a long-lived species, distributed worldwide and is found within tropical and subtropical waters. Hawksbill turtles used to persist in vast numbers around Madagascar coastlines but have been subjected to intensive overexploitation which in turn has resulted in their drastic decline (Hughes, 1973). Hawksbill turtles are known to have made Madagascar famous for their source of beautiful decorative tortoiseshell as early as 1613 even though currently there is no virtual trade maintained that exist (Hughes, 1973). The hawksbill turtle shell until today remains high in demand in some places such as Japan and south-east Asia whilst Cuba and the Dominican Republic have proposed re-opening its international trade (Kemf et al., 2000). The hawksbill turtle, unlike the green turtle has no value for food in Madagascar as its meat is known to be toxic. The reason behind this is related to the diet of the hawksbill turtle which includes feeding on toxic sponges. These toxic chemicals accumulate in the turtle's meat and cause the death of animals that eat it including humans; however, these toxins do not harm the turtle itself (Spotila, 2004).

In response to everyday threats faced by sea turtles, conservation management plans and efforts must be put into practice. If problems are not addressed, populations will continue to decline until the beginning silence of extinction settles over the region like the olive ridley and leatherback turtle population in Malaysia which are said to be on the verge of extinction (Chan, 2006). In the last two decades, drastic declines in both the leatherback and loggerhead nesting turtles were observed and their disappearance from the Pacific is predicted, if no immediate major changes are seen (Spotila et al., 2000; Kamezaki et al., 2003; Limpus and Limpus, 2003; Gilman et al., 2006).

The International Union for the Conservation of Nature (IUCN) Marine Turtle Specialist Group has classified the hawksbill turtle as “Critically Endangered” and green turtle as “Endangered” globally. All seven species of sea turtles are listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), thus prohibiting international trade of sea turtles (Kemf et al., 2000). Therefore, due to their declining numbers worldwide and the fact their current status is listed as endangered, many countries have passed laws and started initiatives in order to conserve these species.

In Madagascar laws to protect the green and hawksbill turtles have been passed as early as 1923 (Rakotonirina and Cooke, 1994). Decree 23 May 1923, prohibited the capture of nesting females and individuals with carapace diameters of less than 50 cm, and measured beneath the plastron. Decree 24 October 1923 declared protected nesting sites on the islands of Nosy Anambo (Diego Suarez), Nosy Iranja (Nosy Be), Chesterfield (Morondava), Nosy Trozona and Nosy Ve (Toliara and Europa) (Rakotonirina and Cooke, 1994). In 1975, Madagascar has ratified the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Decree 75-014) and a decree of 1988 (88-243) appearing to grant all marine turtles absolute protection from exploitation while specifically naming only the leatherback turtle (Rakotonirina and Cooke, 1994). Sadly, this law is not enforced for domestic exploitation and is inconsistent with granting licenses for selling turtle meat (Rakotonirina and Cooke, 1994). Some groups have proposed a global ban on the use of pelagic longline fisheries (Ovetz and Steiner, 2004; Gilman et al., 2006) after high rates of sea turtle bycatch using this kind of fisheries has gained international attention (FAO, 2004 a,b; Gilman et al., 2006). This is only one of the many threats faced by sea turtles. A recent published review regarding the total annual marine turtle catch in Madagascar is estimated to be at 15,000 (Rakotonirina and Cooke, 1994; Metcalf et al., 2007).

For years, dedicated researchers have conducted studies on sea turtles in and around Madagascar which have proved to be worthwhile. They are now the few sources that are available for current researchers to look back as a reference point. The lack of data concerning green and hawksbill turtles nesting sites was noted by Groombridge and Luxmoore (1989) as a result of a review that aimed to look at the available literature regarding these turtles. Rakotonirina and Cooke (1994) reported the status and exploitation of sea turtles in Madagascar giving a general idea on how there are no conservation initiatives or set laws by the Malagasy government to protect turtles. Furthermore, no reported recent studies that have clearly mapped current nesting sites or a recent exploration into local attitudes towards these turtles were done. This is significant in order to implement successful conservation, it is important to communicate with the local community as community based conservation is vital for long term successful conservation.

Therefore, through my study I am aiming to contribute up to date information about nesting sites in Northern Madagascar whilst exploring local people's thoughts and perceptions towards sea turtles. Governmental organization and regional NGO's will be able to utilize the results from identifying and documenting the following in their future conservation management plans and efforts in Madagascar.

- Mapping the location of important nesting sites of sea turtles in Northern Madagascar
- Evaluating these nesting sites, their nesting activity and influencing factors
- Assessing local perceptions of sea turtles including catch, status, protection and threats.

Hypothesis to be tested:

1. In regards to nesting sites
 - Identified important nesting sites will be those with high number of body pits
 - Nesting sites will be found on undisturbed or unaltered beaches
2. In regards to local perceptions
 - Awareness of local fishermen of the endangered status of sea turtles will be low
 - Awareness of local fishermen in regards to the legal legislation by the government to protect sea turtles will be low
 - Turtle catch rates will be high due to low awareness of turtle status and legislation

2. Methodology

2.1. Study sites

Three areas in Northern Madagascar were investigated, Port Saint Louis (8-9 May 2011), Ampasindava/ Nosy Hara Marine Park (25-26 May 2011) and Ambolobozokely (16-17 June 2011), all of which are situated in the Diego Province (Fig 2.1). These sites have been chosen based on key informants' interviews conducted previously by Community Centered Conservation (C3) which identified these as important nesting grounds for green and hawksbill turtles (Appendix 1). In each site the number of nesting beaches available for study varied (Table 2.1.). Each site was surveyed twice on two consecutive days. On the first day new (<24 hours) and old (> 24 hrs) tracks and body pits were recorded and measured, whilst on the second day, only new tracks and body pits (< 24 hrs) were recorded and measured. This method is based on C3 protocol and is followed to assess the popularity of the nesting site amongst sea turtles in the area in comparison to neighboring beaches.

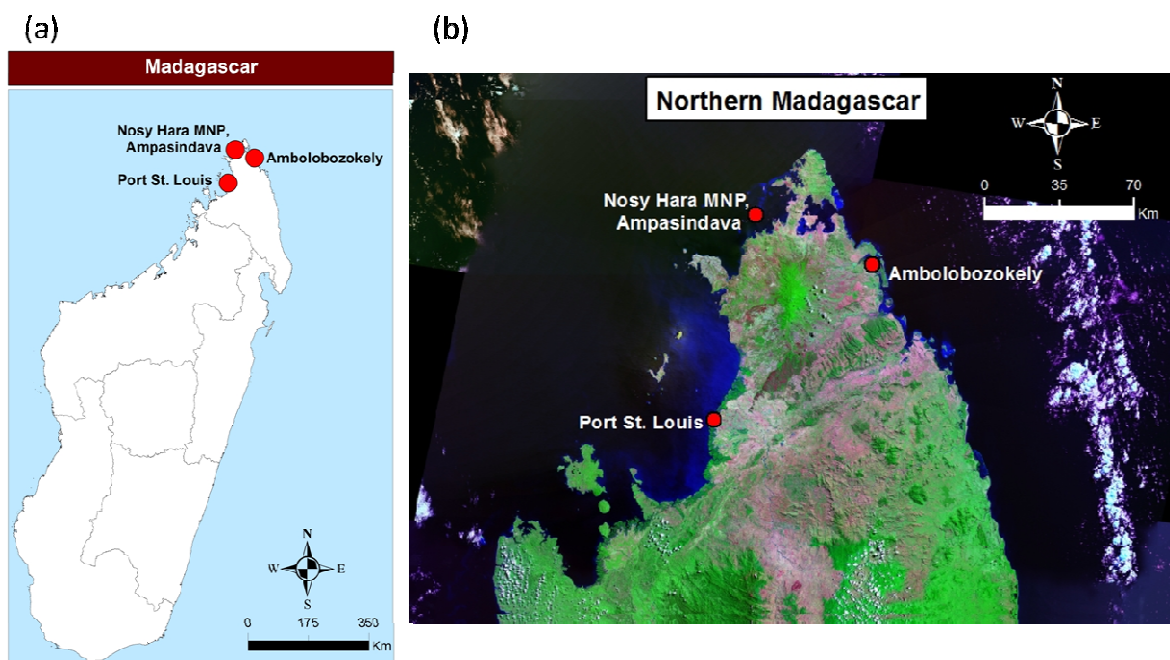


Fig 2.1. (a) Overview of Madagascar with location of study sites (b) Location of the important nesting study sites in Northern Madagascar chosen based on key informants' interviews conducted by C3 in 2009-2010.

Table 2.1. Important nesting study sites and beaches in Northern Madagascar as per key informants' interviews conducted by C3 in 2009-2010. (Island sizes are rough estimates *).

Area in North Madagascar	Survey beach sites	Location	Island size* (m²)
Ambolobozokely	Antognony Baro	Ambolobozokely(Mainland)	
	Anjiafaly	Nosy Tendro (Island)	2922428.89
	Ambatosariolo		
Port Saint Louis	Nosy Mangiho	Nosy Mangiho (Island)	196811.24
	La Sonde	Port Saint Louis (Mainland)	
	Ankarana	Nosy Mitsio (Island)	30306676.13
	Ampasindava (beach)		
Ampasindava(village) / Nosy Hara Marine Park	Nosy Hara	2 beaches North and West (Island)	2930103.33
	Nosy Fotsy	(Island)	120844.74
	Nosy Vaha	(Island)	102873.15

Port Saint Louis is situated on the north-west coast of Madagascar, in the district of Ambilobe. The beach La Sonde is on the main island in between two fishing villages: Ampasin' Antegniny which is 500m south of La Sonde and Andavagnemboko which is 300m to the north. Nosy Mitsio and Nosy Mangiho are both approximately 13 nautical miles away from the mainland Port Saint Louis (Fig 2.1.2). However, Nosy Mangiho does not seem to have any fishing villages present even though a few fishing boats and dwelling tents set up by migrant fishermen were seen on site. Nosy Mitsio on the other hand has a small fishing village on the island around 300 m from Ampasindava beach and some tourist bungalows were observed on site including a tourist boat. Ankarana beach is a quiet beach on Nosy Mitsio and is situated further away from the fishing village.



Fig 2.1.2. Location of beaches on islands and mainland surveyed in Port Saint Louis on the northwest coast of Madagascar.

Nosy Hara Marine National Park is situated within Ampasindava (village) in the district of Diego. Ampasindava hosts a fishing village on the mainland however all the islands surveyed (Nosy Hara – north and west beaches, Nosy Fotsy and Nosy Vaha) are uninhabited islands (Fig 2.1.3). The Nosy Hara archipelago was declared a Marine National Park in 2004 due to its extensive coral reefs. Therefore, a perimeter 50m off the coast of each island is considered to be a no take zone whilst in some areas within the national park, fishing is allowed using specific non-damaging gear. Nosy Hara has also been reported as important for nesting and foraging marine turtles by the Commission Nationale pour l’UNESCO in 1997. It is important to note that Nosy Fotsy is also an important bird nesting site where ~ 5000 pairs of birds visit the island yearly to lay their eggs (official MNP boatman, 2011).

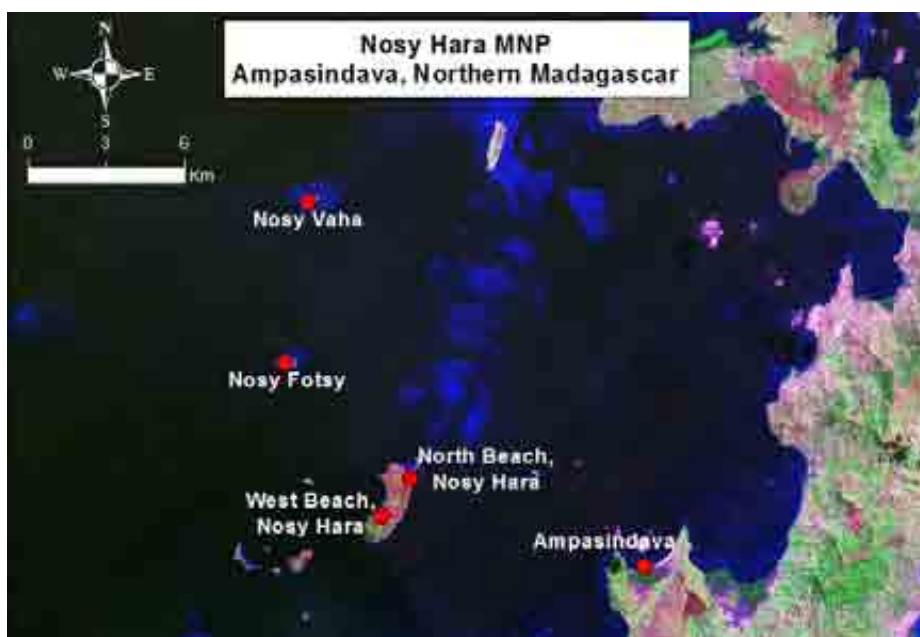


Fig 2.1.3. Location of beaches on islands surveyed in Nosy Hara Marine National Park, Ampasindava in Northern Madagascar (NB: Ampasindava point to show the location of the main village from the islands).

Ambolobozokely is located in the north-east coast of Madagascar within the district of Diego (Fig 2.1.4). It hosts a large fishing village; this village has wind turbines which supplies the village with electricity at night. Two beaches on the island Nosy Tendro were surveyed, these are namely: Ambatosariolo and Anjiafaly which are uninhabited and are on opposite ends of the island. Antognony Baro which is the eastern beach on the mainland has a migrant fishermen camp where fishermen were seen fishing, this island had a substantial amount of turtle carapaces due to high levels of poaching in comparison to all other islands surveyed for this study.



Fig 2.1.4. Location of beaches on islands and mainland surveyed in Ambolobozokely situated on the east coast Northern Madagascar (NB: Ambolobozokely point to show the location of the main village from the islands).

2.2. Data Collection

2.2.1. Mapping of nesting sites

Global Positioning System (GPS) points were taken at each site using a GPS device to map the location of the start and end points of beaches, in addition to the location point of each body pit recorded along the beach. This was done to create maps that lay out the location of the nesting sites and identify beaches with the highest number of body pits in the area.

2.2.2. Assessment of nesting activity

Relevant physical features of the beaches were recorded including nest position (vegetation/sand), and presence of disturbances (nearby villages/migrant fishermen camps/tourism) to assess sea turtle preference in beach selection.

The number of body pits (defined as the hole dug by a female turtle during nesting) and tracks were recorded whilst the number of successful and fake nests were noted when possible, to evaluate nesting numbers. To differentiate between successful and false nests, the track (defined as the pattern created by the flipper marks during crawling on sand) taken by the turtle was followed whilst looking for evidence of front flipper covering, which if present is considered evidence for a successful nest. Another evidence of a successful nest is signs of sand thrown into a mound covering more than 2 m of the emerging track and a deep (20-50 cm) secondary body pit with an escarpment. Evidence of false nests was very little or no sand disturbance (Fig 2.2.2). A false crawl is defined as a track created by a turtle that ascended on a beach and returned to the water without laying eggs (Dodd, 1983; Eckert and Gulko, 2004). It is important to note that it was not always possible or easy to distinguish a successful nest from a false crawl on the field.

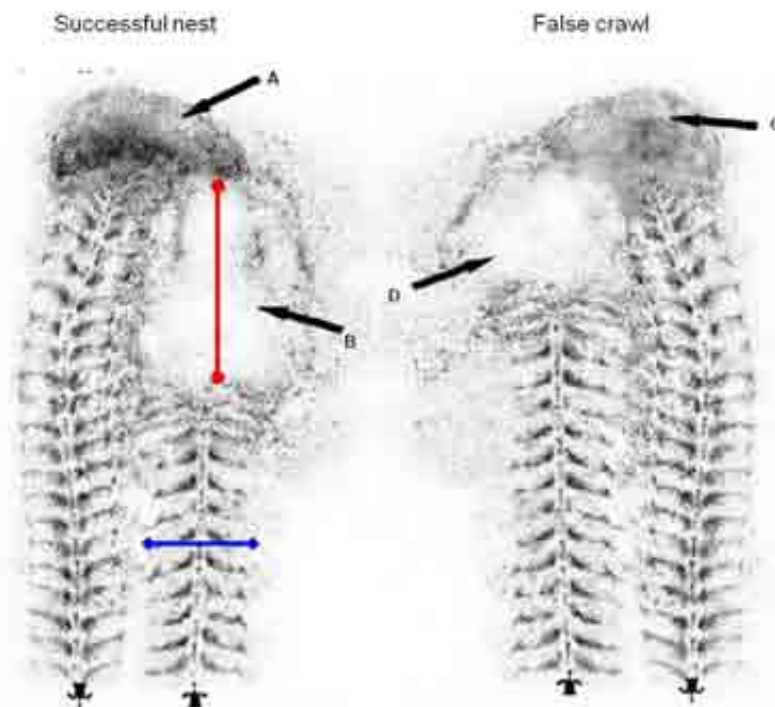


Fig 2.2.2. Successful nesting crawl (left) versus false crawl (right). Successful crawl: (A) secondary body pit which is made as the turtle moves away from the nest as she covers it up, (B) primary body pit covered with thrown sand (usually greater than twice as long as secondary pit). False crawl: (C) secondary body pit; (D) primary body pit. NB: primary body pit is not well covered and secondary body pit is less defined. Highlighted vertically is the length of the primary body pit, highlighted horizontally is width of tracks (Florida Fish and Wildlife Conservation Commission, 2002).

Measuring the width of tracks was done using a tape measure by measuring from one side of the track to the other, this was done for species identification purposes. The age of tracks (old or new) was distinguished easily as new tracks looked fresh with minimum disturbances while old tracks were more worn out and less obvious. This was done to assess the level of nesting activity. Body pit length was recorded as the height from the bottom of the track at the start of the body pit to the top of the primary body pit where the secondary body pit is (Fig 2.2.2). After tracks were recorded and documented nests were marked with spray painted sticks to prevent repeat recording.

2.2.3. Local perception of sea turtle catch, status, protection and threats

In order to assess local perceptions towards sea turtles “The End of the Line” dataset (turtle bycatch section) collected by C3 in 2009-2010 was used (Appendix 2). A total of 563 interviews were conducted in 14 sites around the northern region of Madagascar (Appendix 3). The number of interviewees at each site varied depending on presence of fishermen on site at the time and number of fishermen who agreed to be interviewed. Local fishermen’s awareness of legal laws protecting sea turtles, their current and future status, accidental or intentional captures, gear used for fishing and actions taken were evaluated.

It is important to note that this piece of work is a baseline study and hence there is no historical data to rely on. Most of the data gathered here is based on local fishermen’s knowledge regarding sea turtles, their nesting behaviour, and locations. Furthermore, field data collection methodology followed here is based on C3's protocol (Unpublished).

2.2.4. Statistical Analysis

Data was entered into Microsoft Excel and analysed using R 2.12.1 (R development core team, 2011). In terms of the mapping data, ArcCatalog was used to convert the Microsoft Excel data into shapefiles which were then used in ArcMap to create GIS maps presented here (ESRI, 2011). ArcMap was also used to measure and estimate area size of the islands surveyed. A Generalized Linear Model (GLM) with Poisson error structure and log link was used to test for statistical significance between the number

of body pits (response variable) and the presence of disturbances (explanatory variable), and nest position (explanatory variable) and body pit number (response variable). A GLM was used with Binomial error structure and log link to test the presence of a correlation between nesting position (vegetation/sand) and island size, turtle catch (Y/N) and the reason (Accident/Purpose), status awareness of the respondent (Y/N) and protection awareness (Y/N). Lastly, graphs were created in MS Excel and R to describe findings and all questionnaire answers were grouped into categories based on site and their counts were converted into average percentages and standard errors for reporting.

3. Results

3.1. Mapping of nesting sites

Upon visiting and surveying sites identified as important nesting sites by C3 surveys, some proved to be no longer nesting sites for sea turtles. Out of the 11 beaches surveyed in the 3 different study sites, 8 beaches proved to have traces of turtle presence i.e. tracks, body pits or both. Nesting activity varied greatly from site to site. Out of the 2 beaches surveyed on the mainland, only Antognony Baro in Ambolobozokely (east coast) proved to be a nesting site whereas La Sonde in Port Saint Louis (west coast) had no traces of any turtle presence. In Port Saint Louis (PSL) out of the 4 beaches surveyed, Ankarana beach on Nosy Mitsio seemed to be the only nesting site where 30 body pits and 10 turtle tracks were recorded (Fig 3.1.1).

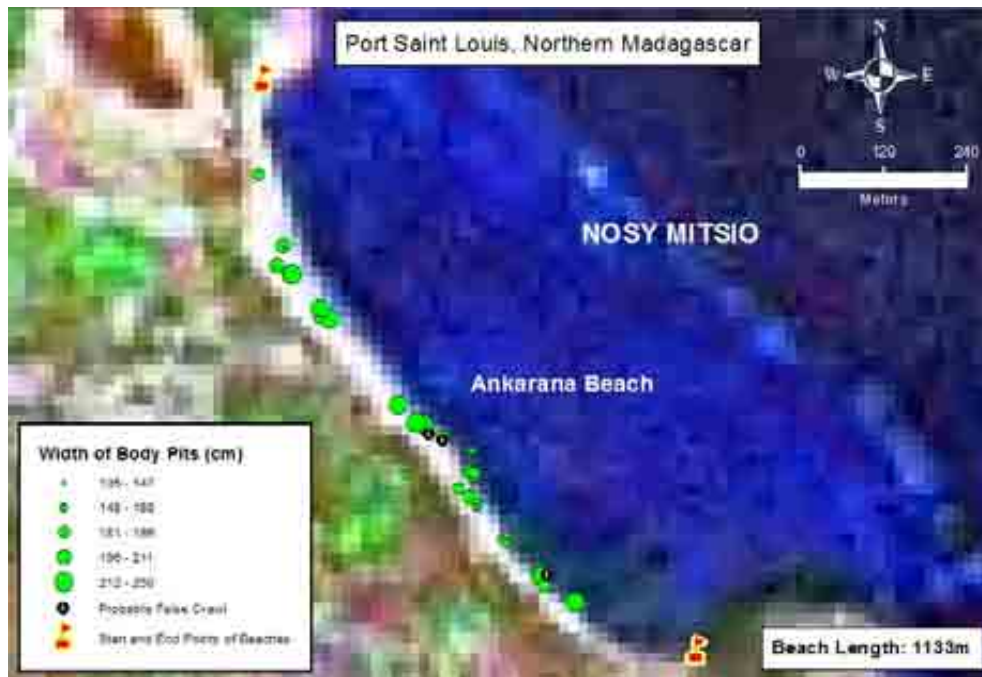


Fig 3.1.1. Map of Ankarana Beach on Nosy Mitsio, PSL showing the distribution of body pits along the beach from the start to end point.

All beaches in Nosy Hara Marine National Park (MNP) had traces of sea turtle presence and 3 out of 4 beaches surveyed are now confirmed as hosting nesting sites. Nosy Vaha (Appendix 4, Fig 1) hosted the largest number of body pits and tracks in the area (77 and 17 respectively). It was followed by Nosy Fotsy which hosted 26 body pits but no tracks indicating that the body pits were old (more than two week old) (Fig 3.1.2) and Nosy Hara North beach (Appendix 4, Fig 2) with 13 body pits and 2 tracks. No body pits were found on Nosy Hara West beach however one track was recorded confirming that turtles do visit that beach.



Fig 3.1.2. Map displaying the distribution of body pits around Nosy Fotsy, Nosy Hara MNP.

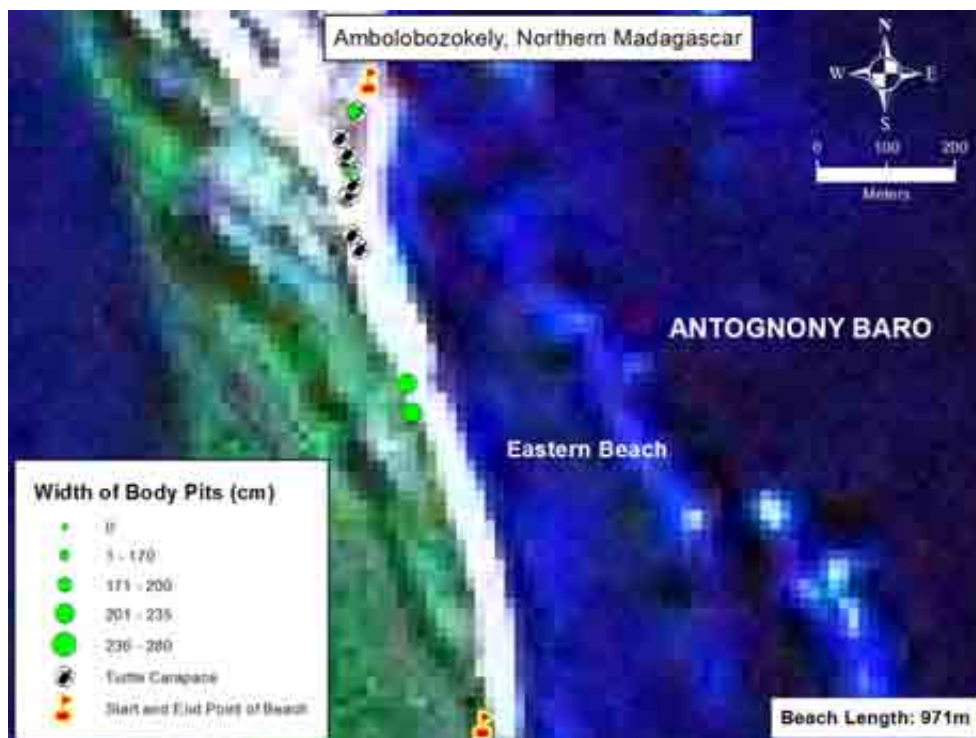


Fig 3.1.3. Map showing the distribution of body pits along the eastern beach of Antognony Baro, AMB.

In Ambolobozokely (AMB), all 3 beaches in the area host sea turtle nesting sites. Ambatosariolo beach on Nosy Tendro had the largest number of body pits recorded in the area which amounted to 14 body pits and 1 track (Appendix 4, Fig 4). Anjiafaly beach also on Nosy Tendro had 10 body pits accompanied by 2 tracks (Appendix 4, Fig 3). The eastern beach on Antognony Baro (Fig 3.1.3) had the least number of body pits amounting to 4 with no tracks present, it is important to note that this beach is on the mainland, had an active migrant fishermen's camp and 10 turtle carapaces were recorded along the beach.

3.2. Assessment of nesting activity

Out of all the sites, the results illustrate that Nosy Vaha is the most active nesting site with the highest body pit density of 77 and 17 tracks whilst Nosy Hara West beach is the least active with only one track recorded and no body pits (Fig 3.2.1).

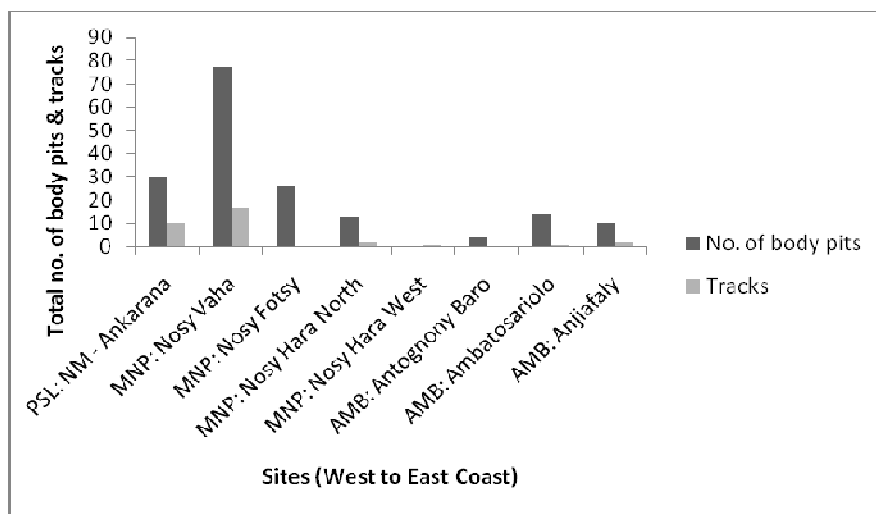


Fig 3.2.1. Total number of body pits and tracks at beaches with turtle presence across all sites.

A generalized linear model (GLM) showed that there is significantly higher numbers of body pits in areas with low disturbance levels than those with high disturbance levels ($z = -4.48$, $p < 0.001$, $n=11$, Fig 3.2.2). This supports the hypothesis that nesting sites will be found on undisturbed or unaltered beaches, confirming that sea turtles prefer quiet beaches.

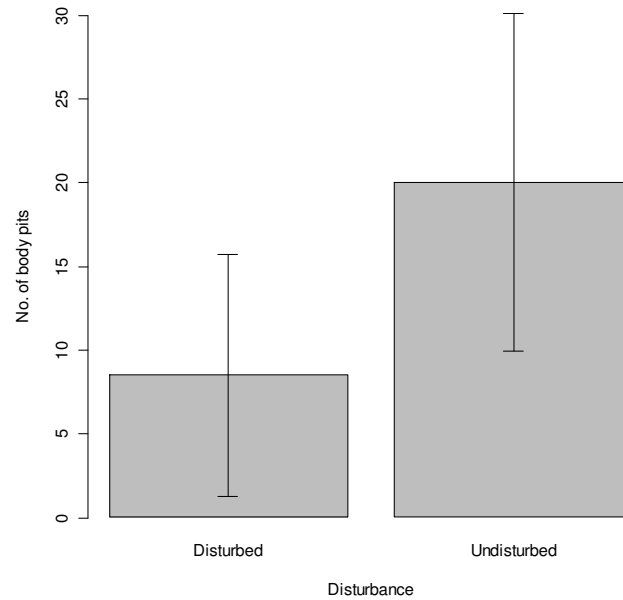


Fig 3.2.2. Number of body pits in relation to disturbance \pm calculated standard errors, GLM ($z = -4.48$, $p < 0.001$, $n = 11$).

Investigations in regards to beach selection to determine whether turtles prefer nesting on vegetated or sandy beaches suggested that on small islands turtles positioned their body pits in vegetation whilst on big islands they prefer positioning their body pits in the sand (Fig 3.2.3). In active beaches with more body pits, it seemed that nesting is preferred to be on vegetation whilst on less active beaches, it is preferred on sand. This was found to be not significantly correlated with island size when tested ($z = -0.55$, $p > 0.05$, $n = 5$). However, the number of body pits significantly correlated with nesting position ($z = -10.23$, $p < 0.0001$, $n = 189$).

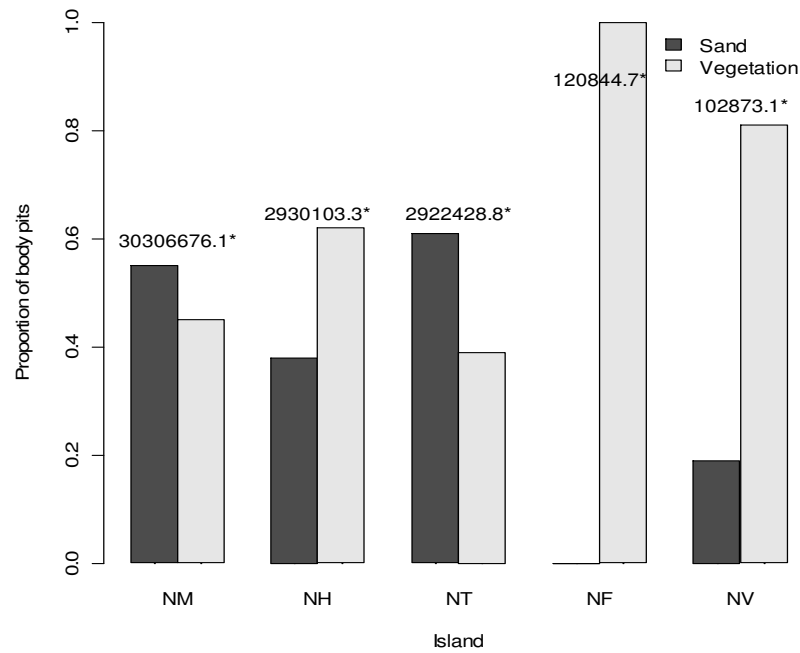


Fig 3.2.3. Proportion of body pits position on sand and vegetation on surveyed islands (Island size*, NM= Nosy Mitsio, NH= Nosy Hara, NT= Nosy Tendro, NF= Nosy Fotsy, NV= Nosy Vaha).

3.3. Local perceptions of sea turtles

Out of the 563 fishermen interviewed for the End of the Line data in 14 sites, 27.71% \pm 4.36 answered Yes to having caught turtles whilst 72.28% \pm 4.36 answered No. Of these, 69.93% \pm 8.93 were accidental captures, 24.74% \pm 4.72 were intentional and 5.21% \pm 2.81 were a mixture of both. The green turtle proved to be the most caught species followed by the hawksbill turtle whilst the leatherback turtle was the least caught species (Fig 3.3.1).

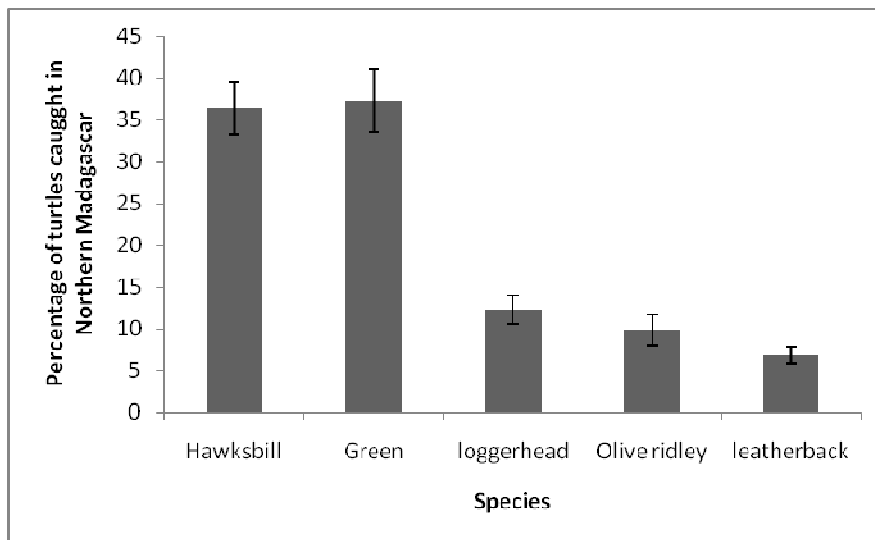


Fig 3.3.1. Proportion of different species of turtle reported as caught in Northern Madagascar in the End of the Line survey, mean values are represented \pm calculated standard errors (n=285).

Most of the turtles whether caught intentionally or accidentally were caught in sea grass beds ($53.56\% \pm 6.16$) while the beach was the lowest ($8.54\% \pm 0.86$) as most captures there are usually intentional (Fig 3.3.2). Nets ($50.91\% \pm 6.82$) are the most commonly used fishing gear followed by jarifa nets ($16.50\% \pm 3.88$) and longline ($20.21\% \pm 4.97$). Some fishermen stated that they sometimes fish with spear guns/harpoons ($3.64\% \pm 1.84$) or use other fishing gear ($4.12\% \pm 1.73$), if intentionally catching turtles on a beach, do it by hand ($4.63\% \pm 2.09$).

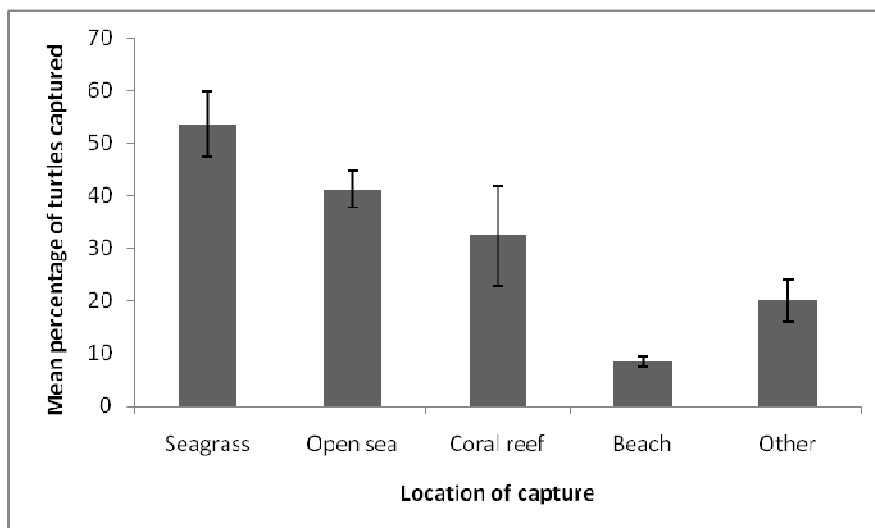


Fig 3.3.2. Mean percentage of turtle capture in each fishing site, mean values are represented \pm calculated standard errors (n=164).

A fair proportion of the respondents said that they release turtles during accidental capture ($38.01\% \pm 5.57$) however the majority of respondents said that they would eat the turtles instead of releasing them ($41.39\% \pm 6.48$) (Fig 3.3.3a). There were many reasons given for the actions taken by the respondents of which the most were food requirements ($40.29\% \pm 6.38$) and money ($7.84\% \pm 2.58$) if they don't release it. Most have no need for them ($28.36\% \pm 6.41$) therefore release them or have noticed a population decline in turtles ($1.81\% \pm 0$) and know it is illegal to catch them by law ($6.29\% \pm 2.50$) in addition to local fadys (local taboos – see discussion) ($8.02\% \pm 2.47$) and other reasons (Fig 3.3.3b).

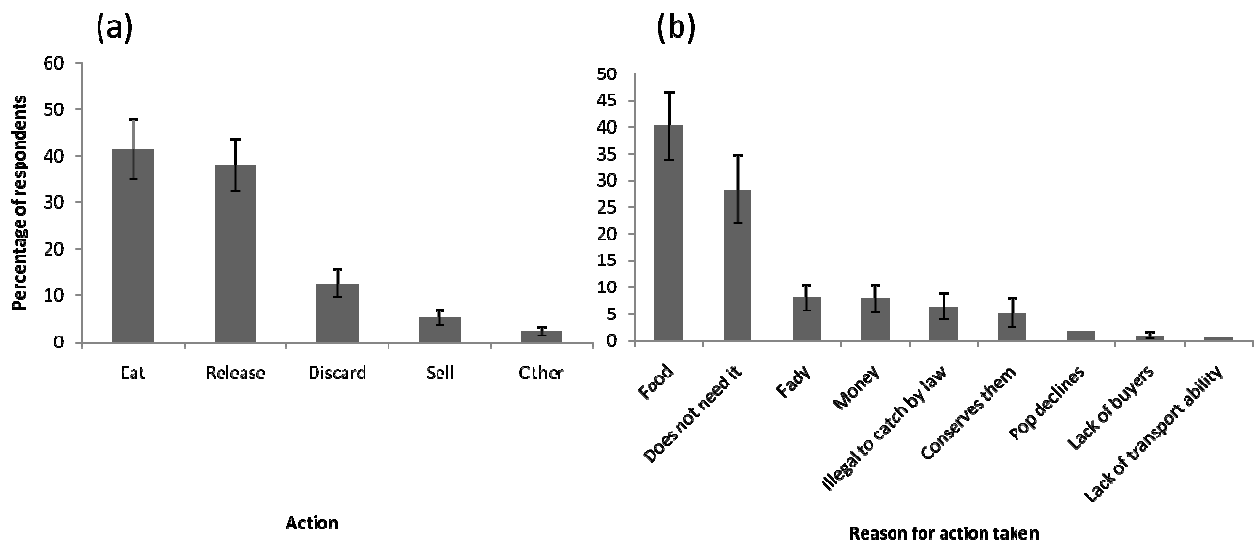


Fig 3.3.3. (a) Action taken by the respondents during accidental capture (b) Reason for action taken by the respondents, mean values are represented \pm calculated standard errors (n=130).

Over a quarter of the respondents ($32.97\% \pm 5.28$) reported that accidental capture makes them feel frustrated whilst others said it left them either sad ($18.72\% \pm 6.46$) or happy ($24.22\% \pm 5.76$) with a similar number who shared a neutral feeling ($22.31\% \pm 4.12$) towards this kind of capture. A small number said that accidental capture makes them feel afraid ($1.47\% \pm 0.99$) for sea turtle population and the remaining few felt reflective towards turtle bycatch. Out of the 563 interviewees, $67.17\% \pm 7.32$ said that there has been an increase in the number of nesting turtles in the last 20 years whereas $22.61\% \pm 5.99$ noted a decrease while $10.22\% \pm 2.09$ said that the number of nesting turtles remain the same and has not changed. The majority said that the increase in number was because sea turtles are

protected by law as it is illegal to catch them ($26.89\% \pm 7.05$) whilst other said that they thought the increase was due to presence of many visual sightings ($22.99\% \pm 4.53$). Some reported that the decrease was due to high capture rates ($21.38\% \pm 5.55$) and habitat destruction ($1\% \pm 0.74$) (Fig 3.3.4).

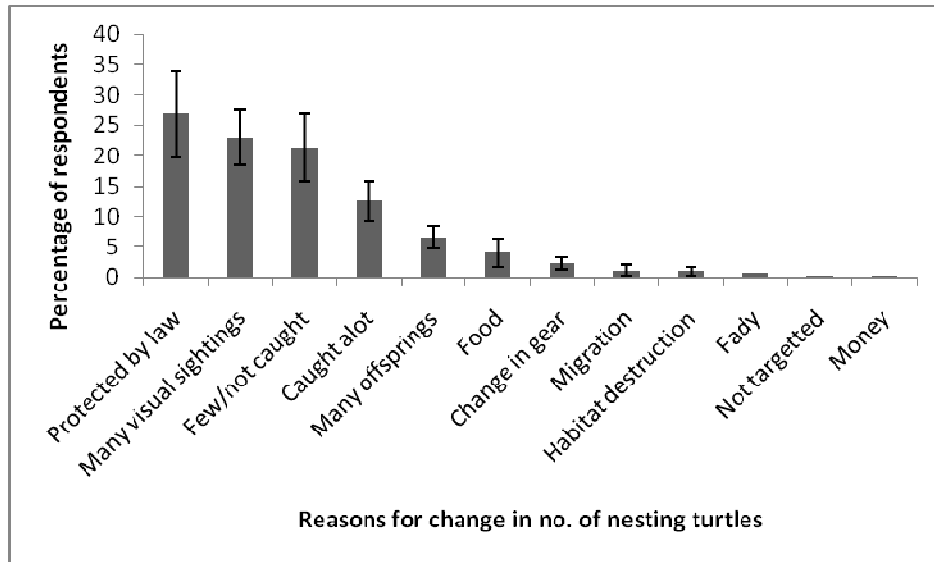


Fig 3.3.4. Reasons for change in the number of nesting turtles according to respondents, mean values are represented \pm calculated standard errors (n=563).

Based on the question exploring awareness of the respondents of turtle status and protection laws, $11.04\% \pm 3.10$ answered Yes to knowing that turtles are being threatened by extinction and are endangered leaving the rest with no knowledge of this ($88.96\% \pm 3.10$). However, when questioned about their knowledge of the prohibition of killing/capturing turtles by law and that turtles are legally protected, the majority answered with Yes ($78.15\% \pm 4.01$) while the rest answered No ($21.85\% \pm 4.01$) (Fig 3.3.5).

A GLM with binomial error structure showed that there is a significant difference in catch rates influenced by turtle protection awareness (z-value = -2.55, $p < 0.05$, n=420) however, no significance was found in regards to turtle status awareness and intentional catch rates (z-value = 1.339, $p > 0.05$, n=81).

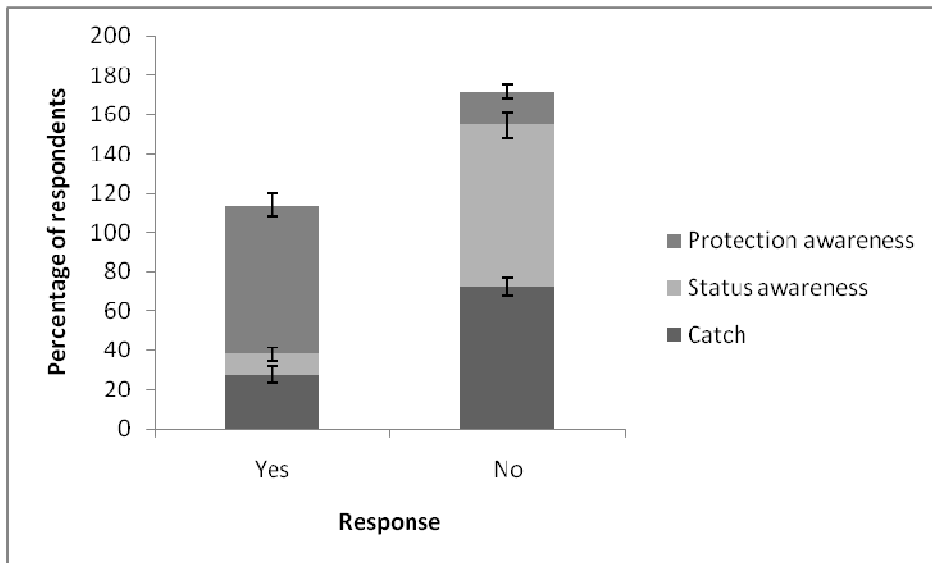


Fig 3.3.5. Response of fishermen to their turtle catch, status and protection awareness, mean values are represented \pm calculated standard errors (n=501).

This proves my hypothesis that awareness of local fishermen of the endangered status of marine turtles will be low but also disproves my second hypothesis as local fishermen awareness to legal legislation is revealed to be high. Moreover, it is correct to say that turtle catch is high due to low awareness of turtle status but disproves the other half of the hypothesis which is high catch is due to low awareness of legislation.

4. Discussion

Identifying important nesting sites in Northern Madagascar is an essential primary initiative for sea turtle conservation. In this study, I investigated and confirmed the importance of seven nesting sites out of eleven that were identified by C3 based on key informants' interviews. The seven beaches are Antognony Baro, Anjiafaly and Ambatosariolo in Ambolobozokely on the east coast of Northern Madagascar, Nosy Hara North Beach, Nosy Fotsy and Nosy Vaha which are within Nosy Hara MNP in addition to Ankarana beach on Nosy Mitsio in PSL on the west coast of Madagascar. All these sites are active nesting sites with traces of turtle presence and nests.

The main reason for turtles choosing these beaches is probably the fact that these beaches are rarely disturbed due to most of them being on uninhibited islands, away from villages and few fishermen that visit them. All beaches present in Nosy Hara MNP had high numbers of body pits in comparison to PSL and Ambolobozokely. This was highly expected as it is a marine protected area with implemented gear restrictions and uninhibited islands.

Out of the two beaches surveyed on the mainland Antognony Baro was the only one with traces of turtle presence even though it had the lowest number of body pits in comparison to the beaches surveyed during this study while La Sonde had none. This could be due to the presence of high disturbances near these sites. La Sonde is situated between two fishing villages Ampasin' Antegniny (500m south) and Andavagnemboko (300m north) therefore, the noise from human settlements and continuous presence of humans in the area in addition to fishing nets all contribute to making this beach less attractive for nesting turtles. Despite being on the mainland there is no village near Antognony Baro. The low number of body pits there could be explained as a result of the migrant fishermen camp present on site. I was informed by the accompanying C3 staff that during their visit in February 2011 they found over a 100 body pits in this area however this time only four body pits were found along the beach in addition to ten turtle carapaces which were seen approximately 100 m away from the migrant fishermen's camp. The scene suggested that these turtles were most probably poached when they came onto the beach for nesting, it was noted that the camp was active during our survey period.

Ambatosariolo and Anjiafaly on Nosy Tandro had a reasonable number of body pits making them important nesting sites. Both these sites are very isolated and face strong winds, waves and tides from the Indian Ocean making it difficult to get to them especially in the local pirogues (traditional wooden boats) used by the majority of fishermen. This makes these beaches more favourable for nesting turtles with no human settlements or disturbance nearby. Similarly, in PSL only one beach proved to be a nesting site namely Ankarana beach on Nosy Mitsio whilst all other beaches at this site proved to be non-nesting sites. This could be due to a number of reasons such as migrant fishermen camps on Nosy Mangiho, presence of tourist bungalows and yachts on the beach Ampasindava which is on Nosy Mitsio and presence of human settlements near La Sonde. PSL is in general a heavily fished location, where the majority of people are involved in fishing due to the large popularity presence of sea cucumber and shark fin trade in the area.

In addition to confirming the identity of nesting sites, my results confirm the theory that nesting activity on beaches is influenced by the presence or absence of disturbance. Therefore, the sites with the highest number of nests (Nosy Vaha followed by all the MNP islands, Ankarana beach on Nosy Mitsio and beaches on Nosy Tandro) had little to no disturbances on them whilst those with high levels of disturbances had none (mainly PSL sites).

My data indicated that sea turtles prefer nesting in vegetation on small islands and in sand on big islands or mainland. This could be due to small islands being more exposed to strong winds with nothing to shield them which in turn causes sand to move easily, making their nests more obvious. If nests are positioned in vegetation, they remain protected and less vulnerable to wind disturbance and predators. Another reason could be that, since islands seem to have more nesting activity and host large number of body pits, turtles have to go further up the beach into the vegetation in order for their nests to not get destroyed by other nesting turtles. Even though nesting position was found to be significant with body pit number, it was not significant when tested with island size.

Looking at local perceptions towards sea turtles, it was found that a small percentage of fishermen in Northern Madagascar actually catch turtles. The majority of the time, most turtle catches are accidental due to gear being left unattended during the day. Fishermen who catch turtles intentionally usually target two particular species, the green turtle for its good meat and the hawksbill turtle for its beautiful

shell. The hawksbill turtle has no value for its meat due to its poisonous nature. Most turtle catches regardless of them being accidental or intentional were caught in sea grass beds which is green turtle's preferred feeding habitat due to its green diet, coral reefs which is where hawksbills forage for sponges and soft corals in addition to open sea where most turtles spend most of their time foraging for food, migrating or moving between nesting and feeding sites. All captures on beaches are usually intentional as fishermen wait for turtles to come onto the beach for nesting before poaching them.

During accidental capture a quarter of the respondents said that they release the turtles as they have no need for it and that nowadays less people buy turtle meat. Some said that the reason for their action of release is because they have noticed a decline in turtle population and want to conserve them. Others stated that they were aware that it is illegal by law to catch them hence they release the turtles. A small group said that it is considered a fady or taboo to catch turtles in their cultural tribe groups. The reasons behind these fadys vary from one village to another in the region. Some of the most common fadys is that ancestors who ate turtles all died, we can assume that they were referring to the hawksbill turtle and it has been scientifically proved that the meat is poisonous due to the toxins the hawksbill intakes during its sponge consumption. However, some fadys are more spiritual for example it is said in one area that if someone kills a turtle, it will cause the turtle's soul to sink into the sea resulting in the killer entering hell (Respondents from the End of the Line interviews, 2009).

In some areas killing turtles is allowed but there are certain fadys to consider during the killing that makes people less likely to kill turtles. For example, silence is essential during the killing, a specialist priest and a ceremony is required to perform the killing while decapitation of the turtle head is not allowed. They must ensure to not turn the shell upside down after killing it as this provokes disappearance of turtles on the site of capture. There are many other fadys to consider therefore making it difficult for fishermen to intentionally catch turtles as it may result in trouble (Respondents from the End of the Line interviews, 2009).

However, fishermen who do not release turtles eat them which is an action taken by the majority of respondents as it is their source of food for the day or they sell it as it will earn them some extra money. When asked about their feelings towards accidental capture, over a quarter of respondents said that they felt frustrated as turtles damage their nets causing them the extra expense and time to replace them.

Some expressed their sadness and fear for turtle population decline in the area, others saw happiness as a result of the opportunity for free food or easy earned money whilst the remaining felt reflective towards the result of bycatch.

The majority agreed that the number of nesting turtles has increased whilst a small proportion of respondents have said the contrary, with declines increasing in areas. Those who have noticed the increase say that this is due to turtles being protected by law and hence very few people catch them. Other reasons that contribute to the increase of nesting turtles include fady restrictions, many visual sightings by fishermen; turtles not targeted much and have many offsprings. Respondents who have said that they think there is a decline in numbers fault it on high capture of turtles for food and money in addition to habitat destruction. Surprisingly, a high number of respondents reported their awareness of turtle protection by law however a very low number were aware of the endangered status of turtles. Catch rates were significantly influenced by protection awareness as those who were aware had low turtle catches.

The result of this study clearly outlines that human disturbances and settlements are contributing to the eradication of important nesting sites and lowering nesting activity on beaches (Mortimer, 1982). Understanding local attitudes towards sea turtles is vital for implementing conservation projects. Exploration of local perceptions towards sea turtles in Northern Madagascar revealed that the majority of fishermen do not target them for their main source of income as mainly they have no need for them. In addition, a reasonable proportion of the local community has noticed a decline in the number of nesting turtles and has expressed mixed feelings of sadness and fear for these populations. This suggests that if conservation projects were to be set up to monitor turtle nesting sites and their population, the local community would be willing to participate in making them a success.

Successful conservation is achieved through the participation and collaboration between scientists, the local community along with governmental and non-governmental organizations. Many conservation practitioners classify participation of local communities into four concepts; these include information sharing, consultation, decision-making and initiating conservation action (Whitemore, 1998; Esenjoy, 2004). It is important to note that every community has different views on the degree and type of participation in addition to their appropriateness and adequacy (Esenjoy, 2004). Worldwide experience

suggests that conservation projects that have included communities as partner participants at all stages of project development and implementation especially level of decision making ensure success (Esenjor, 2004). Community based conservation has previously proved to be successful in Madagascar, one of the most famous examples is Montagne d'Ambre National Park in Northern Madagascar. It acquired its national park status in 1958 and is fully conserved, run and managed by its local community. Moreover, Montagne d'Ambre is one of the most successful and visited attraction parks in Madagascar (visit Madagascar, 2005).

In order for people to accept setting up sea turtle conservation projects, local communities should be made aware of the turtle population situation and the factors that are contributing to nesting sites being abandoned. One way is through organizing national campaigns introducing people to the threats being faced by turtles and suggesting simple conservation strategies and ways to tackle these threats. Currently, C3 have been actively working with the Antsiranana Boy Scout Troop in Diego Suarez, North Madagascar for over a year where they have been training young people to conduct a marine conservation roadshow. The roadshow visits many rural villages all over the region where they perform plays that aim to raise awareness of regional conservation issues faced by urban populations, introducing species that were once thriving in Malagasy waters such as dugongs and turtles which are now in drastic decline in addition to many more issues.

Another example of successful conservation in Madagascar is co-operation between local tourist operators and scientists in order to develop a monitoring program associated with sea turtles on Nosy Iranja. Nosy Iranja Kely is a big island situated in north-west Madagascar and is well known for sea turtle presence in the area. A four star hotel was built which initiated ecotourism activities through the observation of nesting marine turtles mainly in the south of the island to preserve the integrity of the site and protect it against poachers (Bourjea et al., 2006). During the establishment phase of the hotel in 2000, WWF Madagascar and West Indian Ocean Program Office (WWF MWIO PO) initiated baseline research studies of sea turtles through its marine turtle conservation program. Locals were hired by the hotel and trained by WWF to monitor sea turtles nesting activities to ensure that nests are protected and to develop turtle watching activities (Bourjea et al., 2006). This has now provided data on present nesting turtles in Nosy Iranja however, there is no data available prior to 2000 to compare and detect any change in the number of nesting turtles. Therefore, eco-tourism monitoring programs

could be set up in beaches such as on Nosy Mitsio, PSL where tourists were seen visiting, in order to help monitor nesting turtles but at the same time raise awareness amongst the local community and visiting tourists in regards to turtle threats and their declining nesting sites.

Other conservation strategies could include the use of Turtle Excluding Devices (TEDs) in nets which was developed to allow entrapped turtles to escape from shrimp trawl fisheries after it was identified as a major source of mortality in the early 1980s (Kemf et al. 2000). It is evident that the majority of the local fishermen would not be able to afford buying this however, since many of the current conservation projects in Madagascar are funded by NGOs such as WWF, Conservation International, Blue Ventures, Frontiers and other foreign organizations, this could be a way of negotiating the introduction of these devices. Encouraging fishermen to monitor their nets daily instead of leaving their nets unattended for a long time will help cut down the number of turtles that drown yearly due to being caught in nets. Minimizing the use of motor boats at night, removal of unneeded night lights and avoiding disturbing the beach at night will help encourage and increase the number of nesting turtles visiting important nesting sites.

In conclusion, identifying important nesting sites is vital for conserving sea turtle populations along with understanding local attitudes, which is key to successful community based conservation of sea turtles in Northern Madagascar. In this study, I have confirmed that 8 out of 11 beaches in 3 different sites have traces of nesting turtle presence and identified seven important nesting sites through looking at body pit numbers. I have confirmed my hypotheses that nesting sites will be found on undisturbed beaches and that the awareness of local fishermen of the endangered status of marine turtles will be low. However, I found that awareness of local fishermen in regards to legal legislation was high instead of low.

5. Limitations & Future work

During this study a few limitations were faced. Firstly, exploring local attitudes was difficult as secondary data (End of the Line dataset collected by C3) was used therefore, asking the specific questions I would have liked to ask was not possible. A few problems were faced while analyzing this

dataset as it lacked recording consistency due to being collected by many different people. The way the answers were recorded all differed and when referred to the hard copies, a small section of the data did not match completely whilst some things were lost in translation. Secondly, no previous data for the nesting sites investigated in Northern Madagascar is available which makes comparison difficult to assess increase or decrease in number of nesting turtles. Getting to the sites was complicated and limited due to transport issues, boats being unavailable, tide and time restrictions therefore repetitive surveying was impossible. Identification of nests and false crawls was difficult most of the time so it was impossible to further explore the nesting site data.

If given the opportunity, I would like to further investigate local fishermen's feelings towards being involved in conservation and their ideas in regards to community based conservation. Further exploration of their opinions towards realistic conservation strategies that would help them implement and follow these strategies would be done. A high percentage of fishermen seem to be aware of the protection status of turtles hence, it would be good to know the source of their awareness as this would be a good start to finding ways to spread the message for turtle conservation. With regards to nesting sites, setting up small turtle monitoring stations at identified nesting sites would be good to create a proper regional database which would later be useful as a reference point for future comparison to monitor successful conservation efforts. This would also make it possible to identify false crawls and real nests without having to disturb nests in the area as there would be volunteers on watch to protect the turtles from poachers. Despite the limitations faced during the period of this study, I believe that the findings of this project will help fill the void of lack of data and can contribute vital up to date information about important nesting sites on a regional level. In addition to giving an insight into local thoughts and perceptions towards sea turtles in Northern Madagascar.

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8. Appendices

Appendix 1: Key informant sea turtle nesting questionnaire conducted by C3 to identify important nesting sites.



KEY INFORMANT SEA TURTLE NESTING QUESTIONNAIRE

Date

Interviewers:

Site

#

This questionnaire is designed to elucidate **DETAILED QUALITATIVE INFORMATION ON SEA TURTLE NESTING SITES IN NORTHERN MADAGASCAR.** This questionnaire should be directed at community members (not necessarily fishers) who are recognized within their communities as particularly knowledgeable of sea turtles and their nesting sites. These respondents should be identified by local chiefs or heads of fishing associations.

Before commencing the interview, offer the respondent a bottle of soft drink and assure them that the information collected during this interview will be kept completely anonymous. Please use the final blank sheet to record additional information if there is not enough space below.

Please note that question 1 is of the highest priority and most time should be allocated to this question.

Respondent details

Name	
Age	
Years of experience	
Contact information	

1. NESTING

LEAD QUESTIONS

1.1 Where have you seen sea turtles nesting?

*-Make sure that you gather information on **specific beaches** (note the local name of the beach and also Note the name of the areas/villages clearly on the map)** clarify what nesting activity is – on the beach**

1.2 Which species have you seen?

-show photos and explain differences between species A/B for identification

** only show species C-E if they are adamant it is not A or B**

-note both the letter and species name for ID.

-note local names for each species

1.3 Do certain species only nest on certain beaches or areas

- (Note the species names next to beach name given in 1.1 on the map)

PROBES

- Which are the most popular beaches for nesting?
- Do they nest in the same places they did 20 years ago? (If no, Why?)
- When do they most commonly nest? (which months/seasons)
- Does their nesting depend on the tides?
- Do they nest during the daylight or dark?
- How often do sea turtles nest?
- How many eggs do sea turtles lay per nest?
- Have you observed hatchlings? If yes... How many, When, Where, Which species
- Do all the hatchlings survive until adulthood? If No. Why?

It is imperative that you gain detailed information on exact locations of nesting

2. BEHAVIOUR

LEAD QUESTION

What do you know about sea turtle behaviour (Feeding, mating, other)

PROBES

- What do sea turtles eat?
- Where and when do they mate?
- Are the mating zones different from their feeding zones?
- What size and age are sea turtles at the time of reproduction?
- What other behaviours aside from feeding, swimming and mating have you seen?

- How do sea turtles react towards humans?
- What fady are associated with sea turtles?

3. HUNTING

LEAD QUESTION

Where are the main beaches for hunting in the area?

PROBES

- What time of (year / month / season) do people catch the most turtles?
- Who hunts sea turtles (particular races)?
- Why do people hunt sea turtles?
- How are they primarily hunted?
- Are eggs also taken? If yes... Why?
- How has sea turtle hunting changed in the last 50 years

4. CONSERVATION

LEAD QUESTION

Sea turtles could become extinct as a result of hunting and accidental capture by fishers, what could Madagascan people do to stop them from disappearing?

PROBES

- How often do you see tagged sea turtles?
- Who do you think is responsible for their conservation?
- What could fishers do to help protect them?
- What can others do to stop their disappearance?

5. PROTECTION

LEAD QUESTION

Do you know if sea turtles are protected by law or local regulations? If yes, please can you tell us about them

PROBES

- Who enforces their protection?
- What community groups are also helping to protect sea turtles?
- What other ways are sea turtles being protected?
- Do you think that their protection is working? If yes...How/Why?

Appendix 2: Bycatch Questionnaire used to collect the ‘End of the Line’ data. Interviews were conducted in Malagasy and then translated into English.



BYCATCH QUESTIONNAIRE

FORM #

Hello, we are students from the University of Antsirananana and we would like to learn more about the dugong, which you may have heard of, and the capture of certain species such as the sharks, turtles, whales and dolphins in Madagascar. Since fishermen know the sea better than anyone else, we would like to consult you about those subjects. The study shouldn't be too long. Would you be interested in helping us by sharing your valuable knowledge?

Fisher information

Date	Landing Site	Interviewer
Age	Occupation	Name (Optional)

BYCATCH QUESTIONS

Boat and Fishing effort

1. Type: pirogue pirogue with outrigger boat
 plastic boat (12 people) other (specify)

Length: _____

Name of boat: _____

2. Motorized? (Select more than one answer if required)

none (oars/sails) inboard motors outboard motors N/A

HP of motor: _____

If motorized, does it also have a sail? YES NO

3. # fishers per boat: _____

4. Do you always land at this port? (If yes go to question # 5)

YES NO OTHER (specify)

a) Where do you land most often? _____

b) Which other ports do you visit? _____

5. Gear Characteristics (Record units in m or cm or mm): For hooks, refer to hook ID template and record hook sizes from template.

Net	Basket Trap	Palangre
Mesh size:	# Baskets	Hook size:
Total net length:	Basket size	Total line length:
Net width/depth:	Length	Total # hooks:
Floating or anchored:	Basket width & depth	Depth of hooks:
	Trap depth	

Longlines	Harpoon	Other
Hook size: Number of hooks per line: Line length: Floating or sinking lines:		

6. When you go fishing what do you go out to catch? _____

7. If you catch more than one species which species do you catch most? _____

8. During the fishing season how often do you go fishing?
 everyday 5-6 times per week 2-4 times per week
 1 per week other (specify) N/A

9. Duration of trips:
 0-10 hours 10-24 hours 1-2 days 3-5 days >5 days N/A

10. Where do you fish most often? (Take village names if possible, assign code – 10A, 10 B, 10 C, - & mark on map with code; specify whether village, beach, bay, etc.) _____

11. Are there any types of fishing gear that are not allowed?
 YES NO N/A

a) Which gear types are not allowed? _____
b) Why? _____

12. Are there areas where fishing is not allowed ? (Draw locations on map) _____

13. What Months do you fish? _____
If you do not fish every month, why? _____

14. In what months/season do you have the most fishing effort? (Specify names of months)

15. Are there any times of year where fishing is not permitted due to law, local custom or fady?
 YES NO N/A
Why? _____

16. How long have you been fishing? _____

17. a) Since (Insert response to Question 16), has there been a change in fishing grounds? (If NO or N/A, go to b)
 YES NO N/A
 If yes: (Take village names if possible, assign code – 17A, 17 B, 17 C, - & mark on map with code) _____
 Why? _____
 When did this change? _____

b) Since you started fishing, has there been a change in the number of fishers and boats? (If SAME or N/A, go to c)

MORE LESS SAME N/A

Why? _____

When did this change? _____

c) Since you started fishing, has there been a change in the fishing gear you use? (If NO or N/A, go to d)

YES NO N/A

What did you use previously? _____

Why did this change? _____

When did this change? _____

d) Since you started fishing, has there been a change in the kind of species you catch? (If NO or N/A, go to e)

YES NO N/A

What species were caught then? _____

Why did this change? _____

When did this change? _____

e) Since you started fishing, has there been a change in the size of the fish you catch? (If "same" or N/A, go to f)

decreased increased same N/A

Why? _____

When did this change? _____

f) Since you started fishing, has there been a change in the overall weight of your total catch? (If "same" or N/A, go to 18)

decreased increased same N/A

Why? _____

When did this change? _____

18. Are there any fadys about fishing? YES NO N/A

What are they? _____

TURTLE BYCATCH QUESTIONS

19. Do you catch sea turtles in the water BY ACCIDENT/ON PURPOSE/BOTH? (If "Never", go to question # 31)

by accident on purpose both never N/A

20. Which species (write down names and letter from photos)?

21. How often do you catch turtles, by accident or on purpose (Indicate with 'a' for accidental, 'b' for on purpose)?

Never Less than once a year Once a year

A few times a year Once a month Once a week

A few times a week Every day N/A

22. How many in the last year (Record separate answers for each species)?

Est. # _____

23. In what months or seasons do you catch sea turtles by accident or on purpose (Indicate with 'a' for accidental, 'b' for on purpose)? _____

24. In what months do you most commonly catch them by accident or on purpose (Indicate with 'a' for accidental, 'b' for on purpose)? _____

25. In what general location do you catch them, by accident or on purpose (Indicate with 'a' for accidental, 'b' for on purpose)? (Draw on a map and take village name with code)

26. Was this in: open sea over seagrass
 coral reef N/A

27. What kind of fishing gear do you most frequently catch turtles with, accidentally or on purpose? Please specify (Indicate with 'a' for accidental, 'b' for on purpose.):

<i>Net</i>	<i>Basket Trap</i>	<i>Palangre</i>
Mesh size: Total net length: Net width/depth: Floating or anchored:	# Baskets Basket size Length Basket width & depth Trap depth	Hook size: Total line length: Total # hooks: Depth of hooks:
<i>Longlines</i>	<i>Harpoon</i>	<i>Other</i>
Hook size: Number of hooks per line: Line length: Floating or sinking lines:		

28. If you catch one accidentally, what do you do with it? (More than one answer possible)

release it (alive) discard it (dead) kill it and discard it eat it
 sell it other _____ N/A

Why? _____

29. Do you think that you catch (accidentally or on purpose) MORE / LESS / SAME number of turtles as you did when you started fishing? (If SAME or N/A, go to 30)

MORE LESS SAME N/A

Why? _____

When did this change? _____

30. Do you have any feelings about accidentally catching sea turtles?

happy neutral frustrated (damage to gear, loss of time)
 sad shame other (specify) _____ N/A

Explain _____

31. Do you know of any fadys/local stories/myths to do with turtles/consuming turtle meat or eggs?

YES NO N/A

What are they? _____

32. Where do sea turtles nest? (Draw on a map and take village name with code; specify for which species; If N/A, go to question # 35) N/A

33. What time of year do they nest? (specify for which species) _____
_____ N/A

34. Do you think there are MORE / LESS / SAME number of turtles nesting than 20 years ago?
 MORE LESS SAME N/A
Why? _____

35. Do you catch nesting turtles if yes how often? (If answer is "Never", go to question # 37)
 Never Only a few times in my life A few times a year
Once a month Once a week A few times a week Every day
 N/A

36. How many nesting turtles did you catch in the last year? (Record separate answers for each species)
Est. # _____

37. Do you collect turtle eggs if yes how often? (If answer is "Never", go to question # 39)
 Never Only a few times in my life A few times a year
 Once a month Once a week A few times a week Every day
 N/A

38. a. How many turtle nests did you visit in the last year? _____

b. What are the names of the nesting sites? _____

39. Market values (if relevant): What parts and species of sea turtles are eaten / sold? _____

What species are favored for sale and consumption? _____

What is the price for sea turtle (specify quantity and price in Ar or FMG)?
 Meat _____ Eggs _____ Shell _____

40. Do you think sea turtles are threatened by extinction?
 YES NO N/A

41. What do you think are the main threats to sea turtles? _____

42. Is it prohibited to kill a sea turtle or collect their eggs?

YES NO N/A

Other Comments: (Fisher or Interviewer)

Appendix 3: List of Sites (n=14) in which the End of the Line data was collected by C3 in 2009-2010 using the bycatch questionnaire displayed in appendix 2. Shaded rows are those that were present within the turtle nesting survey sites.

Site code	Site (Year)	Region	Number of interviewees
BOK/ADY	Adavagnemboko (2009/2010)	Ambilobe (ABE)	35
AMB	Ambolobozokely	East	44
APD/AMP	Ampasindava (2009/2010)	West	66
ABVY	Ambilobe	Vahilava	4
AMPK	Ampisikina	East	15
ANB	Anbanio	Ambilobe	22
ANT	Antegny/Ampasin' Antegny	Ambilobe	65
ANTS	Antsako	Vahilava	15
HRG	Irohona	West	10
LAL	Lalandaka (Mahajanga)	South	7
NFA	Nosy Faly	South West	32
RAM	Ramena (2009/2010)	East	96
VHA	Vahilava (includes landing sites: Ambalavi(Ambilobe), Antsako, Lalandakana, Vahilava)	Vahilava	28
VOH	Vohemar	South East	126

Appendix 4: Maps displaying the distribution of body pits along the beaches of nesting sites.

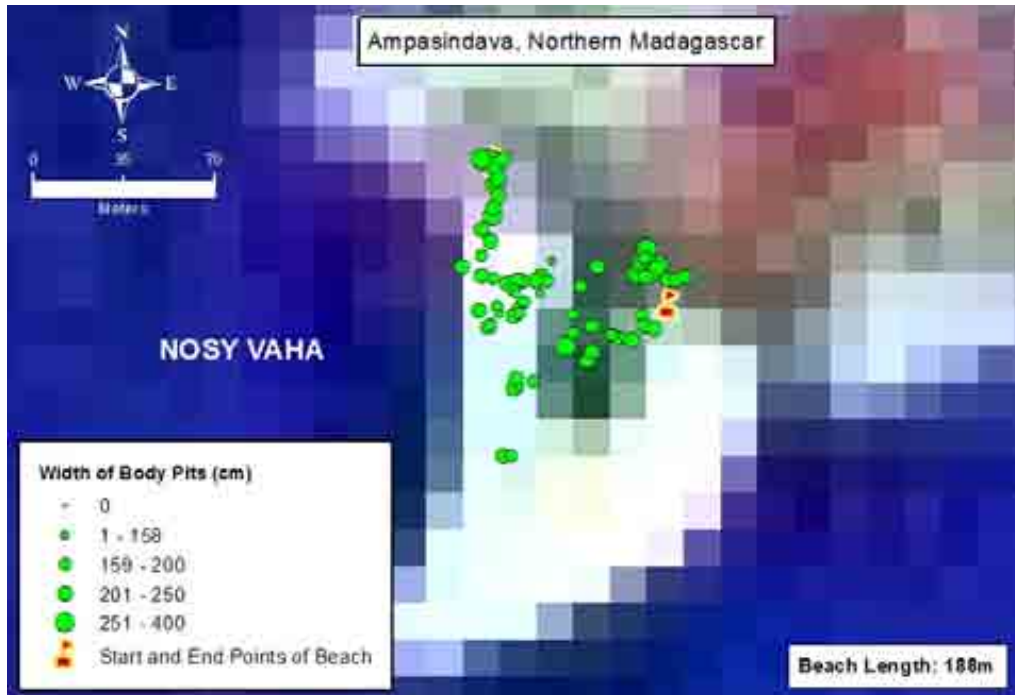


Fig 1. Map showing the distribution of body pits along the beach on Nosy Vaaha.

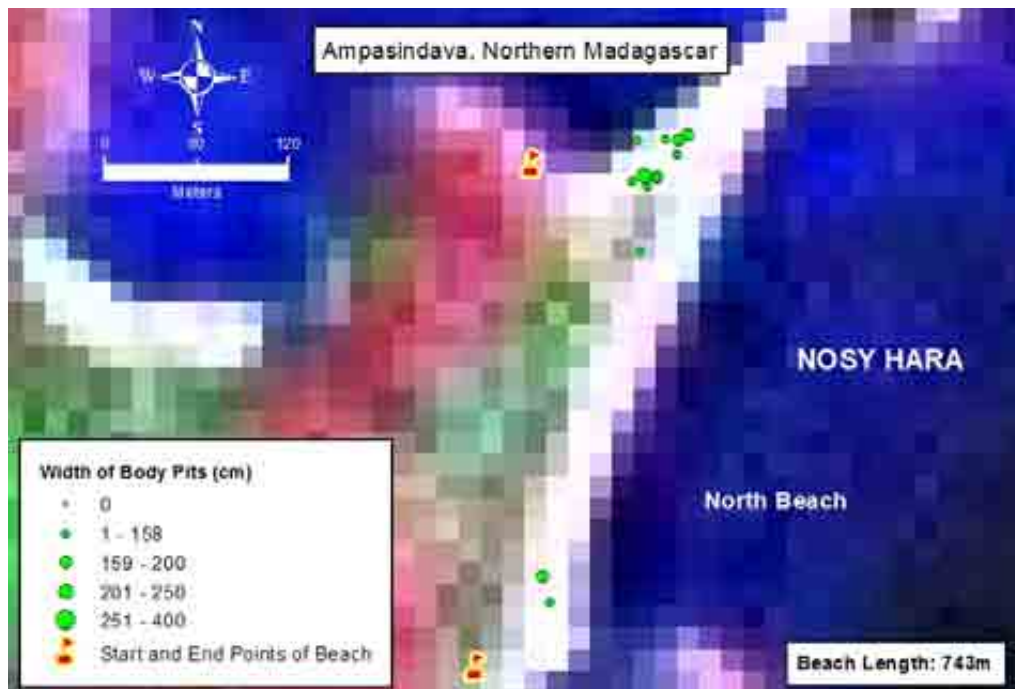


Fig 2. Map showing the distribution of body pits along the north beach on Nosy Hara.

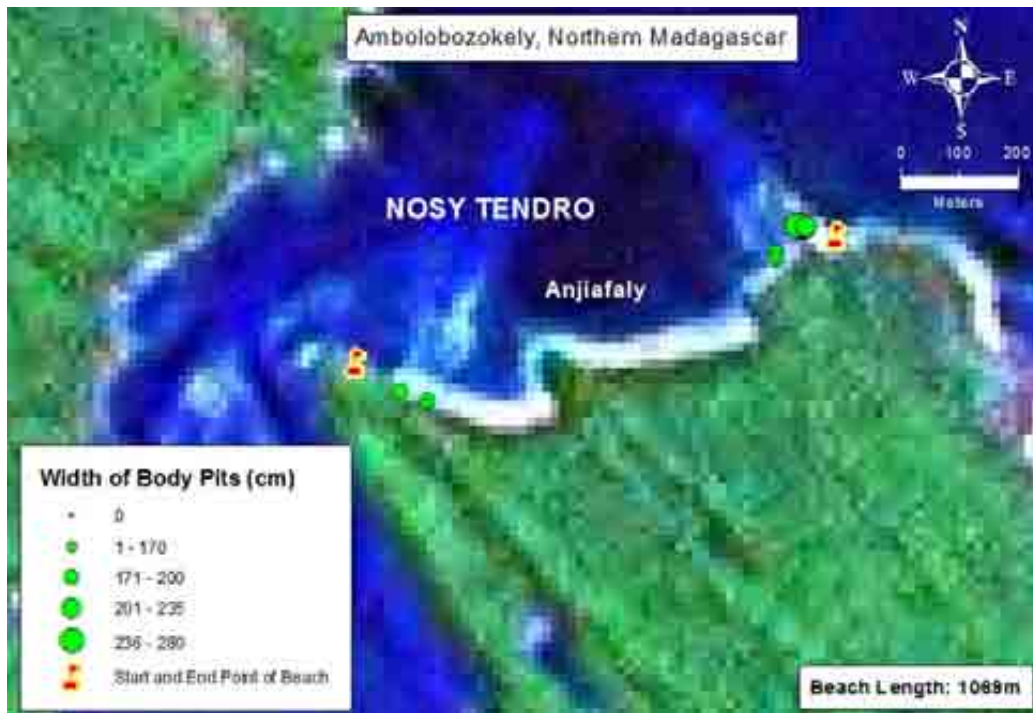


Fig 3. Map displaying the distribution of body pits along the beach Anjiafaly on Nosy Tendro.

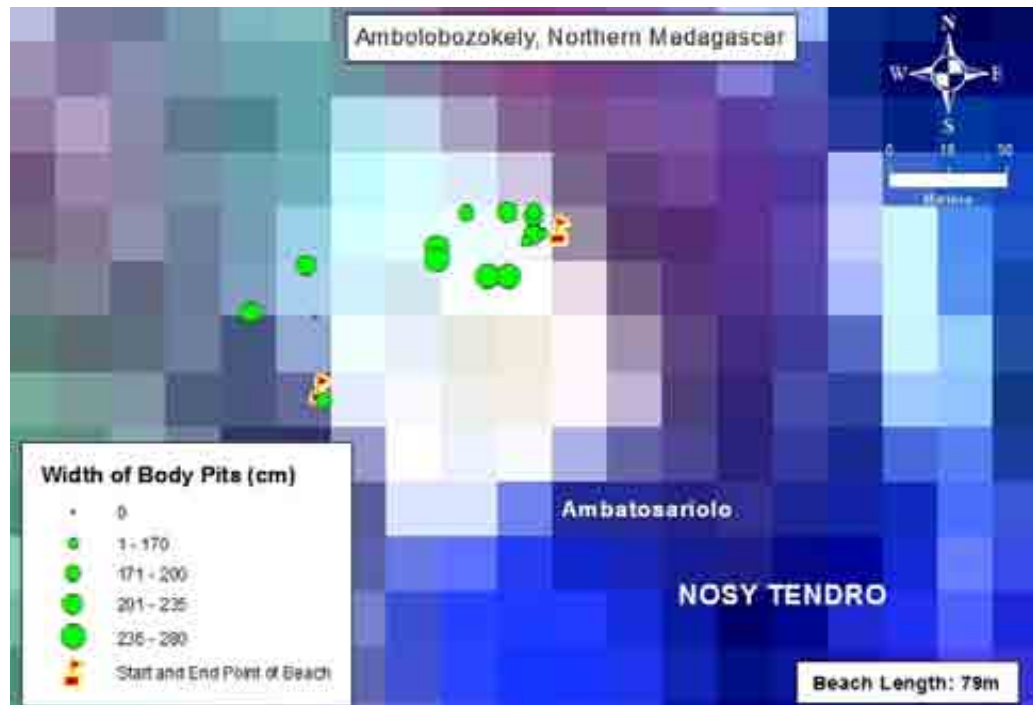


Fig 4. Map showing the distribution of body pits along beach Ambatosariolo on Nosy Tendro.

Appendix 6: Dead turtle carapaces survey sheet

Site name: _____ Location: _____ Survey No: _____

Longitude position: _____ Latitude position: _____

Date: _____ Time: _____

Site description (including vegetation, rocky, sandy): _____

Weather: _____ Temperature: _____ Wind: _____

Beach length (m): _____ Tide (high/low): _____ Sand grain size: _____

Species	Carapace Count	Cause of death*	Signs of damage/missing body parts	Position found in**	Estimate time of death***	CCL	CCW	Comments