

RAPID ASSESSMENT OF DUGONGS AND THEIR SEAGRASS HABITAT IN NORTHERN MADAGASCAR

A REPORT SUBMITTED TO THE CONVENTION ON MIGRATORY SPECIES OF WILD ANIMALS (CMS) SECRETARIAT, ABU DHABI



Community Centred Conservation
C3 Madagascar and Indian Ocean Islands Programme
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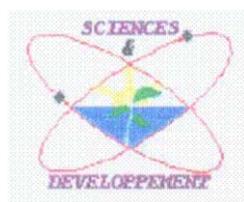
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Edited by Patricia ZR Davis

Community Centred Conservation (C3)

Antsiranana 2010



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EXECUTIVE SUMMARY

This preliminary study, conducted between June and October 2009, represents the first comprehensive survey of the dugong population and its habitat in northern Madagascar. It provided the means for piloting a low-cost, low-tech methodology, previously utilized with success in the Union of the Comoros, and only minor adaptations were necessary for its application in Madagascar, hence the resulting data are comparable.

A total of 80 interviews were conducted with fishers across four landing sites to collate information on dugong observations, threats, knowledge of laws and relevance in local culture. Nearshore seagrass surveys were also conducted in order to ground-truth potential seagrass areas identified using satellite imagery.

Results from the study show that although dugongs were present in large numbers in the past, the population has been in decline, particularly since the 1990s. Deliberate hunting is no longer commonplace, instead accidental capture in gill nets poses the greatest threat to the continuance of the species in the area. The capture and slaughter of dugongs follows ancient traditions and involves various taboos.

Elders showed concern for this threatened resource and they represent not only a valuable and diminishing source of local knowledge but also a means to influence the opinions and behaviour of their communities. Their involvement in future dugong conservation initiatives will be intrinsic to achieving success and consensus amongst fishing communities.

The likelihood of seagrass presence was determined on a broad scale for the whole of northern Madagascar and will be used to prioritize areas for finer scale mapping. This methodology is especially suited to developing countries as it provides a means to rapidly survey large areas at low cost and with limited technical input.

Since completion of this study, the methods have been incorporated into an international standardized survey issued by the UNEP-CMS Secretariat for the MoU on Dugong Conservation. Further research is being conducted until August 2010, extending the area of coverage and providing more data on which to base a conservation management plan for the species.

RÉSUMÉ EXECUTIVE

Cette étude préliminaire, menée de juin à octobre 2009 constitue la première étude complète de la population de dugong et de son habitat dans le nord de Madagascar. Elle a permis de piloter une méthodologie peu coûteuse et demandant peu de support technique. Celle-ci avait été utilisée avec succès au cours d'une étude similaire dans l'Union des Comores. Seules quelques adaptations ont été apportées pour permettre de l'appliquer à Madagascar et de comparer les données.

Un total de 80 entretiens ont été menés auprès de pêcheurs provenant de quatre sites de débarquement afin d'assembler les informations sur les observations du dugong, les menaces et les connaissances des lois et leur pertinence dans la culture locale. Un suivi des herbiers situés à proximité des côtes a également été mené afin de confirmer sur terrain les zones d'herbiers potentielles identifiées à l'aide d'imageries satellites.

Les résultats de cette étude montre que bien que les dugongs aient été nombreux, la population est aujourd'hui en déclin, et ce depuis les années 90. La pêche volontaire n'est aujourd'hui plus très fréquente. En revanche la capture accidentelle dans les filets de pêche constitue la plus grande menace à la pérennité de l'espèce dans la région. La capture et l'abattage de dugongs suivent les traditions ancestrales et incluent de nombreux tabous.

Les anciens sont inquiets pour cette ressource. Ils constituent non seulement une source indispensable de savoir mais aussi un moyen d'influence des opinions et comportements des communautés. Leurs implications dans les initiatives à venir de conservation du dugong seront indispensables pour parvenir à une réussite et un consensus auprès des communautés de pêcheurs.

La probabilité de présence d'herbiers a été déterminée à l'échelle de la totalité de la région nord de Madagascar et sera utilisé pour priorisée les zones pour une cartographie à plus petite échelle. Cette méthodologie est spécifiquement adaptée aux pays en développement puisqu'elle fournit un moyen de suivre rapidement de grandes zones à faibles coûts et avec un apport technique limité.

Depuis l'achèvement de cette étude, les méthodes ont été incorporées au sein d'un questionnaire d'enquête international standardisé délivré par le secrétariat de l'UNEP-CMS pour le MoU sur la Conservation du Dugong. D'autres recherches sont en cours d'exécution depuis le mois d'août 2010, étendant la zone d'étude et fournissant plus de données sur lesquelles nous pourrons nous baser pour l'élaboration d'un plan de gestion de conservation de cette espèce.

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1. INTRODUCTION

The dugong (*Dugong dugon*) is in critical need of conservation intervention (UNEP 2002), particularly in the Western Indian Ocean (WIO) (WWF-EAME 2004). This coastal marine mammal has a low maximum rate of increase of 5 % per year (Boyd et al 1999) and feeds exclusively on seagrass. Populations worldwide have suffered overexploitation primarily due to direct and accidental capture (UNEP 2002). The World Conservation Union lists the dugong's status as vulnerable to extinction on a global scale (Marsh 2008) with an estimated population decline of 20% in the last century (UNEP 2002).

Through the United Nations Environmental Programme (UNEP)'s Convention on Migratory Species of Wild Animals (CMS), an international 'Memorandum for the Conservation of the Dugong and its Habitat' was created in 2007. Although it is a non-binding agreement with voluntary participation, this instrument encourages all signatory range states to develop national Conservation Management Plans for the species' future protection. Few countries within the species' range currently have active management initiatives in place due to a combination of factors including lack of data, technical expertise and political will. This is particularly true for the WIO region, where a severe shortage of information on the species and a lack of financial and human resources have hampered conservation efforts, without which local extinction of the dugong is considered inevitable (UNEP 2002; WWF-EAME 2004).

Madagascar is a case in point, with a huge coastline of over 4000km and globally significant marine biodiversity, yet severely limited technical and financial resources for research and conservation initiatives. Madagascar has been identified as a priority country within the WIO for further research into dugong status, abundance and distribution (UNEP 2002; WWF 2004). The northern and western coasts have been identified as regionally important, but information regarding the species' status and distribution and threats is limited (Cockcroft 1993; Cockcroft and Young 1998; WWF-EAME 2004). By becoming the first signatory state of the CMS Dugong MoU, Madagascar has shown its political commitment to conservation action for this threatened species. Dugongs have

also been protected in Madagascar since 1993 under article 9 of Government Order No. 93-022 covering legislation for fishing and aquaculture which states:

Unless special permission has been granted for scientific or technical experimentation by the Ministry of Fisheries and Aquaculture, it is expressly forbidden to kill, injure or capture marine mammals or other species recognized as endangered.

The next step is to gather sufficient data on the species' status and distribution utilizing low-cost methods, appropriate for a country with limited technical and financial resources (Aragones et al 1997; UNEP 2002) on which to base conservation and management plans. In 2009, Community Centred Conservation (C3) was invited to collaborate with Malagasy partners to initiate much-needed research into dugongs in northern Madagascar with a view to implementing conservation and management actions for the remaining population as soon as feasibly possible.

2. AIM

The aim of this study was to carry out a preliminary assessment of the status, distribution and abundance of dugongs in northern Madagascar by using a rapid assessment methodology already successfully piloted by C3 in the neighbouring nation of the Union of the Comoros.

3. METHODS

3.1 INTERVIEW SURVEYS

Dugong status and distribution in the northwest of Madagascar was investigated using semi-structured interviews of community members (based on Davis and Poonian 2007). A total of four landing sites (at Ramena, Ampasindava, Andavagnemboko and Nosy Faly) were sampled across the Diana (northernmost) province in order to achieve a geographically representative sample, particularly considering the high migration rate of fishers in the area (Philigence Rajesiarinanana, *Service pour la Pêche Maritime de la région de Diana pers comm 2009*; Figure 1).

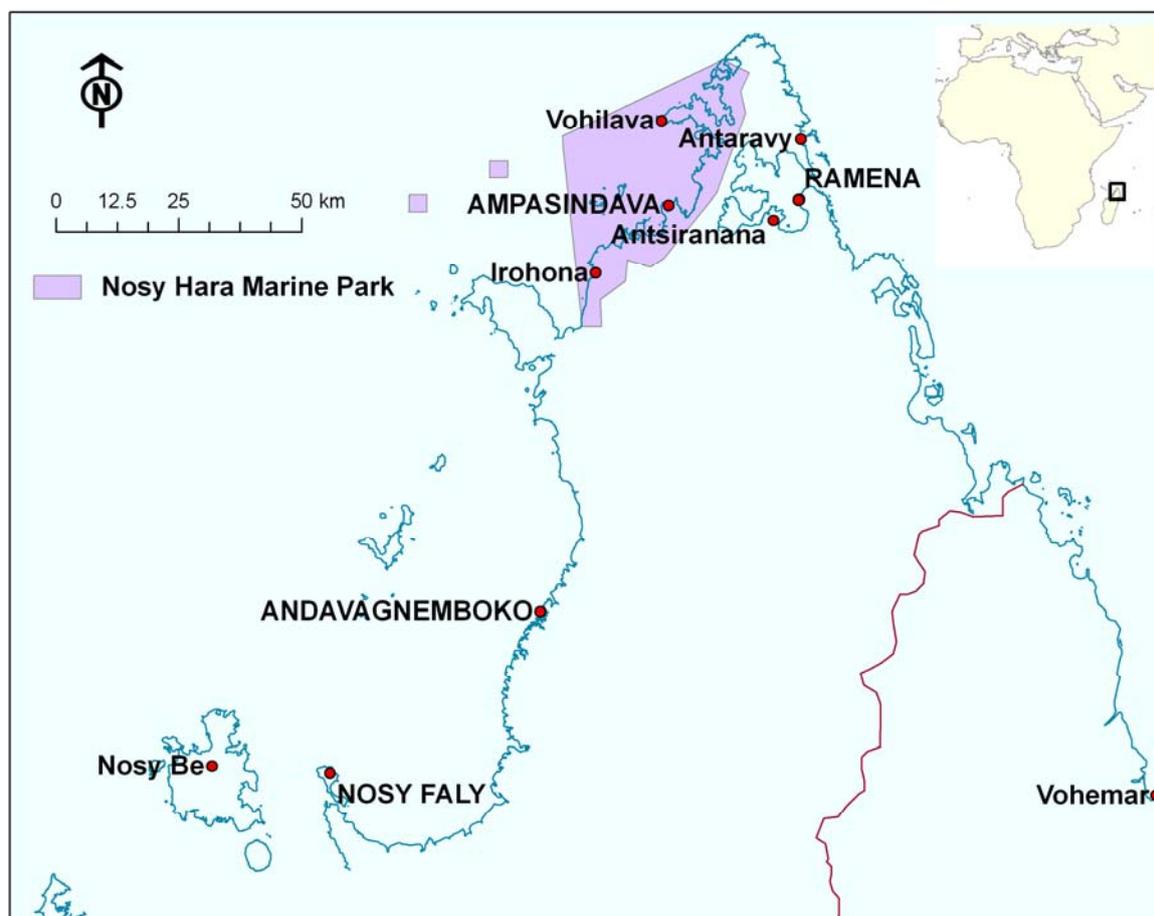


Figure 1. Northern Madagascar showing locations of interview sites: Ramena, Ampasindava, Andavagnemboko and Nosy Faly

Sites were selected based on previous studies in the area that had identified priority areas with high numbers of dugong observations (WWF-EAME 2004) and detailed consultation with local government bodies, Madagascar National Parks (MNP) and *Service pour la Pêche Maritime de la région de Diana*, who identified key regional landing sites.

A total of 80 interviews were conducted between July and August 2009 comprising 74 with community members knowledgeable about the sea (primarily fishers) and six with Key Informants (KIs), regarded by their communities as 'dugong experts' (e.g. senior or experienced fishers / dugong hunters). Graduates from the University of Antsiranana and staff from the *Centre Nationale de la Recherche Oceanographique* (CNRO) conducted interviews in the local Malagasy dialect, *Sakalava*, following training and piloting of the questionnaire.

Interviews were conducted individually in all cases. Interviewees were first shown a picture of the dugong and asked whether they had seen the animal before. If they had, the interview commenced with a few questions to ensure no confusion with dolphins. Such questions related to typical dolphin behaviour, e.g. presence of dorsal fin, breaching behaviour. Once it was ascertained that they were indeed referring to a dugong, interviewees were questioned about the characteristics and incidence of dugong observations, capture, cultural practices, consumption and sale of meat and their level of understanding of the species' status and relevant local and national laws (see Appendix I and II for Fisher Questionnaire in English and Malagasy). Fishers were gathered and selected for interview by local authorities, such as the village chief or council. If the interviewee had not seen dugongs but knew of them they were asked the questions relating to sale and consumption of meat, conservation status and cultural significance. Occasionally, other community members that had seen dugongs (e.g. marine tour operators) were interviewed using the same questionnaire. KIs took part in an open interview to provide wider qualitative information (see Appendix III and IV for KI Interview in English and Malagasy).

3.2 HABITAT MAPPING

Spectral analysis of satellite imagery and aerial photographs was employed to identify the potential location of seagrass habitats throughout the northern region of Madagascar from Nosy Be in the west to Vohemar in the east (Figure 1). Remote sensing as a method for finding seagrass has proven useful in selecting areas of interest for field research (Dahdouh-Guebas et al 1999, Howari et al 2009, Urbanski et al 2009). Seagrass detection is feasible by using Thematic Mapper (TM) band values as a proxy for the presence of seagrasses (Dahdouh-Guebas et al 1999). Three different images of northern Madagascar – Landsat Zulu satellite imagery¹ Landsat natural imagery² and GoogleEarth³ - were analyzed separately and mapped to locate seagrass habitats. Access to colour recognition software was limited for the analysis described here; to compensate, all three different images were superimposed onto one map to assess accuracy of seagrass identification.

Four pilot field sites, Ampasindava, Andovokonko, Antaravy, and Ramena (Figure 1) were visited and the presence of seagrass determined. Mapping was conducted using SeagrassWatch methodology (McKenzie et al 2003). These ground-truthed sites were utilized to infer further potential areas of seagrass habitat using the satellite image analysis described herein. For each, a spectral range (red, green and blue band pixel values with a specified range tolerance) was found which encompassed the four ground-truthed sites where seagrass was known to occur. Using the spectral range, further potential seagrass areas were then selected throughout northern Madagascar. Selected areas were traced by hand and habitats that corresponded in multiple images were identified so that a scale of certainty could be created; seagrass beds that corresponded in all three images were assigned the highest level of certainty, followed by those which corresponded in two images. Areas where water depth was greater than 10m were automatically excluded from the analysis because of the limited depth penetration of the imagery used (Green et al 1996).

¹ LANDSAT ZULU 7 - false colour mosaics compiled from Landsat 7 pansharpened scenes (1999 to 2002). False colour (infrared) enhances detail and identification of vegetation.

² LANDSAT 7 GLOBAL IMAGERY MOSAIC (NATURAL COLOUR - PAN-SHARPENED)

³ GOOGLE EARTH AERIAL PHOTOGRAPHY - DOWNLOADED 7/11/2009

4. RESULTS

4.1 INTERVIEW SURVEYS

4.1.1 Informant description

The majority of informants were fishers, others included Madagascar National Parks (MNP) rangers and tourist guides (Table 1). The age of informants ranged from 19 to 77 and Key Informants (KIs) who provided their ages were between 46 and 75 years old.

Table 1. Description of informant samples from four sites across northern Madagascar.

Site	<i>n</i>	KI (<i>n</i>)	% fishers	Average Age / years \pm SE
Ampasindava	14	2	78.6	45 \pm 3.2
Andavagnemboko	15	0	100	34 \pm 2.0
Nosy Faly	22	1	100	34 \pm 1.6
Ramena	23	3	82.6	40 \pm 2.0
All Sites	74	6	91.0	38 \pm 1.2

4.1.2 Distribution and frequency of observations

The dugong was locally known as *lambohara* or *trozogno*. A total of 147 dugongs were recorded from 89 sightings by 46 informants during a period of 45 years from 1964-2009. Mean group size was 1.7 (SE \pm 0.14) dugongs and 86% of sightings were of lone individuals. Ten percent of informants had seen cow-calf pairs. Dugongs had been observed at a total of 44 sites from Vohemar on the north east coast of Madagascar to the island of Nosy Faly on the north-west coast (Figure 2). Around Nosy Faly, all sightings were between 1980 and 1999 with no recent observations. Observations on the north east coast of the island were also mostly between 1980 and 1999, with just two sightings between the years 2000 and 2009, in the pass of Antsiranana Bay. The majority of animals were observed on seagrass (54%); followed by mud/sand (12.5%), open sea or rocky substrate (7.5%), and reefs (2.5%). The greatest number of observations and the majority of recent sightings (2000-2009) were concentrated around the north-west coast of the region from Irohona to Vohilava and situated within the

Nosy Hara Marine Protected Area (Figure 2). All cow-calf pairs were also observed in this area (between the years of 1978 and 2004) and consistently at the island of Nosy Hara.

The frequency of dugong observations ranged from never to weekly. Only 9% of informants encountered dugongs more than once a year. It was assumed that the likelihood of a chance encounter would increase over time with the observer's age. Therefore the proportion of informants never observing a dugong was investigated with relation to age group. The proportion of informants aged 19-29 never observing a dugong was the same as informants who were 40-49 years of age (50%). Informants aged 50-59 (fishing for three to four decades) were found to have highest incidence of dugong sightings (82%).

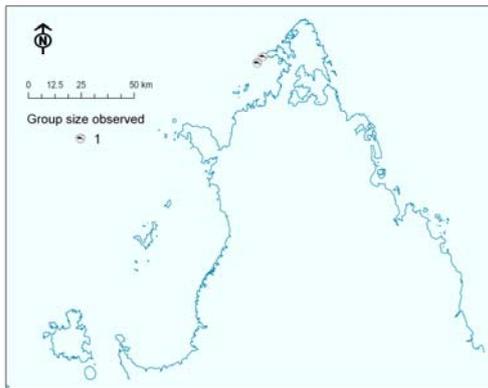
When informants were asked if they had perceived a change in number of dugongs observed and captured over time, 67% of informants responded they thought that there were less dugongs now compared to the past. Nineteen percent of respondents did not perceive a change in dugong numbers observed and captured, 11% believed that numbers were the same and 3% thought there were more.

The perceived decline in dugong abundance was believed to have occurred between 1982 and 2006 with the late 1980s to mid-1990s identified as a period of particularly significant decline. This perception correlates with the trend in dugong observations because the least number of dugong observations were recorded in the 1990s. Over half (54%) of all sightings related to dead (rather than live) dugongs. Reasons given by fishers for the decrease in dugong sightings in recent years included:

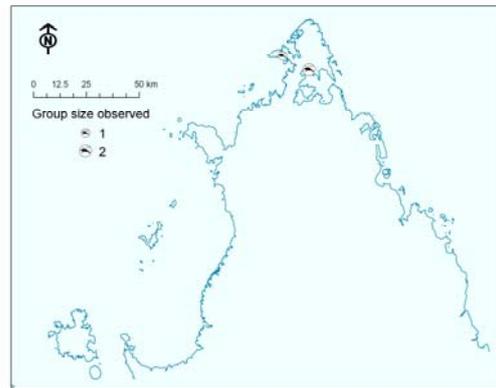
- dugong numbers could be decreasing (47%);
- dugongs had moved elsewhere due to increased boat traffic (13%);
- dugongs produce few young and therefore could not replenish their numbers (13%);
- capture rates have reduced numbers (7%).

Key Informants all noted a decline in dugong numbers and attributed this to past hunting, the increase in motorized craft and migration to new feeding areas.

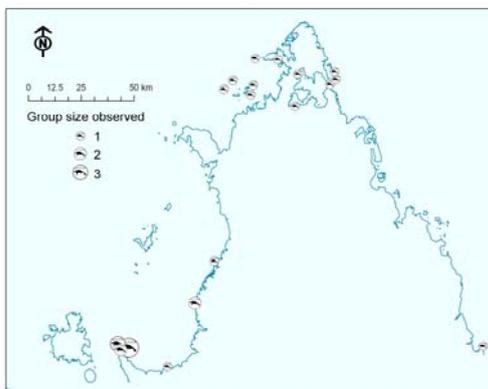
(i) 1960s



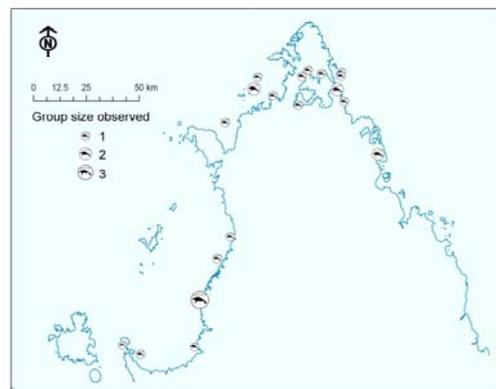
(ii) 1970s



(iii) 1980s



(iv) 1990s



(v) 2000s

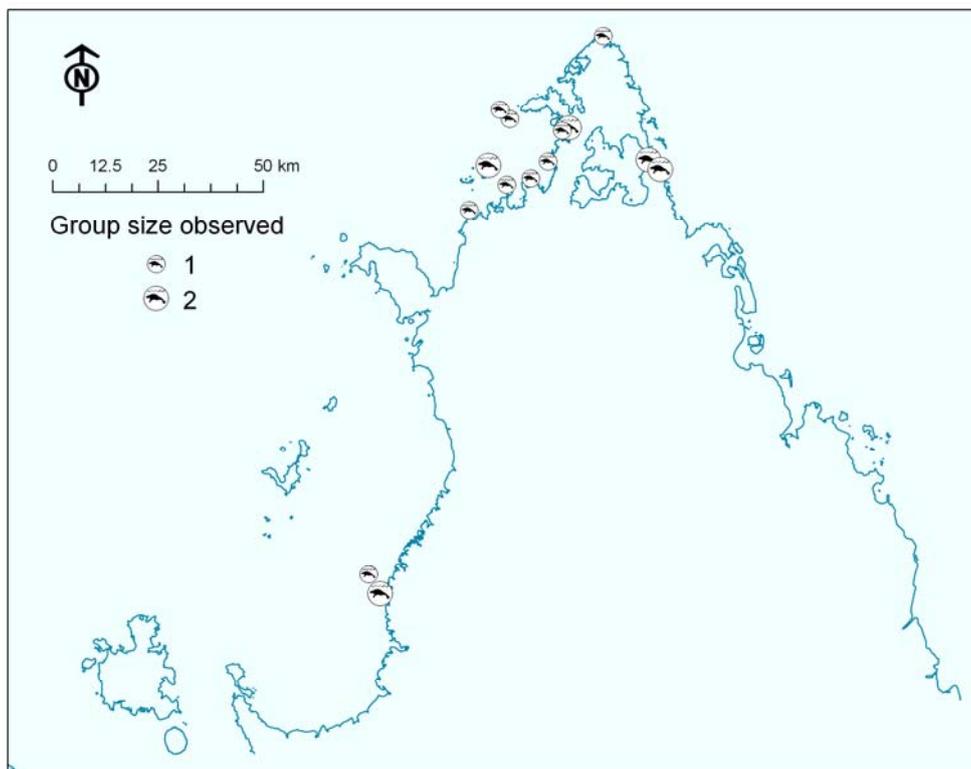


Figure 2. Sightings of dugongs according to decade

4.1.3 Deliberate and incidental capture

When asked how often they captured dugongs, either deliberately or incidentally, the majority of informants (73.9% $n=62$), responded 'never'. Twenty-six percent of fishers reported dugong captures, the frequency of which ranged between once or twice in their lifetime to a few times a week. However, the circumstances of capture were ambiguous with fishers not specifying if capture had been deliberate or incidental. The fate of the majority of captured dugongs was reported to be direct consumption or sale at market and five informants claimed that they would release the animal if they found it alive. The mortality of captured dugongs was 80%. Where a gear was identified for the capture, gill nets, the preferred fishing gear of the majority of fishers (74%) from these landing sites (C3 unpublished data), were used in all cases.



Preparing the nets for a fishing trip

Key Informants provided insight into ancient capture methods. Traditionally, dugongs were captured using the *valkira* method where 'bamboo-structures' were set in the water to create a disturbance which caused dugongs to move out towards open water. The animal would then be pursued by boat until they became distressed and fatigued, which facilitated capture. A similar method was applied using a harpoon (*samandra*, *ranjo* and *famono hosatra*), often equipped with a wooden float so that the speared dugong could be pursued and asphyxiated once fatigued. These methods were generally reported as

outdated, although a harpoon may still be kept on board for this purpose according to two KIs. The proportion of fishers from these four landing sites still using a harpoon is estimated to be 6% (C3 unpublished data).

According to the reports from KIs, contemporary methods for intentional capture are conducted from a 6-8m motorized dugout canoe (*piroque*) using gill nets (*ragaridy jarifa, zedazedada*), typically with a mesh size 3-7 fingers, 3-7m in height and anywhere from 100-900m long, usually used to target large fish. These nets are also thought to be the primary cause of incidental captures. Six men are required to capture a dugong, four to manipulate the net and two to manage the boat. This is also to ensure compliance with *fady*, local taboo, which requires six men from different families to confirm that sexual intercourse has not taken place with the animal. The dugong is encircled with the net and the fishers create noise to cause the animal to panic and become entangled in the net and asphyxiated.

The number of dugong experts (defined here as fishers who were skilled in hunting dugongs and had therefore regularly targeted them in the past) estimated for each community varied greatly between sites. Key Informants in Ramena reported the highest number of experts, with almost all fishers in the village believed to have captured dugongs at some time (including incidental captures, not just deliberate hunting). At Ampasindava, estimates of between 10 and 50 dugong experts were mentioned, with a list of names provided in one case. In contrast, at Nosy Faly, only four were thought to exist. Key Informants claimed to have killed between 10 and 200 dugongs during their lifetime with five of them capturing dugongs when they encountered them on a normal fishing excursion and one (who caught 200) targeting dugongs exclusively.

4.1.4 Consumption and sale of meat

In general, informants stated that dugong meat was sold in 10 x 20 cm strips priced in Malagasy Francs (MGF) per kilogram. The price of meat has varied considerably over time (Table 2). The majority (77 %) of informants admitted eating dugong meat. Consumption was estimated to be greatest in the 1990s with 48% of all informants consuming meat within that decade. After 2000

consumption was lowest with only 17% of informants eating dugong meat and a peak in price (Table 2).

Table 2. Change in market value of dugong meat over time (currently 1 USD = 10,825 MGF)

Decade	Mean price of dugong meat / MGF kg ⁻¹ ± SE
1980s	11,187 ± 4,264
1990s	13,486 ± 3,930
2000 +	40,625 ± 16,719

4.1.5 Knowledge of current status and laws

The majority of informants knew that dugongs were endangered (63%) and protected by law (67%). However, over 30% of respondents were still unaware of the current status and protection in Madagascar answering either that dugongs were not endangered and/or protected or that they didn't know.

Key Informants all mentioned a decline in dugong numbers since they started hunting and in general they were aware of legislation protecting dugongs; in one case a respondent had stopped hunting since the establishment of the Madagascar National Parks office in his village.

All KIs noted the need for conservation efforts and some had been actively involved through (i) community lobbying for Marine Park creation based on the general degradation of marine resources (ii) not teaching their children to hunt dugongs in recognition there were few left. Suggestions given for protection measures included teaching fishers that dugongs caught accidentally should be immediately released, banning gill nets with large mesh size and raising awareness amongst the younger generation.

4.1.6 Taboos relating to dugong capture and consumption

The majority of informants (74%) had knowledge of at least one *fady*, or taboo, associated with dugong capture and slaughter. Of all the *fady* regarding dugongs, most related to the methods of capture, slaughter and consumption of

the animal. Only a few informants described taboos prohibiting the capture of dugongs; for example, it is taboo for certain cultural groups, such as the *Vezo* tribes of southern Madagascar to capture or kill dugongs.

Many *fady* were associated with the sex organs of dugongs. It was a widespread belief that fishermen who have captured a dugong must swear that they have not had intercourse with it. At all times following capture, including during the slaughter, the genitals, teats and head must be covered from the general public, particularly women and children, to prevent discussion about the event. It is particularly *fady* to allow pregnant women in the village any knowledge of the event of capture and slaughter. The head of the dugong must be covered specifically with a white veil at all times.

The slaughter must take place in a quiet and private location, the act of slaughter requires a specialist associated with a specific ethnic group. The specialist will usually have to travel a long distance to carry out the act until which time the dugong remains covered in the village. The event must be respectful and the specialist may lead in a song before slaughter takes place. Slaughter requires tools such as the *mesobe*, a large knife usually 0.5 - 1m long, an axe and a small knife called a *kanife*. The head of the animal must be removed before quartering. The stomach must not be opened so the dugong is cut from the side. During the slaughter certain body parts may not be in contact with the blade, such as the intestines, sex organs and heart. It is *fady* to remove the bones from the place in which the animal is killed and if eating any parts containing bones then the person consuming the meat must remain there also. If any taboo involved in the capture and slaughter are disregarded then it is believed whoever flouted the *fady* will suffer from a stomach ache or illness.

Five out of the six KIs mentioned these same *fady*. It was also mentioned that bones must be discarded in the sea after consumption; that eating meat from around the navel and ears was prohibited as it would make the consumer sick or deaf respectively and that talking nonsense around the carcass (especially commenting about sex) would make you sick. Four out of the six KIs mentioned that oil collected by boiling the dugong's head was used for curing ear infections and one mentioned that the ground bones could relieve stomach ailments.

4.2 HABITAT MAPPING

The map produced from the ground-truthed imagery (Figure 3) displays potential areas of seagrass in northern Madagascar and provides a general guide for areas of interest for field seagrass surveys; verification of the identification of seagrass habitats will be feasible through ground-truthing and mapping of seagrass beds in the field (Borg et al 2009). During ground-truthing surveys, the following eight species of seagrass were recorded:

- *Thalassia hemprichii*
- *Cymodocea rotundata*,
- *Cymodocea serrulata*
- *Halodule uninervis*,
- *Halodule wrightii*
- *Syringodium isoetifolium*
- *Halophila ovalis*
- *Zostera capensis*

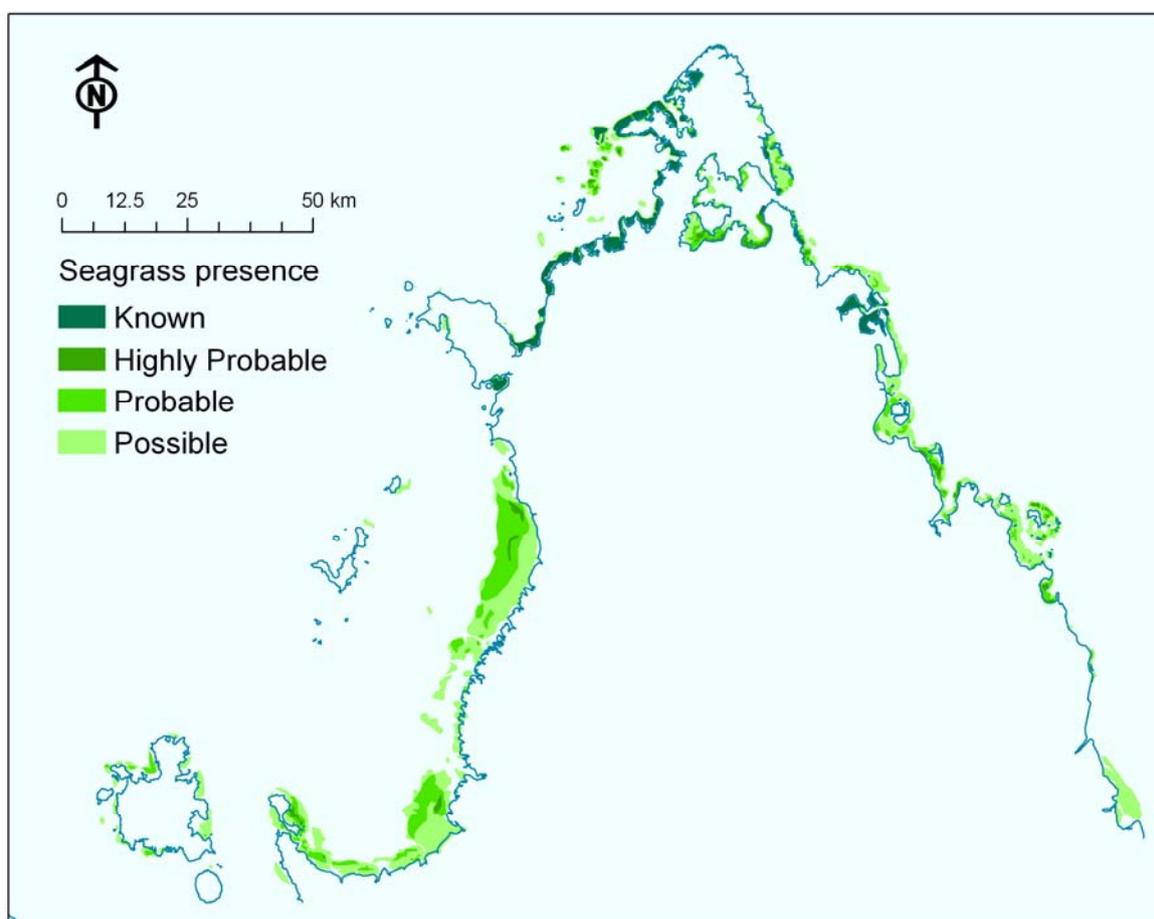


Figure 3. Potential locations of seagrass habitat in northern Madagascar showing degree of certainty

Pixel-based classification has certain limitations in the resolution of seagrass habitat area maps. The spatial resolution of the satellite imagery used for the analysis described above is relatively coarse in comparison with habitat size; thus, mixed pixels within the image can be potential cause for inaccuracies in habitat identification (Mumby & Edwards 2002). More in-depth analysis using images of a higher resolution may provide more accurate identification of locations and percentage cover of seagrass species and further ground-truthing (to be carried out between January and May 2010) will help to refine current maps.



Seagrass mapping using SeagrassWatch protocol

5. DISCUSSION

This study has revealed that a population of dugongs still persists in the northern region of Madagascar and, encouragingly, most cows and calves have been sighted within the protected Nosy Hara Marine Park. However, heavy hunting, particularly in the 1980s has led to a perceived decline in the population despite current high levels of awareness of their endangered and protected status. The prevalence and popularity of gill nets throughout the region is accountable for the overwhelming majority of dugong mortalities and continues to pose a real threat to the remaining population.

In poor coastal communities where people's access to red meat is extremely limited, the capture, whether deliberate or incidental, of these marine mammals usually results in consumption and sometimes sale of their meat. A steep drop off in encounters with dugongs in the 1990s, relatively high consumption levels in the 1980s and 1990s in tandem with a steep increase in the price of dugong meat since 2000, is indicative of a declining population. Although many fishers were aware of legislation prohibiting the capture of dugongs, and claimed this is an effective deterrent to hunting, it did not affect the price in dugong meat as prices continued to be low throughout the 1990s, perhaps as it had not yet become such a rare commodity at that stage.

There was a general consensus amongst fishers that dugongs have declined through past intensive hunting in conjunction with the proliferation of motorized vessels which frighten them away from their usual nearshore feeding areas. Many simply believed that dugongs have moved away to other areas in search of food or to escape boat traffic. Dugong experts in most communities were no longer actively engaged in seeking out dugongs for a living due to their increasing rarity although in key communities, such as Ramena, a relatively large number of these fishers were found to still exist and future research efforts and awareness campaigns should target such villages in order to make headway in preserving the species.

The significant difference in numbers of dugong experts across the survey sites creates heterogeneity in hunting pressure across the region and could be reflective of geographical distribution of the dugong population itself and its habitat. Limited ground-truthing at Ramena was possible during the study due to poor visibility and weather conditions so further surveys will be required to ascertain if dugong food resources are more abundant in this area. More research is also required to determine the reasons behind the variations in hunting intensity across communities, which could also have pertinent socio-cultural drivers. With more than a quarter of respondents having personally caught one or more dugongs in their lifetime, usually accidentally, and more than three-quarters having consumed dugong meat (half of these within the 1990s) the dugong, despite being on the decline, was relatively common twenty years ago.

Fady or local taboos relating to dugongs are widespread and continue to be respected. The apparent presence of *fady* banning the killing and consumption of dugongs in some communities on the east coast (Joamanana pers comm December 2009) will be explored during fieldwork from January to May 2010. The strong adherence to *fady* relating to hunting wildlife have the potential to positively impact populations of endangered species, particularly when relating to community-wide prohibition of hunting and consumption. As with other species, Malagasy culture dictates respect and adherence to a suite of rules regarding the killing and preparation of meat. The dugong's body is thought to closely resemble the human form and associated legends and taboos have evolved to protect against sexual transgressions. The secretive nature of slaughter and in particular the attempt to protect women and children from witnessing the act could indicate emotive responses within the community which could be levered in gathering support for protection measures.

The concern and knowledge amongst older fishers, many who have benefited from hunting dugongs when they were once more abundant, should not be ignored or underestimated as these men may be pivotal in helping introduce conservation measures within their own communities. The unequivocal respect held by all Malagasy people for both elders and ancestors is deep rooted and continues to be a guiding force in daily life today. By conservationists engaging

with these elders, positive and sustainable steps forward may be taken to reducing mortality of dugongs caught accidentally and in introducing community-run protected areas. Their opinions and guidance will be respected and any measures they propose adopted by the community as a whole.

By extending the study area to further sites across northern Madagascar results will be used to create a set of priority dugong protection areas which can be the focus of future state and community-driven conservation and management initiatives. Concurrent bycatch surveys are yielding more detailed information about accidental catch of not only dugongs but also sea turtles, dolphins and sharks in artisanal fisheries throughout the region and can be incorporated into the creation of a 'risk' map. Once results are analysed in August 2010, findings and recommendations will be presented to key stakeholders as part of the longer-term aim to implement tangible actions for conserving this threatened population throughout northern Madagascar.

6. REFERENCES

Aragones LV, Jefferson TA and Marsh H (1997) MARINE MAMMAL SURVEY TECHNIQUES APPLICABLE IN DEVELOPING COUNTRIES. *Asian Marine Biology* 14 (1997): 15-39

Borg JA, Rowden AA, Attrill MJ, Schembri PJ and Jones M B (2009) OCCURRENCE AND DISTRIBUTION OF DIFFERENT BED TYPES OF SEAGRASS *POSIDONIA OCEANICA* AROUND THE MALTESE ISLANDS. *MEDITERRANEAN MARINE SCIENCE* 10(2):45-61

Boyd IL, Lockyer C and Marsh H (1999) REPRODUCTION IN MARINE MAMMALS. In: Reynolds JE III and Rommel SA (eds) *Biology of Marine Mammals*. Smithsonian Institution, Washington p 218 -286

Cockcroft VG (1993) A PRELIMINARY ASSESSMENT OF THE STATUS OF MADAGASCAR COASTAL RESOURCES, WITH SPECIAL REFERENCE TO MARINE MAMMALS AND REPTILES. Final report for United Nations Environment Programme. South African Department of Foreign Affairs and African Wildlife. Dec 1993 16pp

Cockcroft VG and Young DD (1998) AN INVESTIGATION OF THE STATUS OF COASTAL MARINE RESOURCES ALONG THE WEST COAST OF MADAGASCAR. Mission report to WWF, unpublished. 58pp

Dahdouh-Guebasl F, Coppejans E and Van Speybroeck D (1999) REMOTE SENSING AND ZONATION OF SEAGRASSES AND ALGAE ALONG THE KENYAN COAST. *Hydrobiologia* 400:63-73

Davis PZR and Poonian CNS (2007) INCIDENTAL CAPTURE OF THE DUGONG, DUGONG DUGON, IN GILLNETS, MOHELI, UNION OF COMOROS. In Kiska J, Muir C (Eds) 1st Regional Workshop on Incidental Catches of Non-targeted Marine Species in the Western Indian Ocean, Workshop proceeding. 13-15th November 2006, Mayotte, France

Green EP, Mumby PJ , Edwards AJ and Clark CD (1996) A REVIEW OF REMOTE SENSING FOR THE ASSESSMENT AND MANAGEMENT OF TROPICAL COASTAL RESOURCES. *Coastal Management*, 24: 1-40

Howari MF, Jordan BR, Bouhouche N and Wyllie-Echeverria S (2009) FIELD AND REMOTE-SENSING ASSESSMENT OF MANGROVE FORESTS AND SEAGRASS BEDS IN THE NORTHWESTERN PART OF THE UNITED ARAB EMIRATES. *Journal of Coastal Research* 25(1):48-56

Marsh H (2008) DUGONG DUGON. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <www.iucnredlist.org>. Downloaded on 10 June 2010

McKenzie, LJ, Campbell, SJ and Roder, CA (2003) SEAGRASS-WATCH: MANUAL FOR MAPPING & MONITORING SEAGRASS RESOURCES BY COMMUNITY (CITIZEN) VOLUNTEERS. 2nd Edition. (QFS, NFC, Cairns) 100pp

Mumby P and Edwards A (2002) MAPPING MARINE ENVIRONMENTS WITH IKONOS IMAGERY: ENHANCED SPATIAL RESOLUTION CAN DELIVER GREATER THEMATIC ACCURACY. *Remote Sensing of Environment*. 82:248-25

UNEP (2002) DUGONG: STATUS REPORT AND ACTION PLANS FOR COUNTRIES AND TERRITORIES. UNEP : Early Warning and Assessment Report Series, Townsville, 162pp

Urbanski, J A, Mazur, A and Janas, U (2009) OBJECT-ORIENTED CLASSIFICATION OF QUICKBIRD DATA FOR MAPPING SEAGRASS SPATIAL STRUCTURE. *Oceanological and Hydrobiological Studies*. 38(1):27-43

WWF Eastern African Marine Ecoregion Programme (2004) TOWARDS A WESTERN INDIAN OCEAN DUGONG CONSERVATION STRATEGY: THE STATUS OF DUGONGS IN THE WESTERN INDIAN OCEAN REGION AND PRIORITY CONSERVATION ACTIONS. Dar es Salaam, Tanzania: WWF. 68pp

APPENDICES

- I. FISHER QUESTIONNAIRE (ENGLISH) 3pp**
- II. FISHER QUESTIONNAIRE (MALAGASY) 3pp**
- III. KI QUESTIONNAIRE (ENGLISH) 8pp**
- IV. KI QUESTIONNAIRE (MALAGASY) 8pp**



DUGONG QUESTIONNAIRE

FORM #

Fisher information

Date	Landing site	Interviewer
Age	Occupation	Name (optional)

Make sure you've shown the interviewee a photo of the dugong and that they have seen a dugong in the past.

1. How often do you observe dugongs? (If never skip to #10)

- | | | | |
|---|--|---|--|
| <input type="checkbox"/> Never | <input type="checkbox"/> Once in my life | <input type="checkbox"/> A few times in my life | <input type="checkbox"/> Less than once a year |
| <input type="checkbox"/> A few times a year | <input type="checkbox"/> Once a month | <input type="checkbox"/> A few times a month | <input type="checkbox"/> Once a week |
| <input type="checkbox"/> A few times a week | <input type="checkbox"/> Every day | <input type="checkbox"/> N/A | |

2. In which area(s) have you seen dugongs? – (indicate each site on the map with the corresponding form # and specify the exact name of the beach, the bay or the nearest village for each locality)

Site	# individuals	Habitat	Size	Number of times	Day / Night	Year	Month	Dead /Alive	Cause

Habitat types: seagrass / mangrove / reef edge / open sea ; Size: small (<1m) /medium (1<m<2m) / large (>2m); Cause : eg. net / N/A

3. What were you doing at the time of observation or at the time of accidental/deliberate capture?

- | | | | |
|----------------------------------|---|--|------------------------------|
| <input type="checkbox"/> Fishing | <input type="checkbox"/> Saw from the coast | <input type="checkbox"/> Other (specify) | <input type="checkbox"/> N/A |
|----------------------------------|---|--|------------------------------|

If fishing were you fishing by:

- | | | | |
|----------------------------------|--|-------------------------------|------------------------------|
| <input type="checkbox"/> Pirogue | <input type="checkbox"/> Vedette (motorized craft) | <input type="checkbox"/> Foot | <input type="checkbox"/> N/A |
|----------------------------------|--|-------------------------------|------------------------------|

4. How often do you catch dugongs by accident or on purpose?

- Never Once in my life A few times in my life Less than once a year
 A few times a year A few times a month Once a month Once a week
 A few times a week Every day N/A

Site (Draw on map)	# individuals	Habitat	Size	Number of times	Day / Night	Year	Month	Dead / Alive	Cause

Habitat types: seagrass / mangrove / reef edge / open sea ; Size: small (<1m) /medium (1<m<2m) / large (>2m); Cause : eg. net / N/A

5. Do you observe or catch MORE / SAME / LESS dugongs since you started fishing?

- MORE SAME LESS NEVER N/A

If more or less, when did this change? (decades) _____

Why do you think this is? _____

6. The dugongs you have observed or captured were they: In groups In pairs Alone N/A

If in group, how many individuals? _____

7. Have you even observed a female and her calf? YES NO N/A

If yes: Date _____ Site _____

8. At what time of day/night do you observe or capture the most dugongs? _____ N/A

9. If you catch a dugong, what do you do with it?

- Eat Sell Release it (alive) Discard (already dead) Kill and discard

other (specify) N/A

10. How many fishermen hunt Dugong in the village?

11. Market value (if relevant): What parts of the dugong are eaten/sold? _____

How is the dugong sold? _____

What is the price per unit for dugong meat? (specify the unit and the amount in Ar or FMG) _____

12. Have you ever eaten dugong meat? YES NO N/A

If yes: Date _____

13. Do you know of another name for dugongs? _____

14. Do you know if there are MORE / LESS / SAME number of dugong now compared to when you started fishing?

MORE LESS SAME N/A

Why? _____

15. Are dugongs endangered? YES NO N/A

16. Are dugongs protected by law? YES NO N/A

17. Are there any fadys about dugongs? YES NO N/A

What are they? (Specify village) _____

18. Do you know any stories about dugongs? _____

IF INTERVIEWEE HAS CAPTURED DUGONGS, DO A KEY INFORMANT INTERVIEW



FANADIHADIANA MIKASIKA LAMBOHARA

FICHE

Mombamomba ireo mpamintana

Daty	Fonenana	Mpanadihady
Taona	Asa atao	Anarana (isankarazany)

Fahazoana antoka tsara mpamintana iray mba ahafantatra tsara mombamomba ilay lambohara sady efa nahita izany lambohara izany

1. Impiry nahita lambohara anareo tatotato ? (raha tsiaro mandeha amin'ny # 10)

- Tsiaro indraiky taminy fiainako Indrakindraiky fo taminy fiainako Ambanin'ny indraiky isantaona
 Indrakindraiky isaka taona Indraiky isaka fanjava Matetiky isaka fanjava Indraiky isaka herinandro
 Matetiky isaka herinandro Isanandra N/A

2. Aiza avy ireo faritra efa nahitanao lambohara ? – (Indiquer chaque site d'observation sur la carte avec le # de fiche correspondant et préciser le nom exact de la plage ou du village le plus proche pour chaque localité)

Toerana	Isany (# individus)	« Habitat »	Alavany	Impirynahina hita	Alinfa sa matsagna	Taona	Fanjava	Maty sa velona	Antony

Karazany tany ipetrahanany: Ahitry andranomasina / Honko / Ivelany riva / Any aminy lalina ; Karazany alavany: Fohy (<1m) / erany na antonony (1<m<2m) / Lava (>2m);
 Antony : eg. Harato / Tsy haiko

9. Izy koa mahazo lambohara anareo, atao ino ?

- Ahanina Alafo Avela (velona) Ariana (maty) Vonena sady ariagna
 Hafa (omeo) Tsy hay

10. Firy ny isany mpamintana mangala lambohara eto amin'ny tanana eto? _____

11. Ny vidiny (si *pertinent*): Aia eo aminy tenany no azo alafo na mety ahanina? _____

Magnano akory fandafosana lambohara ? _____

Ohatrinona no vidiny nofiny isaka lanjany (omeo aminy Ar na FMG) ? _____

12. Efa nihinana lambohara va anareo ? ENY TSIA TSY HAY

Raha eny: Daty _____

13. Misy anarana hafa ahaizanareo lambohara ? _____

14. Rango anareo namintana, araka ny fahaizanareo, nihegny/nihamaro/mira ny isan'ny lambohara?

- MARO VITSY MIRA TSY HAY

Naninona? _____

15. Mihalany taranaka moa ireo lambohara ireo ? ENY TSIA TSY HAY

16. Arovana moa ireo lambohara ireo ? ENY TSIA TSY HAY

17. Misy fady ve miaraka aminy lambohara ? ENY TSIA TSY HAY

Ino avy izy ireo ? (*ambarao amin'ny tanana dia ireo fady ireo*) _____

18. Mahafantatra ny tantara mikasiky lambohara va anareo ? _____

Izikoa ilay mpamintagna efa nahatratra lambohara, ampaminoa Key informant interview.

Awareness

LEAD QUESTION

Have you noticed a change in their abundance? _____

PROBES

Do you think there are more or less as there were 30 years ago?

LEAD QUESTION

Do you know if dugongs are protected by law? _____

PROBES

- Who enforces their protection?
- Are they protected in any other way?
- Do you know of any local groups that are helping to protect dugongs?
- Do you think their protection is working?

LEAD QUESTION

Dugongs were hunted in Tanzania and Comoros and have now disappeared. What could we do in Madagascar to stop them from disappearing? _____

PROBES

- Would you suggest any alternative methods of fishing that would not affect dugongs and their habitat or fishermen livelihoods?
- What can other stakeholders do to stop their disappearance?
- Who do you think is responsible for their conservation?

Awareness

LEAD QUESTION

Moa ve nahatsapa fa misy fiovagna aminy hamaroandreo ? _____

PROBES

☞ Moa ve nitombo sa nihengny ny amaroany izikoa hioarigny aminy 30 taona lasa ?

LEAD QUESTION

Moa ve misy lalagna miharo lambohara _____

PROBES

- ☞ Azovy miantoko ny fiarovagna lambohara?
- ☞ Moa ve misy fomba hafa entinaro miharo lambohara?
- ☞ Moa ve misy olo na Association magnampy aminy fiarovagna lambohara?
- ☞ Haraka hevitrinao mandeha tsara io fiarovagna lambohara io sa tsia ?
