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Madagascar Working Paper No 4

DECLARATION

THE STRATEGIC PLAN FOR THE MANAGEMENT OF THE COASTAL ZONE OF THE MASOALA PENINSULA, MADAGASCAR is a working document. It provides broad guidelines for the writing of specific management plans for the different coastal resources in the region. These plans need to be written as soon as agreement has been reached between all interested and affected parties on the general direction that will be taken in the sustainable development of the coastal zone. The study of coastal resource use on the Masoala Peninsula is an ongoing and growing component of conservation and development initiatives in the region. The authors would very much appreciate comments and suggestions.

Francois J Odendaal Marcel Kroese Jaomanana

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Cape Town, South Africa

The Strategic Plan for the Management of the Coastal Zone of the Masoala Peninsula, Madagascar

by

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Sambatra atsika Masoala; toerana malalaka, rivotra sy rano madio, ny raha hoaniny mbola azahoana malaka. Ka tokony iarahan-tsikc miaro, mikarakara ianinstika mba ho lovan-taranaka ny hatsarany...

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EXECUTIVE SUMMARY

The inhabitants of the Masoala Peninsula rely heavily on marine organisms as a source of both income and protein. Unfortunately the coastal resources are exhibiting signs of over-exploitation as a result of increasing pressure from an ever-growing number of resource users. Unless meaningful steps are taken in the near future, there will be further degradation and possibly the eventual collapse of the resource base. In such an event, the cost, for both the human population and the environment will be large.

Coastal zones are the meeting places of the oceans and the land. These complex environments contain a variety of resources that are functionally interrelated. When properly managed these resources can bestow substantial benefits on the human inhabitants of the coastal zone, and the positive effects can extend far beyond the region's borders. However, the management of coastal zones is never easy. This is a result of the large number of resources that are involved, the interdependencies between them, and the powerful human forces that are exerted on them.

The purpose of this report is to provide a strategic plan for the management of the coastal resources of the Masoala Peninsula. The essence of the plan is to declare the entire coastal zone of the Masoala Peninsula a Marine Protected Area (MPA) that consists of three components parts:

- Three marine reserves that will form the core of the MPA. These reserves will not only help protect the region's coastal biodiversity, but their presence will benefit the fishing industry because they have the potential to function as nursery areas from which the waters around them may be

restocked. They will convey additional benefits and opportunities to the local population through the development of responsible ecotourism.

- The Baie d'Antongil Marine Sanctuary where marine mammals and reptiles will enjoy the protection that they need for their survival which and are not afforded to them elsewhere in Madagascar. There are however also other advantages to declaring the Bay a sanctuary. The management of motorized fishing boats will be easier on account of the area having protected status. The presence of a sanctuary will open enormous possibilities for ecotourism development. For instance, the growing whale watching industry on Ile St Marie can be effectively extended to include the Baie d'Antongil, thereby creating an additional gateway to the region.

- The rest of the MPA will be under a system of coastal zone management so that the sustainable utilization of marine resources can be maximized while conflicts between users are minimized at the same time. Inventive management methods such as rotational harvesting will need be applied in the MPA and fishers will need to gain access to appropriate technologies.

Although the declaration of a MPA, as outlined above, will go a long way on the road to sustainable resource use on the Masoala Peninsula the geographical division of the region into areas that will enjoy different levels of protection is not in itself enough. The problems facing the coastal zone have their origin in the actions of its human inhabitants. Management of marine resources thus really means the management of the people who utilize them. Therefore a large component of coastal zone management must be directed towards the resource users themselves. It is absolutely essential that these users are thoroughly educated as to the nature of the resources. When humans are unaware of how detrimental their actions are to the natural

environment, they cannot be expected to refrain from such actions, particularly if they derive financial gain from their practices.

Resource users also need to be appropriately organized if the goal of optimal and sustainable exploitation of resources is to be realized. Most fisheries-related problems stem from the perception that the sea as an open-access resource that can be exploited for short-term gain. Fishers need to be organized into management units that will confer on them responsibility for a particular area from which other users are excluded. This system will instill a sense of resource ownership in the fishers which will cultivate a desire to look after the resource over a long period of time. They must be the real managers of the resource and will have to be willing to sacrifice short-term gain for a more sustainable future. The impression of the authors is that many fishers will find such a system amenable to their needs.

It is proposed that a comprehensive coastal zone management project be instated immediately. The project will be run by a Coastal Zone Management Authority that consists of a Coastal Zone Manager, the directors and staff of the marine reserves and the Baie d'Antongil Marine Sanctuary, an educational officer, and a technical officer in charge of developing mariculture and aquaculture projects. The Coastal Management Authority needs to work closely with the management units to which the fishers belong, and must make every effort to involve them in management of the resources.

This report provides guidelines for the writing of specific management plans for many of the coastal resources. These resources include multi-gear multi-species fisheries, as well as the shark and octopus fisheries. The strategic plan highlights aspects of the management of these resources which need immediate attention. The abolition or modification of destructive fishing practices and the need to investigate new but appropriate technologies to

increase the fishers' catch are priorities. The report also provides guidelines for the management of the mangrove ecosystems that are nursery areas for many of the commercial fish species, and for the conservation of marine reptiles and mammals. Finally, some guidelines for the development of a responsible ecotourism industry are provided. It is important to understand that the strategic plan with its guidelines is not a substitute for specific and detailed management plans. It is premature to develop specific management plans for certain of the resources. In most cases however, detailed management plans can, and in fact must, be prepared now so that effective management strategies can be put in place in an organized fashion.

Several important considerations must underpin coastal zone management in the region:

- Many of the resources in the coastal zone are functionally interdependent as well as overlapping in the potential uses that humans have for them. It is therefore imperative to develop an approach in which conservation and development are optimally integrated and not merely listed under the cover of an Integrated Conservation and Management Plan (ICMP).

- Responsibility for conservation and development projects are gradually being transferred from the international community to national organizations, a process which is long overdue. The transfer of control over peoples' destiny must not however stop there. Responsibility for management must be shifted as far as possible to the local resource users themselves. They are the people who will gain most from sustainable utilization of resources, and the ones who will suffer most when these resources fail.

- It must not be forgotten that human pressure is directly related to population size. While it may be difficult to curb migration to the region, the authors believe it will not be very difficult to introduce family planning to the region and provide people with the means to do so. Most people are painfully aware of the link between large families and poverty.

CHAPTER 1

INTRODUCTION TO A STRATEGIC PLAN FOR THE MARINE RESOURCES OF THE MASOALA PENINSULA, MADAGASCAR

1.1 INTRODUCTION AND BACKGROUND

Madagascar is an island that is rich in endemic biodiversity. Over eighty percent of the species occur nowhere else in the world. Today the country is facing impending ecological disaster as a result of overexploitation of its natural resources and the virtual total lack of management. Although precise figures are hard to obtain, it is thought that less than eight percent of the original tropical forest cover still remains. In the hope of averting even larger-scale ecological destruction, various integrated conservation and development projects have been initiated in Madagascar but, like in most developing countries, these well-intentioned efforts are, at best, showing poor or mixed results. In the terrestrial environment the devastating effects of deforestation and soil erosion continues virtually unabated so that conservationists agree that for this country the writing may already be on the wall.

The Masoala Peninsula is one of the last regions in the country where significant pristine rainforest cover can still be found. Over the years there have been several conservation initiatives in the region,[2] all of which have met with limited success. Renewed efforts by the integrated conservation and development community and the Malagasy Government have resulted in a

large initiative known as Project Masoala. The primary target has been the rainforest, but after a preliminary investigation of the Masoala Peninsula's marine resources the focus has gradually been broadened to include the coastal zone.

The inclusion of the coastal zone in proposed integrated conservation and development actions in the region comes not a moment too soon. The coastal zone is intimately connected with the terrestrial environment. In essence it is a shell of living resources which overlaps with, and encircles the terrestrial resources. Many of the problems associated with the overexploitation and unwise use of terrestrial resources are also present, and often more pronounced, in the coastal environment. The vast majority of the region's inhabitants live on the coast and depend on the sea for much of their protein intake. Depletion of these resources will undoubtedly result in socioeconomic problems that will extend into the terrestrial environment. The initiative taken by the government and non-governmental organizations (NGOs) to have marine reserves delimited is therefore encouraging, although this is only the start of sustainable development. This document is the latest contribution to this process. An integrated approach which seeks to maximize output from the different resource bases and minimize conflict between users, is vital.

The pervasive philosophy underlying this report is that the solution ultimately lies in the hands of the resource users. " These are the people who will gain the most through effective management and who will suffer the most from the loss of the resources on which their livelihood depends. NGO projects are transient in nature. It is the users of the resource who will provide the continuity which is vital for long-term planning and management. Government agencies and NGOs can influence the course of events, but the fishers are the ones who decide on a day to day basis what will happen at sea. The same goes for other users of the coastal zone resources.[8]

The purpose of this document is to provide a strategic plan for the management of the coastal zone of the Masoala Peninsula. An integrated and holistic approach to the problem is advocated. The coastal zone is a complex system and time is running out. Hence numerous management guidelines are included in this document; however they should not be confused with specific management plans that need to be written soon. Resource users need to be closely involved in the process. They are the main players in the bottom-up approach advocated by this plan: to not take full advantage of their knowledge and skills would doom any externally imposed coastal zone management plan to failure.[5,9,10]

1.2 SCOPE OF WORK

The following Scope of Work was faxed to Dr F Odendaal in early September 1994. There were essentially two components to the study:

TERMES DE REFERENCE
FRANCOIS ODENDAAL
Consultant pour le volet Marin

Gestion des ressources marines

Le consultant en ressources marine aura a elaborer un plan directeur pour la gestion des ressources marines autour de la presqu'ile Masoala. Pour cela, deux aspects seront considered: -L'exploitation durable des ressources halieutiques afin de permettre la professionalisation de cette activite et de fixer les interesses sur les regions cotieres; - et la delimitation des reserves marines, afin de preserver un habitat viable a long terme pour les especes vivant dans la region, et ainsi assurer la regeneration des especes. Cette partie comportera aussi l'elaboration d'un systeme de suivi et de controle de la biodiversite marine qui puisse mettre en exergue la viabilite de la methode utilisee.

1. Exploitation durable des ressources marines

Objectif:
- Etude et proposition d'une procedure viable pour le renforcement des pouvoirs locaux afin de donner a la communaute riveraine, le controle des ressources marines,

- Etude et mise en place d'un systeme d'exploitation rationnelle des eaux lagunaires de la presqu'ile (rotation de la peche)

-Etude et proposition concrete sur l'opportunite et la faisabilite de la peche pelagique,

- Analyse des gestions et elaboration d'un plan directeur pour la gestion des ressources marines autour de la presqu'lle Masoal. Ce plan directeur devrait inclure:

1) la planification de l'amenagement du reserve marin,
2) la planification des suivi-evaluation ecologique.

Description:

Les differentes etudes anterieures seront mises a profit, surtout quant a la connaissance du Consultant de la presqu'"le pour les etudes qu'il y a deja conduites au cours de deux demieres annees, a savoir:
* visite de terrain de decembre 1992
* consultation en janvier 1993
* visite et tournage de films en octobre-decembre 1993
* donnees sur la biodiversite collectees dans les coraux, les sables de plage, les mangroves et les estuaires en 1993.

D'autre part, des donnees sur les activites de peche des villages cotiers autour de la presqu'"le sont disponibles aupres de I'Assistant Technique en matiere de ressources halieutiques du Projet, lesquels pourront etre depouilles conjointement avec le Consultant.

Si des etudes complementaires s'averent necessaires, elles seront menees avec le concours de I'Assistant Technique en matiere des ressources marines du Projet (Jaomanana).

2. Delimitation des Reserves Marines.

3. Duree

Les travaux de terrain seront menes durant les Mois de Septembre et Octobre 1994.

4. Produit

Exploitation durable:

Un rapport final qui detaillera le plan directeur de gestion des ressources marines autour de la presqu'"le Masoala sera soumis vers le 15 Decembre 1994. Ce rapport repondra aux objectifs cite;s precedemment dans les paragraphes 1 et 2. D'autre part il comportera:

- Un plan d'exploitation des ressources marines, ainsi que les modalites pratiques de sa mise en oeuvre,
- Les details afferants a un systeme de controle et de suivi de la biodiversite marine.

Le plan directeur serait ecrite ensemble avec le Halieute du Projet.

Les autres produits a remettre au projet avant le 31 Decembre 1994 comprendront: 1. Toutes les donnees courantes sur les corails, la faune des cotes sablees, la faune et la flore des mangroves a etre presentes comme especes par des matrices de site (a presenter en tableau en tant qu'originale, et sur disquette). Ces sites devront etre reportes avec le plus de precision possible sur les cartes nautiques et topographiques de la FTM.

Le Projet Masoala effectuera 1'incorporation des cartes et des donnees mises a sa disposition par le consultant aux bases des donnees du GPS de Masoala.

Calendrier:

- the delimitation of marine reserves;
- the management of marine resources.

This report deals with both aspects. Delimitation however, is dealt with in considerable detail elsewhere.

1.3 COLLABORATORS AND CONTRIBUTORS

The team appointed by Project Masoala consisted of CARE consultant, Dr F Odendaal, and his Malagasy counterpart Mr Jaomanana. Dr F Odendaal invited Mr M Kroese, an expert on marine mammals and reptiles, to participate. The team's insight was enhanced by various people who have worked with, or visited Dr F Odendaal and his colleagues before and during the study, and particularly by numerous discussions with a large number of local inhabitants of the Masoala Peninsula.

One of the team's strengths was its background knowledge of the Masoala Peninsula. Dr F Odendaal has spent a total of eight months in the region, traveling around the Peninsula more than fifteen times and covering significant sections by foot, kayak and pirogue. This experience was acquired during Dr F Odendaal's first consultation in December 1992; during his collaborative study with Dr Kremen and Dr V Razafimahatratra from January to March 1993 (various other scientists also participated in the study,

La date limite du rapport preliminaire sur la delimitation est le 15 Novembre 1994. Ce rapport lui sera retourne avec commentaires avant le 1 Decembre 1994. Le rapport final doit etre rendu le 15 Decembre 1994, avec le rapport final de la delimitation detaillant le plan directeur.

Chronologie (Sommaire)

Sept/Oct Travaux sur terrain
Novembre Ecriture des rapports, soumission des proposition de delimitation preliminaire.
Decenbre Soumission du plan directeur et du proposition de la delimitation finale.

Le consultant est prie de faire une debriefing a l'ANGAP avant son depart de Madagascar.

notably Dr P Hockey[12] and Dr B Riegl),[13,14] during Dr F Odendaal's consultation from October to December 1993, when various marine ecologists joined him on the Masoala Peninsula, notably Dr A De Ruyck, Prof A McLachlan,[15] Dr G Kerley, Dr P Webb, and Dr T Woolridge;[16] Mr M Kroese,[17,18] and during Dr F Odendaal's current consultation from September to December, 1994, when he was joined by Mr M Kroese, Mr Jaomanana, and Dr M Vely.[19]

Mr Jaomanana's association with Masoala began in 1990 as a field officer for Lutheran Church's SAFAFI project. Later he became Project Masoala's Technical Assistant for marine resources. He has lived on the Masoala Peninsula for four years, has traveled around the Peninsula numerous times and visited virtually every village between Nandrahanana and Cap Est. Mr Kroese has traveled around the Peninsula six times and spent a total of four months in the region.

1.4 ABOUT THIS DOCUMENT

The report is divided into eleven chapters. In this chapter (Chapter 1) a brief introduction and details of the terms of reference are presented. In Chapter 2 the *status quo* of marine resources is discussed briefly and the interested and affected parties are identified and listed. In Chapter 3 the rationale behind the delimitation of strategically placed marine reserves and other marine protected areas (MPAs) is discussed. This bulk of this chapter is an abridged version of an earlier working document[4] that dealt specifically with the delimitation of marine reserves. The process of delimitation was not an arbitrary one, and it is important that managers understand why the borders of the reserves are where they are, and why certain parks have special zones inside them. These reserves and other MPAs form the backbone from which further actions are suspended. Broad guidelines for reserve management are

presented at the end of this chapter. In Chapter 4 two underlying prerequisites for successful management namely; the education and social organization of resource users are discussed. In Chapter 5 guidelines for the management of most fishing resources, are provided. Shark and octopus fisheries are discussed in Chapters 6 and 7 respectively. In Chapters 8 and 9, guidelines are given for the management of marine mammals and reptiles, and mangrove and seagrass habitats respectively. Chapter 10 provides guidelines for the management of ecotourism development. In the final chapter (Chapter 11) arguments are made in support of an integrated approach to management of the marine resources on the Masoala Peninsula. There is a need for benefits from resources to be maximized in a sustainable manner and conflicts between users minimized.

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15 Prof A McLachlan is one of the world's foremost experts on sandy beaches. He also has considerable experience in marine conservation. He and his team visited the Masoala to do a biogeographic study on sandy beaches in collaboration with Dr F Odendaal. The report of this study is pending.

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19 Dr Michel Vely is a veterinarian surgeon with considerable experience in marine mammal pathology and has conducted many aerial surveys. He is currently working in conjunction with the Centre for Dolphin Studies, Port Elizabeth Museum, South Africa and provided much of the anecdotal information on whales.

CHAPTER 2

PATTERNS OF COASTAL RESOURCE USE ON THE MASOALA PENINSULA, MADAGASCAR

2.1 INTRODUCTION

The state of the coastal resources of the Masoala Peninsula have been described in a preliminary report,[1] and verbally at meetings with representatives of the Malagasy Government, the US Government, a variety of NGOs and other interested and affected parties.[2] The main finding of the preliminary investigation, namely that the coastal resources on the Masoala Peninsula were seriously threatened, are confirmed by further studies described in this chapter.

A two-pronged approach was used in studying patterns of coastal resource use. Fishers and other people that live in the coastal zone were interviewed to gain an idea of their perception of trends in the abundance and quality of the various marine resources. However, it was felt that the patterns of resource

use that came from the interviews had to be confirmed by an independent scientific study on the impact of humans on their resources. Together the two approaches would provide a picture that urgently calls for comprehensive management of coastal resources in the region.

2.2 PERCEPTIONS OF RESOURCE USERS

The lives of the inhabitants of a region are intimately tied to the well-being of their resources. This is particularly true of rural parts in the developing world where people live off the land on a daily basis. The resource users are very much aware of any changes in their resources and are often able to detect small changes in the abundance of target organisms that may have gone unnoticed by outsiders. Their views are therefore not only legitimate indicators of resource-use patterns but these people are also able to provide insight and information that would have been impossible to obtain over the same period of time through rigorous scientific methods.

The authors and their colleagues formally interviewed people using a carefully designed questionnaire with a range of questions on resources. Trends in the abundance of some of these resources were known, or could be assessed independently by the authors. This allowed responses to be validated to some extent and the interview data were considered to have a high level of reliability. The full methodology is described elsewhere.[3]

There are, however, several problems with formal interviews that are difficult to overcome. One is that the questions were chosen *a priori* by the investigators so that one or more important aspects of resource use might have been be left out altogether. Therefore, in addition to formal interviews, the authors also had numerous discussions with a wide range of inhabitants of the

coastal zone. These people included experienced fishermen, some of them very old, as well as local shop owners who have dealt in marine products for many years.

2.2.1 INTERVIEW DATA

Detailed interviews were conducted[1,3,4] to study patterns of resource exploitation; one part of the questionnaire required fishers to rate the abundance of the most important marine resources on a scale of 1-5 for the past year, 5 years ago and 10 years ago. People were randomly selected in villages for interviews.

Table 1. The percentage decrease of marine resources, given as percentages, in seven villages on the Masoala Peninsula, adapted from previous studies.[1,3,4]

Resources	Rantabe	Ambanizana	Ambodifo raha	Anibodi rafla	Ratsianarana	Ambodiletra	Masoala	Decline
Fish	50	28	45	32	60	52	45	38
Sea turtle	-	14	0	41	60	40	40	33
Sharks	13	22	-	44	56	41	28	34
Sea cucumber	0	68	0	58	58	64	40	41
Octopus	50	25	-	40	41	44	15	36
Lobster	25	43	-	61	41	48	30	41
Crab	40	63	33	36	37	56	35	43
Whales	11	0	15	13	20	27	14	14
Oyster	22	9	0	22	5	13	15	12
Dugong	0	28	60	22	10	9	55	26
Shellfish	40	9	5	16	17	20	28	20

Responses indicate that the abundance of all resources has declined over the last decade. Not surprisingly, the most pronounced declines were observed for sea-cucumbers *(dinga-dinga),* crabs, and lobster. These organisms are slow-growing and easily collected by fishers. A fringe of the *dinga-dinga* populations is protected only by the occurrence of some species in deeper water and the lack of scuba diving equipment until now. Fishers also noted that in some localities almost all the remaining *dinga-dinga* belong to inedible

species. Lobsters are exploited without regard to size and a commercial concern has deployed lobster boats all along the east coast where lobsters are most abundant. The distribution of crabs is highly localized and they are easy to catch. Furthermore, the mangrove habitat which is a nursery for many commercial fish species is endangered by various activities (see Chapter 9).

Respondents indicated that fish, octopus, sharks and sea turtles have also declined both in numbers and in sizes. Many of the coral reef fish have characteristics that make them highly vulnerable to overexploitation, particularly when destructive fishing methods are used. '" The decline in octopus is at first perplexing as these organisms are fast breeders. The problem appears to be that their population sizes are limited by available shelter so that habitat destruction on the reefs influences their numbers negatively. Sea turtles are caught incidentally in nets[7], which are becoming increasingly common, and are invariably slaughtered. Sharks have been targeted intensively by fishers who sell their fins to buyers all along the east coast of the Peninsula. They are generally regarded as a resource which is not easily exploited in a sustainable manner, and their decline on the Peninsula mirrors the worldwide decline in their numbers. '

The abundance of four groups of organisms namely dugongs, shellfish, whales, and oysters are not thought to have declined noticeably. However, estimations of trends in their numbers are hampered by several factors. Dugongs are already so rare that very few fishers see even one per year. The 1 to 5 scale might therefore be inappropriate for an estimation of their numbers. Shellfish are also difficult to estimate as many people would tend to collect them only at times when other protein sources are scarce. Whales also occur in low numbers and most of them occur offshore so that fishers would be able to observe only a fringe of the whale population. Oysters were included as a test category as it was hypothesized that it was unlikely that their numbers

would have decreased. However, their population numbers can be affected by siltation or by people desperately in search of food, as is the case along certain poverty-stricken parts of the South African coast.

2.2.2 Anecdotal Information

Anecdotal information[4] confirmed the trends that were apparent from the formal interviews. Many people felt that the fish were not only getting scarcer, but that they were also becoming smaller, which again is an indication of overexploitation. Some people were able to provide figures of catch sizes in the that show dramatic decreases in catch per unit effort in the Baie d'Antongil over the last decade. At a meeting at Maroantsetra fishers gave graphic descriptions of the damage inflicted by trawlers in the Baie d'Antongil, with the dumping of the by-catch being the major concern.

2.3 THE EFFECT OF HUMANS ON THE RESOURCES

All marine resources included in the interviews were indicated to have declined over the last decade. " To empirically test, and further investigate the underlying reason for the decline in marine resources, studies were undertaken to examine the effect of fishers on the coastal ecosystem. The study focused on a number of lagoons and reefs on the east side of the Peninsula. A number of biological and habitat variables were quantified at each site. Human pressure on the site was estimated and related to biological and habitat variables in order to determine the effect of human exploitation on them. The full methodology and statistical analysis is described elsewhere.[4]

Three types of habitats were considered separately: the isolated coral heads in the lagoon itself, the surface of the reeftop, and the zone immediately behind

the reeftop on its landward side. The latter zone consist of contiguously distributed coral deposits and is referred to as the mosaic zone.

In each of 10 lagoons between 40 and 160 individual coral heads were studied. For each coral head the number of fish species were counted and the amount of hiding space available for fish and the degree of degradation of the coral head was assessed. The later two variables were assessed by subjectively rating each attribute on a scale of 1 to 5.

The amount of coral cover and the number of coral species on reeftops and mosaic reefs were quantified using line transects and intercept methods. Coral health was assessed by estimating the proportion of dead and broken coral and by estimating the percentage of algal cover on the coral. Lines on graphs indicate 0.05 % significance levels.

2.3.1 The Human Impact Index

To quantify human pressure on a reef a Human Impact Index (MI) was calculated using characteristics of the fisher population and the site itself that may cumulatively affect the level of human impact on them. The following variables were thought to influence human impact: the number of fisher families that used the site; the size of the lagoon; the depth of the lagoon, and distance that resource users had to travel to get to the site. These values are summarized in Table 3. The full rationale behind the HII is explained elsewhere.

Table 3: Human Impact Index (HII) for the different sites.

SITE	FISHER LOAD	FISHER LOAD RANKED	LAGOON DEPTH	VILLAGE DISTANCE	LAGOON SIZE	HUMAN IMPACT INDEX (HII)
Ambodirafia	60	5	3	3	3	14
Ratsianarana	24	2	3	5	2	12
Ankoalahidy	18	2	3	5	5	15
Vavarana	18	2	5	5	5	15
Ankarandava	40	4	5	5	4	18
Vinanivao break	51	5	2	3	2	12
Vinanivao central	51	5	3	4	2	14
Ankazofotsy	45	4	4	5	1	14
Beyond Fady Point	8	1	3	1	3	8
Near Fady Point	18	2	3	4	3	12
Ambodiletra	30	3	3	5	2	13

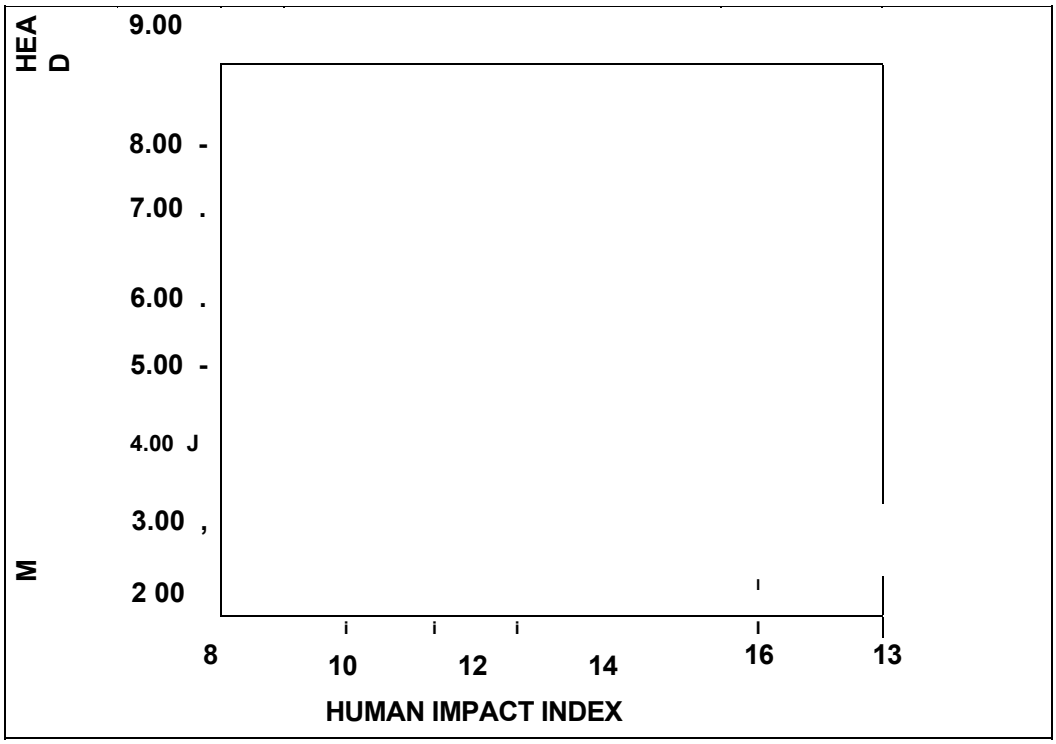
2.3.2 The Effects of Human Exploitation in lagoons

There were marked differences between the 10 different lagoons examined both in terms of the numbers of fish species present and in terms of the condition of the coral heads themselves.

- There was a significant negative correlation between the number of fish species associated with individual coral heads in the different lagoons and the Human Impact Index (Figure 1). The number of species of fish declined with increasing human impact.

- There was also a significant correlation between the coral degradation index for a particular site and the Human Impact Index for that site (Figure 2). Coral degradation was far greater at sites with higher HII scores. The coral degradation index can be considered to be a subjective assessment of coral health and as such an indirect measure of fish habitat integrity.

Figure 1: Mean number of fish species associated with individual coral heads in 10 lagoons subject to differing levels of human impact.



2.3.3 THE EFFECTS OF HUMAN EXPLOITATION ON REEFS

In order to determine potential effects of humans on reef structure, both the number of species of corals and the amount of live coral cover was estimated for sites subject to different levels of human impact. Quantitative data were collected from mosaic zones at 6 different sites and reeftops at 10 different sites. There were pronounced differences between sites. In the case of both the mosaic zones and the reeftops differences between sites were significantly correlated with the Human Impact Index (HII) derived for each site.

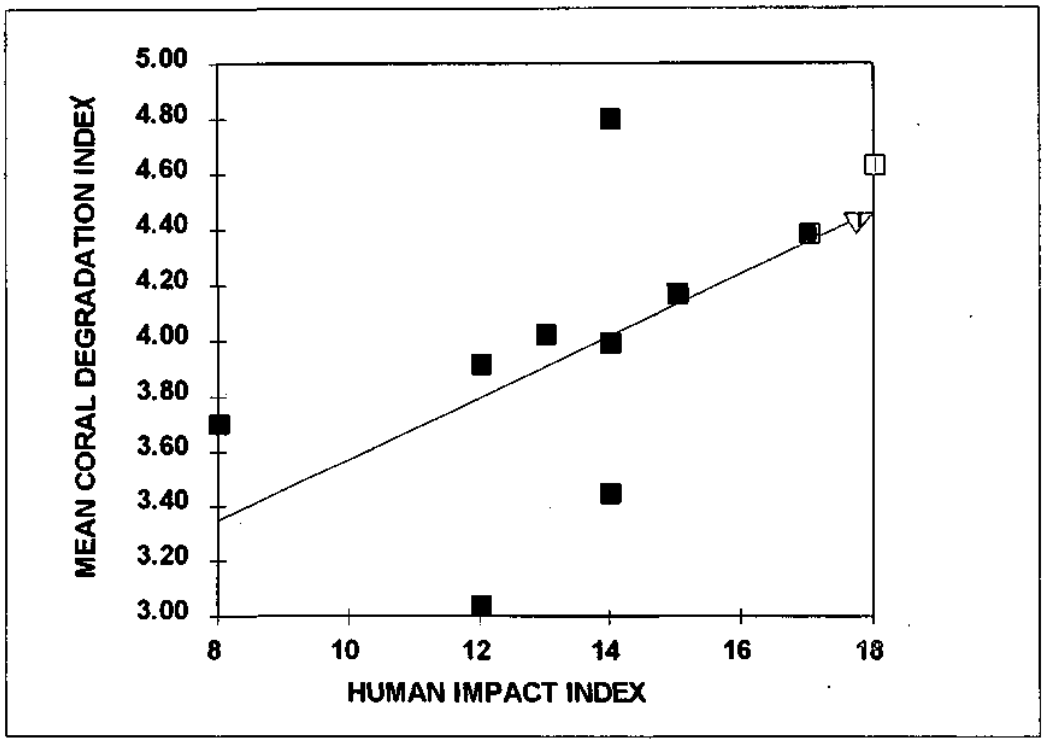

MEAN CORAL DEGRADATION INDEX
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
8
10
12
14
16
18
HUMAN IMPACT INDEX

Figure 3: Number of coral species recorded from transects run through mosaic reefs at 6 sites subject to different levels of human impact (HII).

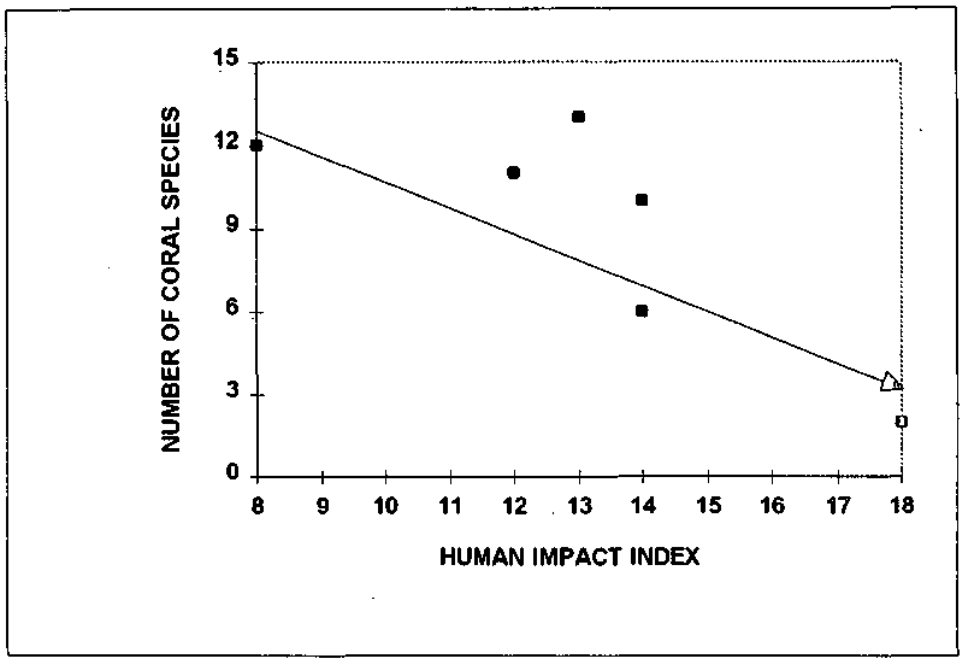


Figure 4: Amount of live coral cover recorded from transects in mosaic zones at 6 sites subject to different levels of human impact (HII).

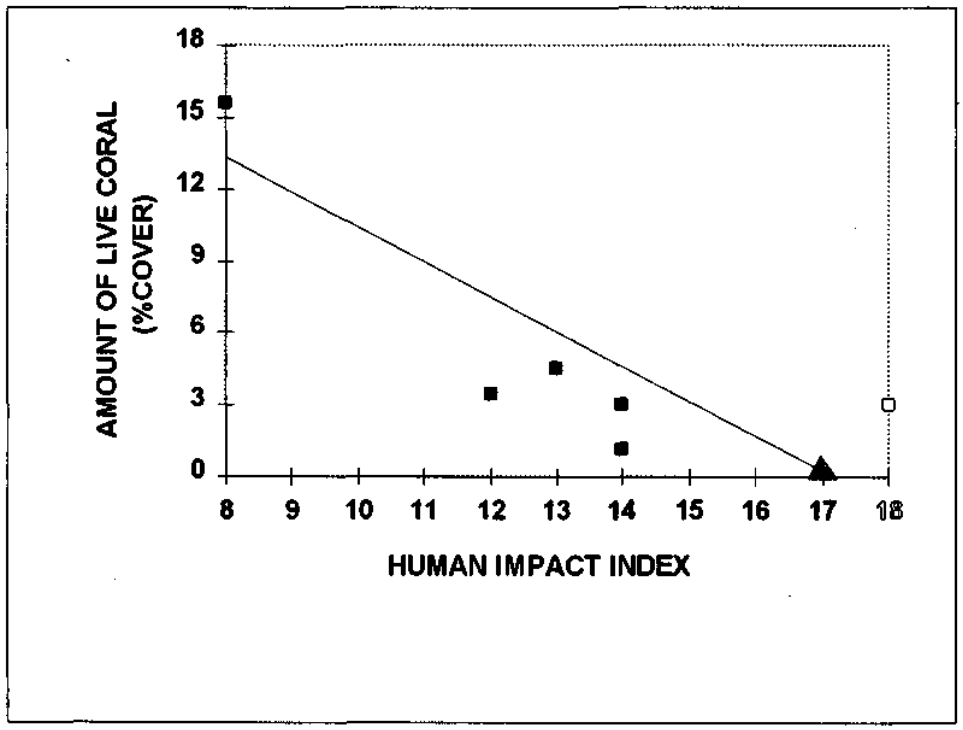


Figure 5: Number of coral species recorded in transects on reef tops at 10 sites.

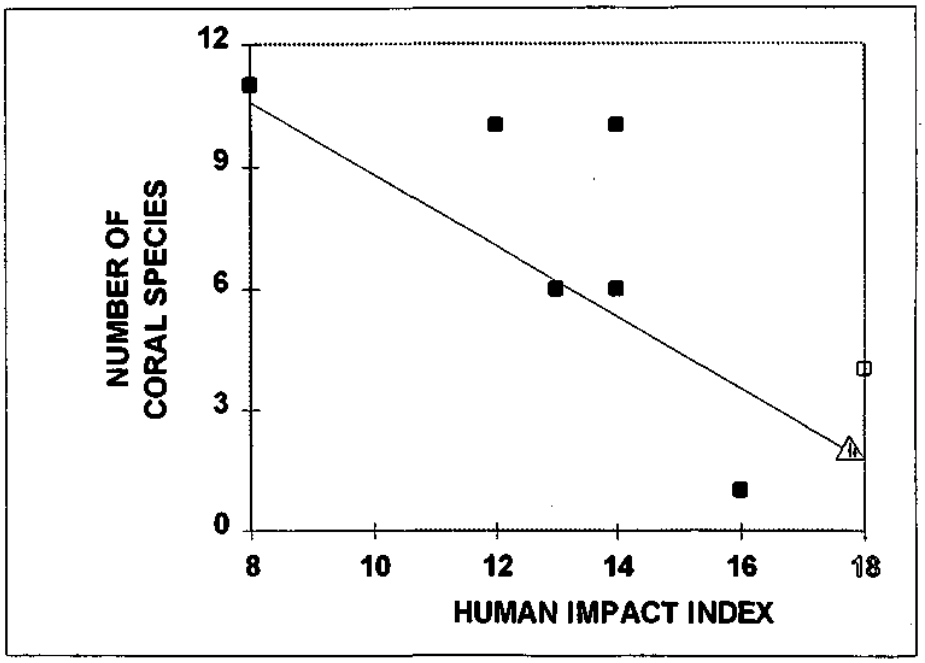
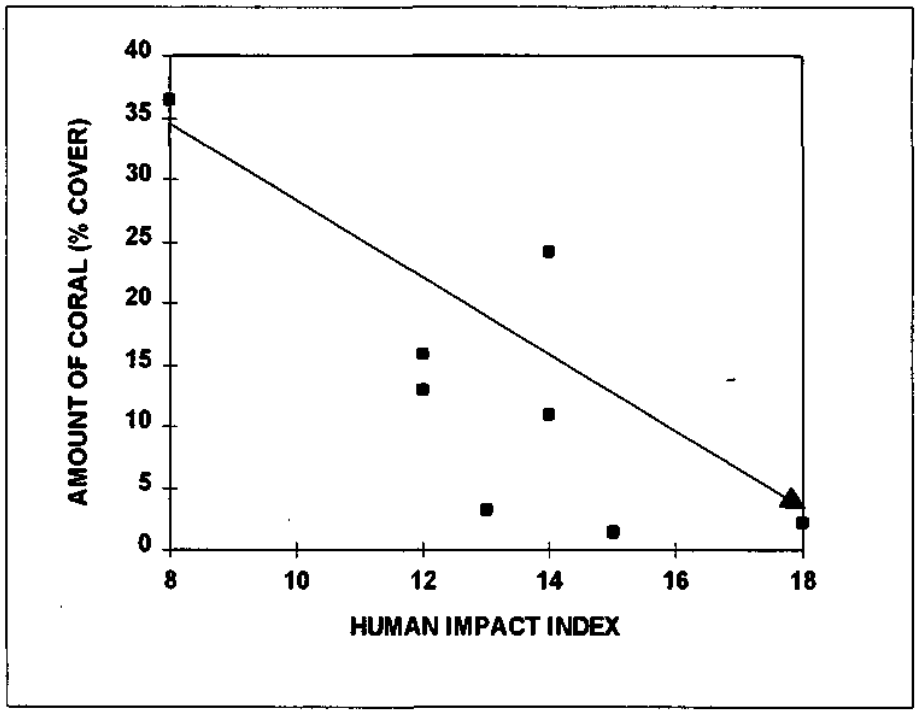


Figure 6: Amount of live coral cover recorded from transects on reeftops at 10 sites



2.3.4 THE MECHANICS OF DESTRUCTION

A number of factors could account for differences in coral and fish between sites. Although statistically significant correlations between the various variables measured and the independently derived Human Impact Index lends support to the idea that the impact of humans is of great importance in determining their biotic structure, simple correlations provide little information on the underlying processes resulting in such correlations. It is possible that such correlations are in fact spurious and merely the result of the. two correlated variables responding independently to a third unaccounted for variable. In order to further explore reasons for differences between sites, the least impacted site (Beyond Fady Point) was examined in more detail. The lagoon is the least impacted of the areas utilised, therefore only these data were used in this analysis.

This analysis revealed that differences in the number of fish species associated with individual coral heads at a particular site was determined by the size of the coral head (Figure 7) and the amount of hiding space provided by the coral head itself (Figure 8). There was no significant relationship between the number of species and degradation status of individual coral heads (Figure 9). The latter point is not surprising as the coral heads on this site were relatively healthy.

However, when differences between sites are examined a different pattern emerges. There was no significant relationship between the HHI and either the availability of hiding spaces or the size of individual coral reefs (Figure 10). There was however a significant increase in the coral degradation index associated with an increase in the HHI (Figure 11). The coral degradation index is a subjective assessment of the health of the coral head and takes into account the amount of coral that was dead, how much was broken and how much algal cover there was.

Figure 7. Relationship between number of fish species and size of individual coral heads for the lagoon Beyond Fady Point.

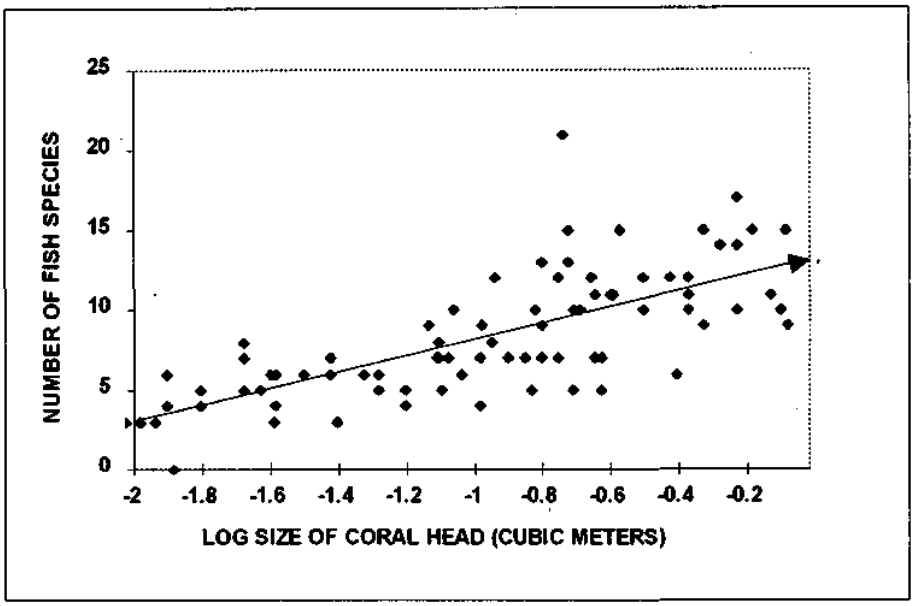


Figure 8: Mean number of fish species recorded from coral heads (Beyond Fady Point) with different amounts of hiding space.

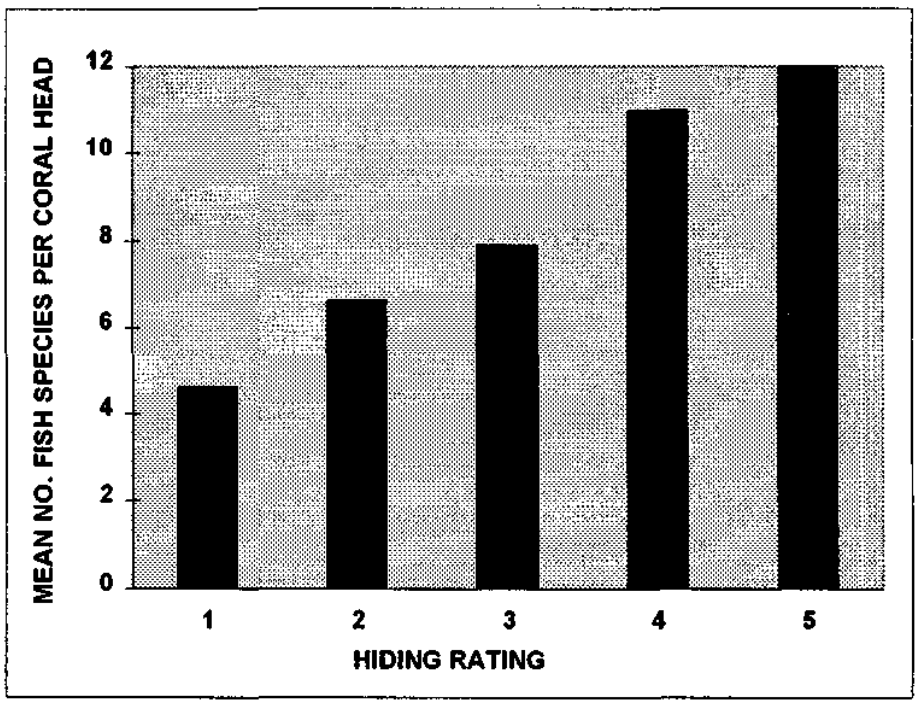


Figure 9: Mean number of fish species recorded from coral heads (Beyond Fady Point) with different degradation ratings.

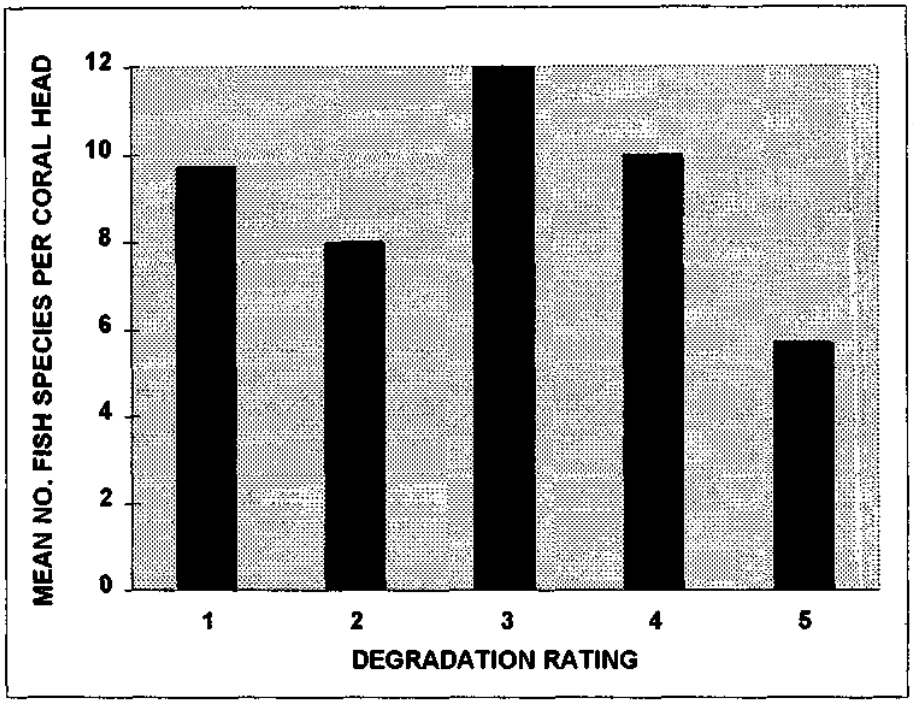


Figure 10: Relationship between human impact index and amount of hiding space at the site

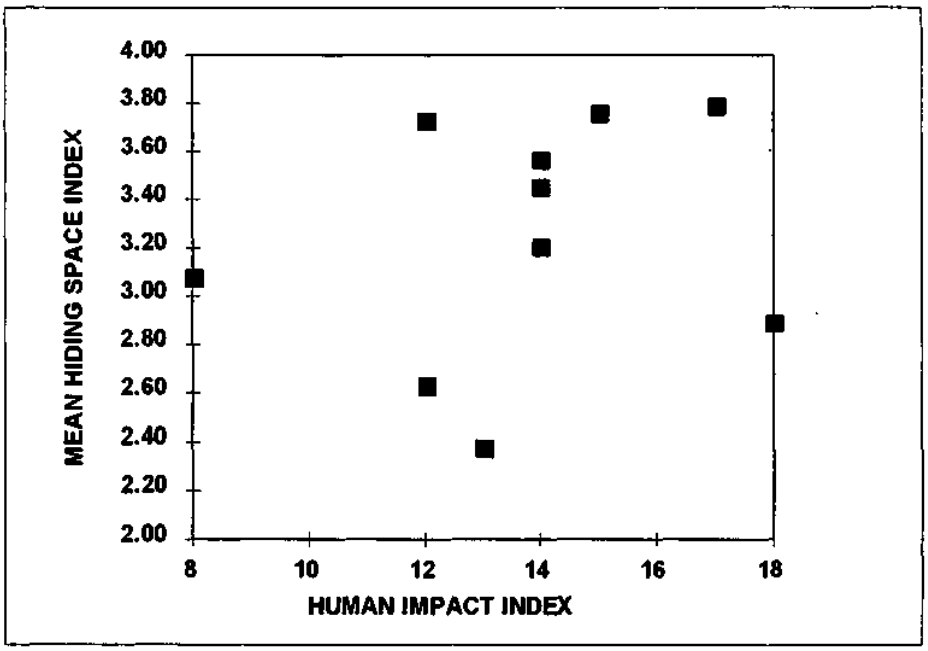
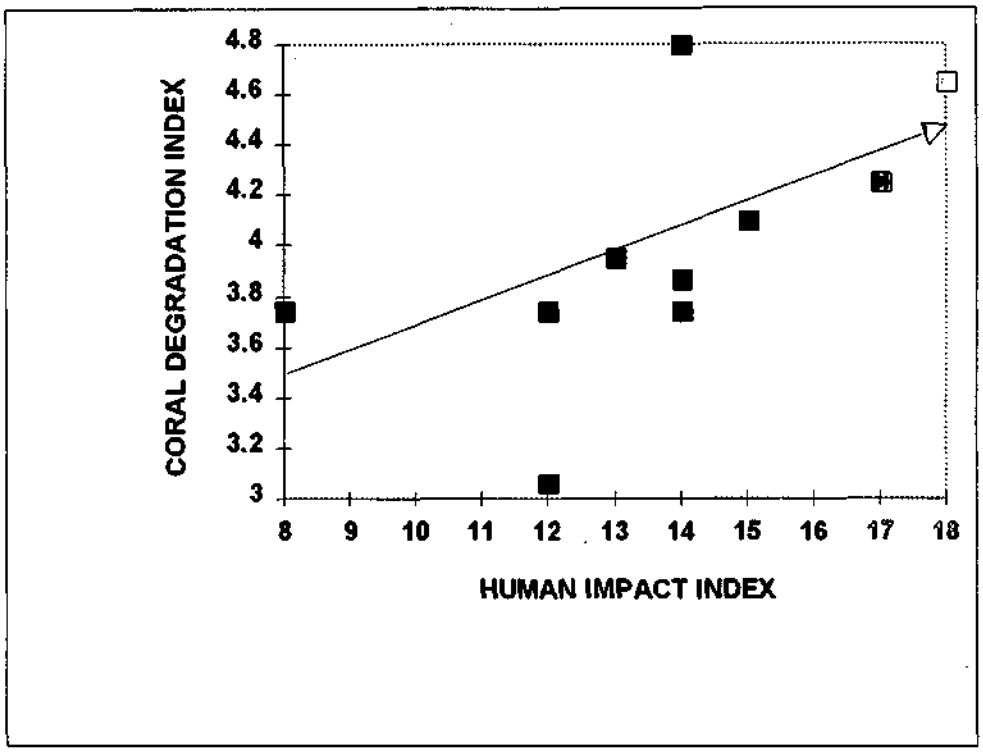


Figure 11: Relationship between Human Impact Index (HII) and coral degradation index.



All these features can reasonably be expected to indicate poor health. Because the coral heads provide the habitat necessary for many fish species the coral health index ultimately provides an indirect assessment of fish habitat integrity.

The ecological factors that influence fish communities in coral reef systems are not clear.[10] However, the data presented here suggest that one important effect humans have within the lagoon systems is to influence the degree of coral degradation. Although the effect of overfishing cannot be ruled out, it is possible that the greatest threat to the resources is destruction of the coral and therefore the habitat on which many of the associated species depend. It is imperative that studies on the effect of humans on the different components of

the coral reef system need to continue so that meaningful management plans can be drawn up.

2.4 INTERESTED AND AFFECTED PARTIES

2.4.1 LOCAL RESOURCE USERS

The most important of the affected parties are the fishers on the Masoala Peninsula in particular, and all the people of the region in general. The largest part of the population lives in the coastal zone and they depend heavily on marine organisms as a source of protein. Appendix One present figures on the population that live on the coast itself, or as far as 5 km inland. Working on an estimation of five members per family, and a total population of 20,000 starting at Cap Est and excluding Maroantsetra, it can be estimated that at least 80 % of the region's people live in or near the coast and are at least to some extent dependent on coastal zone resources..

Fishers are defined as individuals who earn more than 50% of their living from the exploitation of marine organisms. However, a large percentage of non-fishers also harvest marine organisms (Table 2). There probably are very few people in the coastal zone who never make an effort to catch or collect marine organisms themselves.

Table 2. Activities of families in villages expressed as percentages

Villages	Rice fanning	Fishing	% Fishers Families	Hunting	Forestry	Casta Crops
Rantabe	100	33		0	33	33
Ambanizana	100	48	6	0	62	71
Ambodiforaha	86	71	31	0	86	86
Ambodirafia	82	90	41	0	44	44
Ratsianarana	100	56	7	0	66	56
Ambodiletra	88	63	83	13	75	63
Masoala	40	80	-	0	80	80

The benefits to the local population from coastal zone resources can undoubtedly be increased with proper management, and may extend into non-fishing activities such as coastal ecotourism which is the fastest growing branch of that industry (see Chapter 3 and Chapter 10).

Many of the inhabitants of the coastal zone have the following points in common:

- They rely heavily on marine resources as a protein source;
- They depend to varying extents on marine resources for their livelihood;
- They are involved in multi-gear multi-species fisheries (see Appendix Two);
- They will have more benefits from marine resources when the coastal zone is under proper management.

2.4.2 THE INTERNATIONAL COMMUNITY

The interests and concerns of the international community in the Masoala Peninsula is represented by a number of government and non-governmental organizations (NGOs) of which the most important ones are USAID, CARE INTERNATIONAL (MADAGASCAR), THE PEREGRINE FUND (TPF), WILDLIFE CONSERVATION INTERNATIONAL (WCS), and the MISSOURI BOTANICAL GARDENS. A more complete description of the involvement of the various parties and the conservation history of the region is presented elsewhere."

2.4.3 National Agencies and Organizations

There has been a growing interest and involvement of the national government agencies in conservation and development in the region. The most important ones are: ANGAP, the Department of Water and Forestry, and the new Ministry of the Environment.

2.4.4 Business Interests

There are a number of businesses that can lay claim to being interested and affected parties. These include local shop and boat owners on the Masoala Peninsula itself, as well as business people interested in marine products from other parts of the country as well as abroad.

2.4.5 The Power to Influence the Future

There has been a gradual shift of responsibility for the running of conservation and development projects in the region from international organization to national organizations. This shift is appropriate and needs to continue. However, the local inhabitants, in particular the resource users, are the people most affected by what happens on the Masoala Peninsula. Therefore the responsibility of managing the coastal resources should untimately lie with them. Other interested and affected parties can only assist them in a facilitatory role.

On the Masoala Peninsula, like in many other situations in the developing world, time is running out fast for guidelines to be translated into meaningful actions that will increase the chances for the sustainable utilization of resources. The coastal resources in the region are declining fast. Considering the ever-increasing growth of the human population and the arrival of new technologies to exploit the resources, drastic steps need to be taken to save

what pristine habitat is left over in the region. The first aim should be to arrive a strategy that encompasses the entire coastal zone with all its different components. This report should go a long way to fulfilling that aim. The next step is to identify key protected areas that will play a significant role in an overall plan to safeguard against the collapse of resources until specific management plans can be written and implemented.

2.5 FOOTNOTES AND BIBLIOGRAPHY

1 Odendaal FJ. 1993. Preliminary report on marine conservation and exploitation of marine resources on the Masoala Peninsula, Madagascar. Report prepared for CARE (MADAGASCAR), pp 53.

2 Debriefing of the consultant FJ Odendaal in Antananarivo in December, 1992, to representatives from ANGAP, CARE (MADAGASCAR), USAID, and Louis Berger International. The status of marine resource exploitation was outlined as well as the urgent need for the management. The meeting was alerted to the presence of large commercial vessels and the damage they were causing to fish stocks.

3 Razafimahatratra V, Odendaal FJ, Kremen C. 1993. Marine Exploitation on the Masoala Peninsula, Madagascar: the human perspective and interactions between marine and terrestrial resources. *In:* Abtracts of 8th South African Mar Sci Symp, Mykonos, South Africa.

4 Odendaal FJ, Kremen C, Kroese M, Razafimahatratra V, Hockey P, Eekhout S. 1995. Exploitation of marine resources by artisanal fishers on the Masoala Peninsula, Madagascar. In Preparation.

5 McClanahan TR. 1987. Overfishing and coral reef degradation: A preliminary report from east Africa. Conservation Biology l(2):97-99.

6 Pauly D, Thia-Eng C. 1988. The overfishing of marine resources: Socioeconomic background in southeast Asia. Ambio 17(3):200-206.

7 Most targeted shark fishing is done with gill nets, resulting in a high bycatch of other species (turtles, marine mammals, skates and rays and fish). Mesh size is small, resulting in the capture of many small shark with fins that have no commercial value. Sharkfishing is unregulated and no systematically collected catch data is available. However, G van Schalkwyk at Cap Est who fishes commercially for sharks as well as buying fins from local fishers, also confirmed the decline in their numbers..

8 Compagno LVJ. 1990. Shark exploitation and conservation. In: Elasmobranchs as Living Resources: Advances in the Biology, Ecology, Systematics and the Status of the Fishery. Pratt HL Jr, Gruber SH, Taniuchi T (eds). NOAA Technical Report 90.

9 Branch G, Odendaal FJ, Lasiak T. 1995. Exploitation of shellfish in the vicinity of Dwesa Marine Reserve, Transkei, South Africa. In Preparation.

10 Sale PF. 1982. The structure and dynamics of coral reef fish communities. *In:* Pauly D, Murphy GI (eds). Theory and Management of Tropical Fisheries, pp 241-253. ICLARM Conf Proc 9. Manila, Philippines.

11 CARE INTERNATIONAL (MADAGASCAR), WILDLIFE CONSERVATION SOCIETY, THE PEREGRINE FUND. 1995. Proposition des Limites du Parc Masoala. Soumise a la Direction des Eaux et Forets. 79 pp

CHAPTER 3

THE DELIMITATION OF MARINE RESERVES ON THE MASOALA PENINSULA, MADAGASCAR

3.1 BACKGROUND

Coral reefs are the most diverse communities in the sea. Functionally intricate and ecologically fragile, they contain perhaps one quarter of all marine species and are truly the tropical rain forests of the oceans.[1] In spite of their exceptional biological diversity, tropical reef systems are not very productive and they cannot withstand unmitigated human pressure. Like rain forests, they are among the most endangered ecosystems on Earth.

The last few decades have seen large scale destruction of many of the world's tropical reef systems as the result of various human pressures, including coastal pollution from deforestation, overexploitation by fishers, and coral mining.[5,6,7] These pressures continue to rise despite recognition of their destructive effects. In terms of biodiversity, the continuing world-wide loss of coral reef systems is a great one.

The situation of the coral reefs on the Masoala Peninsula is no different from those of the rest of the world: human pressure on all the coastal biological systems has been steadily increasing for decades; the deterioration of the reefs is clearly visible, even to the untrained eye; and the decline in the quantity and quality of marine resources is causing alarm among fishers and scientific investigators alike. The evidence of destructive practices and trends, detailed elsewhere, includes the following:

- *Declining Catches.* For several years, fishers along the entire coastline have been noticing a dramatic decline in the number of fish caught per effort, as well as in the sizes of individual fish. These are tell-tale signs of over-exploitation. "

- *Small Mesh and Gillnets.* The use of gillnets within the lagoons is common, and increasing. Virtually all the nets have mesh sizes that are dangerously small (< 5 cm and often < 2 cm). As a result, juveniles of many fish species are caught before they can breed. A wide variety of species end up in the nets and almost all of them are eaten.

- *Destruction of Coral.* Physical destruction of sizable coral structures occurs on a daily basis. People break the coral to get access to speared octopus, or to release tangled nets. The use of pirogues in the lagoons also causes damage to the corals. This is primarily a consequence of the fact that they are propelled by poling although coral heads are also

sometimes sheared by pirogue bottoms. The poles are also used to stamp on coral heads and scare fish into the nets. Anchors are let down regardless of the substrate they will land on and are often dragged through coral beds. At low tide people trample the reeftop while searching for marine organisms. Shallow lagoons and reefs near areas of high population density are particularly susceptible and some now resemble underwater deserts.

- *Commercial Fishing:* At least two companies fish extensively in the Baie d' Antongil and they are reported to be doing great damage to fishing stocks. Their activities continue unabated despite a previous report and a debriefing.[8,10] Local fishers and their organizations appear powerless to stop the destruction of their livelihood. The extent of damage already caused by commercial fishing needs to be evaluated further.

- *Spearguns:* Once a rare method of fishing used only for subsistence, speargunning on Masoala has risen sharply and entered a commercial dimension. Certain wealthier individuals have purchased spearguns and now contract local divers to hunt for them in exchange for a share of the catch. Many tropical species, such as parrot fish, are territorial and slow-growing so that pockets of large individuals are easily annihilated by speargun hunters, just as a stand of old-growth forest is harvested with chainsaws. Replacement is slow and may not occur. Spearguns extend the reach of humans into areas of the reef system, such as the breaks, where breeding stocks of fish had previously been relatively safe from harvesting by net. Spearguns have caused widespread damage to coral reef systems, ' and are now illegal in various countries such as the Seychelles and Mauritius.

- *Destruction of Mangroves.* Mangroves and seagrass beds are functionally interdependent systems[14] that are extremely

productive[15,16] and the breeding ground for many reef and pelagic fish species.[14,17,18,19] However, mangrove wood is strong but flexible and makes ideal ribs for boat hulls. Mangroves are also used for other parts of boat construction, charcoal manufacturing and even floor polish. The mangrove forests are heavily disturbed in many areas such as Ambanizana, Nandrahanana and Antalaha, and has virtually disappeared from Maroantsetra.

- *International Exploitation:* Outside interest in Masoala's marine products is rising. The nature of many of the targeted species is such that they are almost always exploited on a non-sustainable basis.[20] Certain organisms that have been overexploited elsewhere along the coast of Madagascar, such as sea cucumbers, still occur in reasonable (although rapidly declining) numbers on the Masoala Peninsula. There is already a business concern based at Cap Est that markets artisanal fishing products such as shark fins. Representatives of a Korean company,[21] investigating the availability of a variety of marine products on the Masoala Peninsula, were encountered by the authors. These businessmen have visited main centers as well as remote localities to arrange for local fishers to collect material for them. The authors have also been approached for information on fishing stocks by one fishing company in South Africa, as well as by restaurateurs and an individual interested in exporting tropical fishes.

- *Indiscriminate Sharkfishing:* Sharkfishing is common on the Masoala Peninsula. Fishers do not discriminate between sought after and undesirable species, despite the clearly noticeable decline of this resource. ' ' Sharkfins are bought by outside interests invariably at prices far below their world market value.[23] Some buyers periodically travel around the Peninsula for this purpose, while at least five local merchants buy fins and ship them to Antalaha and Maroantsetra. Because sharks breed slowly and pups suffer high mortality, shark

fisheries are usually unsustainable. Sharks are the top predators in the marine environment and their removal from the system has serious ripple effects that extend far beyond their own demise.

These trends and activities are closely linked to rapid human population growth on the Peninsula.[26] They spell disaster for the region if allowed to continue unabated. Even at present levels the above practices and trends will lead to the further decline, and finally the collapse, of artisanal fisheries along this coastline on a time-scale measured in years rather than decades. Unprecedented and perhaps irreparable damage to the marine resources of the region can be predicted with confidence, unless an integrated management plan is applied to the coastal zone in the very near future.

The situation is analogous to a tract of tropical rainforest which is accessible, without limitation, to a large and growing number of people. The end result will be the same: destruction of the resource. The future of Masoala's marine environment is as bleak as that of the rainforest. Its demise will dramatically affect the people of Masoala, particularly as the vast majority of humans live on the coast and depend on fish and other marine organisms for their protein intake.

Management of tropical fisheries has never been easy.[28,29] Fishing on the Masoala Peninsula, as in other tropical regions, is multispecific and organisms are harvested using a wide variety of methods and gear.[8] The complexities are difficult to address through classical management procedures such as controlling catch or effort.[27,28] Such procedures often require extensive information about the status of stocks and are complicated and expensive to enforce, making them inappropriate where stocks are multispecific and budgets limited.[27,28,29] The establishment of marine reserves has been promoted as a viable alternative.[28,30] Numerous studies have highlighted the beneficial effects of marine reserves on

fisheries.[31,32,33,34,35,36] These effects include recovery of fish numbers and increases in size. The delimitation, establishment and subsequent management of marine reserves is not only an attempt to protect biodiversity, but a well-conceived component of a comprehensive and integrated marine conservation and development strategy.

3.2 THE FUNCTION AND DESIGN OF MARINE RESERVES

Much has been written about the functions of reserves. They are primarily designed to protect species of particular interest, to preserve entire, functioning biotic communities and to maintain biotic diversity into perpetuity.[37,38] Many different criteria have been proposed to facilitate comparison and prioritization of areas under consideration for selection as marine reserves, including representativeness, uniqueness, biotic diversity, endemicity, fragility, pristineness, aesthetic appeal and the occurrence of rare and endangered species.[38,39,40,41,42,43,44,45]

The importance of marine reserves to such esoteric goals as the maintenance of biotic diversity into perpetuity has, however, been eclipsed by the role that they can play in the management of resources.[28,30,46,47,48,49] Marine reserves can be of great economic importance, with a direct and immediate bearing on the lives of many people.[50,51,52]

In addition to their role in preserving established fisheries, marine reserves can play a significant role in attracting visitors with hard currency. Coastal tourism is the world's fastest growing industry, worth over $7 billion annually in the Caribbean alone. Other coastal regions have seen the number of visitors double and triple over the last decade. A survey of seventy world heritage sites revealed tourism to be the main source of income for local populations associated with these sites.[54] Dr F Odendaal, who has visited many tropical marine reserves in the Pacific and Indian

Oceans as well as the Caribbean, considers the Masoala Peninsula to have extremely high potential as an ecotourism destination. Unspoiled marine reserves will greatly enhance the attraction of the entire region. Few people want to spend two weeks in the rain forest only; on the other hand a tropical coast vacation with excursions into nearby tropical forests and pristine coral reefs would have enormous appeal to the most discerning ecotourist. This was very clearly illustrated by the successful marketing of two ecotourism trial runs conducted by Dr F Odendaal on the Masoala Peninsula in 1994.[55] A locally run ecotourism industry could provide considerable revenue to Park Masoala and inhabitants of the region alike, on a sustainable basis.

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Marine reserves have many other benefits as well. ' They have significant research and educational value, and are ideal tools for monitoring changes in areas such as the Masoala Peninsula, where ecological baselines no longer exist. The detection and extent of such changes frequently form the basis for management decisions.

Marine reserves are more likely than terrestrial reserves to be designed to accommodate multiple uses. The proposed delimitation of marine reserves on the Masoala Peninsula attempts to conserve maximum biodiversity, but also recognizes the pivotal role that coastal and marine protected areas can play in fisheries management as well as ecotourism development. Maximizing all of these functions in reserve design may at first appear to be an impossible task. For instance, from a conservation point of view the bigger the reserve the better, but bigger reserves would mean smaller fishing grounds. The following practical considerations are typical of most studies of reserve design:

- Should there be one large reserves or many small ones?

- Should reserves be entirely off-limits to fishers, or should certain forms of limited access such as rotational harvesting be allowed?

- Where should reserves be located so they can best fulfill their conservation and development aims?

The policy of the delimitation team was to estimate the minimum size and number of reserves that need to be totally protected, leaving as much coastline as possible for use by fishers. However, the implicit understanding in taking this approach was that the areas outside the reserves will be properly managed in their entirety, with the totally protected reserves as part and parcel of a comprehensive management system. If a situation develops in which the recommended management guidelines are not met, then it is probable that the areas set aside as reserves will not be sufficient on their own to protect the region's coastal resources.

3.3 DEFINITIONS OF MARINE MANAGEMENT AND PROTECTED AREAS

The literature abounds with acronyms referring to coastal zone management: CRM (Coastal Resources Management), CZM (Coastal Zone Management), CAMP (Coastal Area Management Planning), MPA (Marine Protected Areas), and so on [46,47,57,58,59,60] Marine reserves have been defined as spaces to which specific forms of management are applied which normally include limited entry,[46,61] while marine parks are specialized marine reserves in which multiple use, including education, recreation and preservation, is encouraged and sometimes implemented by zoning schemes.[46,62]

The view of the current delimitation team is that, on the Masoala Peninsula, as in perhaps most other places, simpler is better, not only in

the design and implementation of MPAs but also in their labeling and definition. In this report, Marine Protected Area (MPA) refers to any defined area where some, albeit very limited, forms of protection are offered to living marine resources. Marine reserve refers to an area to which human access is restricted, and marine sanctuary refers to an area in which one or more target species can seek refuge. Therefore, all marine reserves and sanctuaries are MPAs, but not all MPAs are reserves or sanctuaries. Management of marine resources implies actions inside and outside of such areas designed to make the various uses of marine resources more sustainable.

The reserves, sanctuaries, other marine protected areas, and all actions that concern the use of coastal resources need to be included in an Integrated Coastal Zone Management Plan, hereafter referred to as the ICZMP.

3 4 METHODOLOGY AND APPROACH TO DELIMITATION

3.4.1 BACKGROUND AND BIOGEOGRAPHIC ZONES

The Masoala Peninsula has a coastline about 230 km long, from Maroantsetra to Cap Est, with intermittent landing points (Figure 1). The weather and state of the seas on the Masoala Peninsula is frequently unfavorable for underwater observations and may even prohibit, for days at a time, travel by sea from one point to another. Logistical support came largely from the local infrastructure and frequent problems were encountered. The allotted time was not expected to allow detailed study of every point on the entire coastline, so we employed a three-stage approach that allowed for the sharpening of focus from one stage to the next. Firstly, the coast was divided into nine biologically distinct regions; secondly numerous underwater sites were examined in detail to collect quantitative data; and thirdly, the regions were compared using a set of criteria weighted in several possible ways that represent possible preference scenarios.

The first stage was to identify the major biogeographic subdivisions along the coastline by examining 1:100 000 maps and black and white US satellite photographs provided by Project Masoala, and by surveying the coastline from aircrafts and boats. Major divisions were based on obvious geographic and habitat features that could reasonably be expected to influence marine biology, such as whether a particular stretch of coast was flanked by the Baie d' Antongil or the open sea, or was in a transitional zone between the two. On a smaller scale, major breaks in the coral reefs, which would tend to isolate the biology of different parts of the reef

system, were identified. The presence of these breaks was verified by an extensive survey from the air and sea, taking the team around the coast several times, and ensuring that no special areas or previously unknown features were overlooked for possible inclusion in a MPA.

Virtually the entire coastline from Ambatofotsy, some 10 km north of Cap Est on the east coast, to Nandrahanana on the west coast, was observed from varying distances by boat, kayak and foot, some sections many times over. The entire coastline between Nandrahanana and Cap Est was observed from the air at a speed of about 200 km/hr, flying at a height of 1000 meters. The coastline from Ampanavoana to Nandrahanana was again observed from a height of 200 meters and recorded with a high resolution Sony Hi 8 video camera, and the section from Antalavia to Ambanizana was videotaped at a height of 1000 meters for the purpose of constructing a map.

The largest biogeographic division on the Masoala Peninsula lies between the Baie d' Antongil on the west side and the open ocean along the eastern shores. Almost the entire length of the eastern shore is flanked by a coral barrier reef that separates the open ocean from a system of lagoons. Several large breaks are found in the barrier reefs so that there are clearly discernible biogeographic subdivisions in the coral, which starts at the tip of the peninsula and continues northward along the eastern shore. For the purpose of this study, we divided the coastline into nine subdivisions (Figure 2).

The Baie d"Antongil Area comprises the west coast of the Masoala Peninsula, starting at Nandrahanana where Project Masoala has a base, and ending at Ambavazaha near the tip of the Peninsula, where the transition from the Bay environment to the east coast coral reef starts.

The Masoala Area starts at a slight protrusion near the village of Ambavazaha, extends around the tip of the Peninsula, and ends at the holy site of Anjagnaharibe which includes a rocky outcrop known as Vato Masigny. This prominent rock formation is a site of both religious and biogeographical significance, as it extends far enough into the ocean to isolate the Masoala Area reef system from the next reef system to the north.

The Ankazofotsy Area starts at the northern end of Vato Masigny and extends to just south of the village of Vinanivao where a very large break has formed in front of the mouth of the Vinanivao River.

The Vinanivao Area extends from Vinanivao northwards to just south of the Anaovandrano River where a very large break occurs in front of the mouth of the Anaovandrano River.

The Tanjona Area extends from the mouth of the Anaovandrano River, around Cap Tanjona, to the mouth of the Ampanavoana River.

The Ampanavoana Area comprises the coast north of Ampanavoana to the mouth of the Fampotakely River. This section of about fifteen kilometers has almost no reefs except for a barrier reef about one kilometer long that is split in two by a narrow break at Ankoalahidy.

The Tanjokantafana Area starts north of the mouth of the Fampotakely River and extends to immediately south of Ratsianarana where there are several breaks in front of the mouth of the Ratsianarana River.

The Cap Est Area starts at Ratsianarana and extends to Cap Est, immediately north of which lies a large break.

The Ambatofotsy Area is the next system north of Cap Est, starting after several very sizable breaks near the mouth of a river, known locally as the Iagnobe River but denoted on the 1:100 000 maps as the Onive River. This area lies outside, and about 4 km north, of the region that is usually considered to be the Masoala Peninsula. However, the team was attracted to this area in part because of the sighting of two dugongs in the lagoon by G van Schalkwyk of Cap Est in August, 1994. However, Dr F Odendaal later interviewed a fisher who lives next to the lagoon and he had not seen a dugong there for many years.

In the second stage, we selected and sampled underwater sites in each of the nine biogeographic subdivisions, except the Ampanavoana Area which has only one location with barrier reefs or lagoons, at Ankoalahidy. This site was studied extensively on an earlier visit and found to be badly impacted upon.[11] Furthermore, Ankoalahidy is the only possible mooring spot in the area and a popular fishing spot for the large village of Fampotakely, whose people have no other lagoon available south of the Fampotakely River.

In the third stage the authors identified the areas with greatest potential to serve as marine reserves or protected areas, rated them according to a wide range of variables, and finally compared them to one another while weighting the variables in different ways to reflect possible policy priorities.

3.4.2 Sampling of selected sites

Twenty one localities containing a total of thirty-eight sampling sites were selected in each of the nine biogeographic subdivisions, except the Ampanavoana Area (Figure 3). One site did not fall directly into any of the subdivisions, but in the lagoon near the Iagnobe Rivers' mouth between the Cap Est and Ambatofotsy Areas.

The Bay side, including numerous localities such as Fampotabe, Ampamolahambe, Ambodiforaha, Andranobe, Androka, Ambanizana, and Nandrahanana, had been considered extensively on earlier occasions.[8,11] All sampling sites on the Bay side (except for one at Namantoana), were between Tampolo and Antalavia, as it is the only stretch of that length suitable for a reserve. It is flanked by a forested plain which inclines gently into the Bay and its shallows contain impressive coral deposits, while the rest of the coast is steeper.

At each site fish and hard coral species were counted as a rough measure of representativeness. The degree of coral breakage, algal cover and general coral health were each scored on a scale from 1 to 10. For example, a site in which all the corals were dead would be given a general health score of 10, whereas a site in which all the corals were alive,

unbroken and had no algal cover would get a general health scores of 1. The methods for assessing corals are described in detail elsewhere.

To ensure comparability, each sampling site was classified as one of three habitat types: lagoon, mosaic zone in the lagoon, and reef break. Assessments vary in the different habitat types. The reef breaks, for instance, tend to be less damaged as they are deeper and not as accessible to fishers. The team tried to get rough counts and assessments in each of the three different habitats so that the sites could be compared effectively. Two investigators sampled each site by searching the habitat using a mask and snorkel for a minimum of 45 minutes, or until the investigator was satisfied that he was no longer encountering any new species. Video images of individual corals and outcrops were taken at selected sites as a record of the range of coral health and degradation encountered.

3.4.3 Marine mammals and reptiles

For most coastal regions of the western Indian Ocean there are no data on the numbers of coastal marine mammals and reptiles, the impact of human interaction and environmental degradation on them, or the viability of specific stocks. Such data are imperative for the formulation of conservation and management recommendations for coastal MPAs. The intricate oceanography in the Masoala region and proximity of the continental shelf makes for a complicated and diverse marine system. Six species of Cetacea and one species of Sirenia (dugongs) have been identified, and it is likely that other cetacean species also frequent these waters. Determining abundance trends through accurate, regular population assessments is imperative in formulating conservation and management strategies.

The number of dugongs in particular needs to be assessed. Dugongs are probably Africa's most endangered marine mammal; their numbers are declining at an alarming rate throughout their range, ' and there is clear

reason to believe they are vulnerable to extinction. ' Similarly, the four turtle species known to occur in the Masoala region, *Chelonia mydas,* *Eretmochelys imbricata, Caretta caretta* and *Lepidochelys olivacea,* are all known to be vulnerable as their numbers are declining worldwide. Both dugongs and turtles depend on seagrass for food, and they are likely to play an important role within these communities. ' Seagrass beds are a highly productive coastal ecosystem that supports major detritus-based food chains and faunal assemblages.[14,76,77] Disruptions in the seagrass bed ecosystem could have far-reaching economic and environmental effects.[76]

A preliminary aerial survey was conducted to investigate reports of both dugongs and turtles on the Masoala Peninsula. Additional information was gathered through interviews with fishers and boat crews. An area of 480 2 km in the vicinity of Cap Masoala was surveyed as several dugong sightings are reported from this area.[80] Aerial surveys can provide quantitative data necessary to estimate populations, as well as qualitative information,[79] but they are very expensive.

Aerial surveys entail flying an aircraft on a pre-determined transect search route while observers count sightings (quantitative data). Secondary sightings occur when the aircraft is not on the survey track and are not included in density or census calculations although they may help establish population distribution (qualitative data). The area from Nosy Ambatoharana on the east side of the Penninsula to Ampamolahambe on the west was surveyed with nine transects 10 km in length and 5 km apart. The effective observation area with observers on both sides of the plane was found to be a strip 800 m wide. Densities of both individuals and groups were calculated by extrapolating the densities observed in the transect strips to the total area that the animals are considered to likely to inhabit. Dugong sightings, for instance, should not be extrapolated to areas where seagrass is absent or beyond the 50 m isobath.

3.4.4 MANGROVES AND SEAGRASS BEDS

Mangroves and seagrasses are the cornerstones of two of the most productive ecosystems known.[14,78] The fisheries resources of many tropical areas are nutritionally and physically dependent on mangroves and seagrasses.[14] This dependence was illustrated by a study which showed that 550,000 ton of fish caught in Indonesia in 1978, worth US$194 million, consisted of species directly linked to mangroves and estuaries at some stage of their life cycle.[46]

While mangroves and seagrasses rank higher in gross primary productivity than many other ecosystems, ' they also enhance fisheries by stabilizing the physical environment, providing refuge, and contributing to the detritus food chain, which in turn helps to maintain ecosystem stability. These ecosystems are increasingly subject to destructive activities, threatening not only mangrove and seagrass areas, but the integrity of coastal ecosystems.

Mangrove forests are ecosystems comprised mainly of evergreen broad-leaved halophytic trees. ' They are found along sheltered coasts, bays, tidal lagoons and estuaries. Although sometimes occuring far inland, they are never totally isolated from the sea. The most extensive mangrove forests, including about fifty species, are found in southeast Asia. Less than fifteen species have been found on Madagascar, mostly on the west coast.[83]

Mangroves perform four major roles: they aid soil formation by trapping debris; they filter land runoff and remove terrestrial organic matter; they serve as habitat for fish, invertebrates and birds; and they produce detritus that contributes to offshore productivity.[84]

Seagrasses are angiosperms that are fully adapted to the marine environment. Seagrass beds provide a nurturing habitat for fauna and

promote a high faunal productivity. There is a significant relationship between seagrass biomass and diversity of animal life; where seagrass has been destroyed, many fish and invertebrate species simply disappear.[76] The seagrass meadows act as buffers between coral reefs and mangroves, reducing wave energy and exporting nutrients to nearby ecosystems.

Mangrove-seagrass interactions are an important component of coastal zone dynamics.[14, 87] The UNESCO Working Group in the Carribean classified mangrove ecological processes into four types: physical; nutrimental; animal migrations; and those involved in human impact.[87] By acting as hydrodynamic barriers which dissipate wave action, seagrass beds create a low-energy zone favored by mangroves. Seagrass beds trap and stabilize sediments, thus preventing abrasion or burial of those parts of the mangroves needed for aeration. Fringe and basin mangroves act as sediment binders and regulate freshwater flows, thereby buffering changes in salinity that would otherwise affect the seagrasses adversely. Mangroves and seagrass beds export or "leak" nutrients in the form of dissolved and particulate organic matter, thereby ensuring optimal growth and development for both systems. Animal migrations also link seagrass and mangroves, leading to an exchange in energy between feeding and sheltering habitats. Various fish (Haemulidae and Lutjanidae) spend the early part of their lives in the mangroves and seagrasses before moving to other systems.

The distribution of mangroves on the Masoala Peninsula was determined by flying along the coast and marking their location on a map. Rough notes on the amount visible from the air were later compared with videotapes of the coastline. Mangroves were also observed from boats, and stands were visited when possible to determine the species that occurred there. Local people were interviewed on their use of mangroves and notes on seagrass beds were made while diving."

3.4.5 EVALUATION OF POTENTIAL MARINE RESERVES While many criteria for the delimitation of marine reserves have been identified,[38,39,40,41,42,43,44,88] applying these criteria poses several difficulties.[88] Some rest upon data which is time-consuming to collect. Others depend on value judgments, such as the aesthetic appeal of an area, which vary somewhat depending upon the inclination of the particular investigator. Still other criteria may be in conflict, for example, uniqueness and representativeness.[88]

Of the initial nine biogeographic areas, three were ruled out immediately, as potential marine reserves. The Ampanavoana Area has only one small reef, and there is no reason to believe that the sandy beaches in the area are unique or endangered. The Vinanivao Area contains too many people, the reefs have already suffered considerable damage, and it is not far from the Masoala Area which clearly has much higher reserve potential. The Ankazofotsy Area was similarly ruled out on grounds of proximity to the potential Cap Masoala marine reserve, which would likely extend into the Ankazofotsy Area in order to protect both sides of the holy site of Anjagnaharibe.

Each of the six potential reserve areas selected from the original nine biogeographic subdivisions were rated on a scale of 1 to 5 in terms of each criterion, where 1 indicated low desirability as a marine reserve, and 5 indicated high marine reserve potential. For instance, a habitat diversity value of 1 meant that the site included few habitat types, while a rating of 5 meant the area contained almost all of the habitat types which occur on the Masoala coast.

Most biological characteristics were highly quantifiable. Returning to the example of habitat diversity, if an area contained more than 80% of the thirteen possible habitat types (Table 1), then it received a rating of 5. If it contained less than 20% of them, it was rated 1. Representativeness of

Table 1: Criteria which were evaluated when comparing sites.

1 Rare, Unique or Unusual Features: Special features such as holy forests often enjoy some form of traditional protection already, and call for a high rating.

2 Representativeness of fish and coral species: Based upon a simple numerical count of species.

3 Overall Condition of Coral: A combination of subjective ratings of coral breakage and algal overgrowth.

4 Non-fishing Activities: Reserve potential would be negatively affected by harbour construction in the area, while a research station might enhance it.

5 Short-term Urgency: The short-term (three years) future of an area may be subject to special pressures, such as non-sustainable exploitation by international commercial interests.

6 Current Impact: Impact by the usual users of an area.

7 Protection through Park Status Potential: The extent to which it is feasible to fully protect an area through park status depends, for instance, on the attitude of local government, the presence of regular shipping lanes, the amount of nearby deforestation, and the number of people living in an area.

8 Ecotourism Potential: A combination of (i) attractiveness, (ii) accessibility, (iii) infrastructure, (iv) proximity to the terrestrial park, (v) proximity to other places of interest, (vi) range of activities available to tourists, (vii) proximity to good forest, (viii) potential for managing tourists, (ix) acceptability to locals, (x) potential for local involvement, and (xi) potential for long-term survival of the industry.

9 Mangrove Protection Potential: Simply the amount of mangrove present.

10 Habitat Diversity: An equal weighting of the absence or presence of the following habitat types: lagoons, reefs, breaks, exposed rocky shore, sheltered rocky shore, exposed sandy beach, sheltered sandy beach, islands, mangroves, seagrass, littoral forest, estuary, and swamp.

species was derived directly from species counts at the sampling sites. Other criteria were somewhat quantifiable, such as overall condition of coral, which quantitatively combined subjective ratings of coral breakage and algal overgrowth. Still other criteria (such as rare, unique or unusual features), were not, strictly speaking, quantifiable, but it was possible to express the investigator's informed subjective judgment in terms of a numerical rating. Subjective ratings were made in this study by Dr F Odendaal and M Kroese. The ecotourism potential of a site combined a suite of sub-criteria, both quantifiable (such as the proximity to the terrestrial park, and the range of activities available for ecotourists), and subjective (such as attractiveness of the area).

Once all the variables have been rated for each potential marine reserve area, the "apples versus oranges" problem of comparison is immediately apparent. One area might have high ecotourism potential which could bring in much needed funds for running the park, while another site may be unappealing to tourists but contain the last population of a rare organism. The two sites would show different profiles of high and low ratings.

In this study, the comparison problem was addressed by providing policy-makers with several different Overall Ratings (ORs) for each area, calculated under several different assumptions about policy priorities. (Table 4). For instance, under one priority regime it is assumed that ecotourism is most important because it is crucial to success of the reserve. Ecotourism potential is therefore weighted heavily, influencing the OR perhaps twice as much as all the other variables put together. Under another priority regime it is assumed that conservation of biodiversity is paramount, and ecotourism development is strictly optional. The relative weightings could well be reversed. However, there is high covariance between many of the variables, so it would not be surprising to get approximately the same results under different priority

regimes. For example, an area with high species representation will for that very reason be attractive to ecotourists, and so will probably rank highly in any priority regime.

3.4.6 HUMAN DEMOGRAPHIC CONSIDERATIONS

The distribution and number of people are of the utmost importance in designing reserves and developing management guidelines, a much less difficult task when human numbers are low; yet as human population density increases so does the need for reserves and management. The peoples technological development must be considered, as well as their sheer numbers; a hundred fishers with pirogues and spears may damage marine resources less than a handful of fishers armed with gillnets and 2 ton motorized vessels. We therefore visited all the coastal villages to see how many people lived there, how many fisher families there were, whether they owned their own boats and whether they had motorized vessels. Interviews with fishers along the entire coast also contributed to our understanding.

3.5 RESULTS OF THE DELIMITATION STUDY

3.5.1 SAMPLING OF SELECTED SITES

The number of fish and coral species found at the thirty-eight sampling sites, as well as the levels of coral breakage, algal growth, and overall coral health, are shown in Table 2. For easy comparison between sites, species count percentiles are also shown.

3.5.2 AERIAL SURVEY OF THE COAST

The aerial survey confirmed the positions of the reef breaks used in the initial definition of biogeographic subdivisions (Figure 2), and that the Tampolo Area has the largest visible coral deposits on the Baie d' Antongil side of the Peninsula. We also found that the Tanjona Area has the most extensive mangroves, and the Ambohimahery and Ratsianarana

Rivers also have extensive mangroves that extend several kilometers upriver. All of the areas were rated on mangrove protection potential on a scale from one to five, based on the aerial survey and site visits. A

Table 2: Results of Underwater Sampling at 38 sites on the Mosoala Peninsula.

Site No	Area	Locality	Zone *	Fish Species	%ile	Coral Species (alive)	%ile	Algal Growth Index**	Coral Breakage Index"	Coral Health Index**
1	1	Ambatofotsy 1	L	49	61	14	70	4	5	4.5
2	1	Ambatofotsy 2	H	62	84	12	60	3	1	2
3	8	Onive Mouth	L	25	34	0	0	10	8	10
4	2	Ambodiarafia 1	L	43	58	14	70	2	1	2
5	2	Ambodiarafia 2	H	48	65	19	95	1.5	1	1.5
6	2	Ambodiarafia 3	H	53	72	16	80	1.5	1	1.5
7	2	Ambodiarafia 4	M	44	59	12	60	4	3	4
8	2	Ambohomahery 1	L	53	72	7	35	7.5	3	7
9	2	Ambohomahery 2	H	52	70	14	70	1	1	1
10	2	Ambohomahery 3	M	41	55	14	70	4	4	6
11	2	Ratsianarana	L	56	76	17	85	1.5	1.5	1.5
12	3	Tanjokantafana 1	L	10	14	0	0	7.5	10	10
13	3	Tanjokantafana 2	M	17	23	12	60	1.5	7.5	8
14	4	Ankoala	L	51	69	17	85	4	4	3
15	4	Ankarandava 1	L	12	16	5	25	8	5	9
16	4	Ankarandava 2	H	54	73	16	80	1	2	1
17	4	Antsabobe]	L	68	92	20	100	4.5	3.5	3.5
18	4	Antsabobe 2	M	58	78	19	95	5	4	4
19	4	S Antsabobe 1	L	56	76	18	90	7.5	7	7
20	4	S Antsabobe 2	M	47	63	15	75	6.5	7	6.5
21	4	Tanjona 1	L	28	38	13	65	6	7.5	7
22	4	Tanjona2	M	31	42	17	85	6	8.5	8
23	5	Vinanivao 1	L	32	43	3	15	7	6.5	7
24	5	Vinanivao 2	M	47	63	16	80	5.5	6	5.5
25	5	Ankazofotsy 1	H	71	96	17	85	2	1	1.5
26	5	Ankazofotsy 2	L	48	65	12	60	5.5	4.5	4.5
27	5	Ambodiletra 1	L	61	82	17	85	1	1	1
28	5	Ambodiletra 2	L	_	_	_	0	4	5	3.5
29	5	Agnajaharibe Pt 1	L	29	39	8	40	2.5	8	8
30	5	Nosy Nepato Pt 2	H	65	88	16	80	1	1.5	1.5
31	6	Nosy Nanto	L	62	84	16	80	2	2	2.5
32	6	Cap Masoala	L	43	58	15	75	4	4	3.5
33	8	Namantoana	B	74	100	10	50	6.5	5.5	6
34	7	Antalavia	B	45	61	17	85	2.5	2.5	2.5
35	7	Marofototra	B	66	89	18	90	2.5	2	2
36	7	Anaravana 1	B	48	65	20	100	1	1	1.5
37	7	Anaravana 2	B	_	_	_	0	3	2.5	3.5
38	7	Tampolo	B	50	68	18	90	3.5	3.5	2.5

*L-lagoon; M-mosaic; H-reef break; Baie d'Antongil

** Scale is from 1 (no breakage, no algae, all corals alive), to 10 (high breakage, high algae, all corals dead)

publication on mangroves and their usage on the Masoala Peninsula is currently in preparation.

The aerial survey revealed several interesting and geomorphologically diverse breaks in the coral south of Cap Est. These breaks have long finger-like projections that extend into the lagoon as deep channels, but have never been visited by the investigators as they are located in the extremely wide lagoon that runs from Cap Est to Ratsianarana, off the usual routes used by any of the crafts that frequent the area, including the zodiac of Project Masoala.

3.5.3 MARINE MAMMALS AND REPTILES

The aerial survey area covered 72 km^ out of a total area of 480 km. No dugongs were observed. Four turtles were observed, giving a density of 0,06 turtles km^ or 28.8 turtles for the total area surveyed. A single humpback whale and a group of 5 bottlenose dolphins were encountered between transects and classed as secondary sightings.

Anecdotal information gathered during interviews included the following: an adult pair of dugongs were seen in Ratsianarana two weeks before the delimitation team visited the area. A single dugong was reported from the Cap Masoala area approximately three months before the interview was conducted. These were the only recent dugong sightings reported.

Fishers report seeing many humpback whales during the months from July to October. We encountered five in the space of two hours off Cap Est. Four more humpbacks were seen during the two months the team was in the field.

We encountered five schools of bottlenose dolphins, ranging in size from one to eight animals, at Antsabobe, Cap Masoala, Namantoana and Sahaleno.

The low number of whale sightings was predictable, as most whales leave the Baie d'Antongil by November.[66] Humpback whales use the Baie d' Antongil as a nursery area where their calves grow and gain strength for the migration to Antarctica. Up to 250 whales per month have been observed congregating in the Baie d'Antongil during winter. This has positive implications for ecotourism, as whale watching is a ten billion dollar industry worldwide, and growing. Enterprising businessmen on Ile St Marie are already conducting whale watching trips. The biggest cause of unnatural fatalities to marine mammals is entanglement in gillnets, and there is a large-scale shark gillnet fishery operating in the Baie d' Antongil. This could seriously endanger the marine mammal and turtle

so

populations, as was illustrated in 1994 when a whale became entangled in a gillnet near Maroantsetra and had to be killed. It is imperative that the Baie D' Antongil nursery area be protected from activities that are harmful to whales.

Turtle sightings are encouraging as this region is not ideal for turtle breeding, the coastline being too exposed and the beaches very narrow. However, many turtles are also captured in gillnets, and are considered locally to be a delicacy. Four species of turtle forage in this region. Since turtle numbers are declining throughout Madagascar,[72] and indeed throughout the world, a sanctuary area would benefit their stocks greatly.

The absence of dugongs is most alarming. During our initial survey in 1993, seven sightings were made in two months. Although the aerial survey did not yield any dugong sightings, this does not mean that dugongs have become locally extinct. Less than 10 % of the good dugong habitat on the Masoala Peninsula was actually viewed from air during the

aerial survey. Recent sightings in the Baie d' Antongil and the Cap Masoala area indicate that a small population still remains. They must receive the highest possible protection, and this means preserving their seagrass habitat as well as protecting the dugongs themselves.

3.5.4 EVALUATION OF POTENTIAL MARINE RESERVES The six potential reserves were rated according to the criteria set forth in Table 1, with "representativeness" being based on the average of the species counts at each sampling site within the area (Table 3). For purposes of comparison, each site was given an overall relative (OR), using nine different priority scenarios (Table 4).

Table 3: Average ratings of criteria used to assess site suitability.

A: The OR is the true unweighted average of all variables, and the separate ecotourism potential and representativeness variables have not been averaged out.

B: The OR is the average of the biotic variables only, with all the ecotourism, management and human impact variables omitted. The biotic variables are: rare, unique, or unusual features; representativeness; overall condition of coral; mangrove protection potential; and habitat diversity.

C: Ecotourism potential (EP) is twice as important as all the biological variables (BV) put together, and the OR is calculated according to the following formula:

The Tampolo Area received the highest overall rating in seven of the nine priority regimes. Next came Cap Masoala, with the highest overall rating in two of the priority regimes, and the second or third highest in the rest. Cap Est came third by recieving the second or third highest overall rating in all but one priority regime. Fourth came the Tanjona Area with third place in one category and fourth place in six other categories.

$$\frac{((\text{Average of EP sub-variables}) \times 2) + (\text{Average of BV})}{3}$$

D: The weighting of ecotourism potential (EP) equals that of all the biological variables (BV) put together, and the OR is calculated according to the following formula:

$$\frac{(\text{Average of EP subvariables}) + (\text{Average of BV})}{2}$$

E: The OR is the average of all the ecotourism potential sub-variables only, with all other variables omitted.

F: The OR is the weighted average of all variables, with the ecotourism potential sub-variables as well as the representativeness variables averaged first, before being averaged with the other variables.

G: The OR is the average of all variables excluding ecotourism potential.

H: The ecotourism potential (EP) is twice as important as the rest of the variables (AV) minus the biotic variables (BV), and the OR is calculated according to the following formula:

$$\underline{((\text{Average of EP}) \times 2) + (\text{AV} - \text{BV})}\ 3$$

I: The ecotourism potential (EP) is as important as the rest of the variables (AV) minus the biological variables (BV), and the OR is calculated according to the following formula:

$$\frac{(\text{EP}) + (\text{AV} - \text{BV})}{2}$$

3.5.5 HUMAN DEMOGRAPHIC CONSIDERATIONS

Five of the six potential marine reserve areas have large and growing human populations which use marine resources (Table 5). The exception is the Tampolo Area where there are only six villages with a total of about fourteen families engaged in fishing. For this reason, establishing and managing a marine reserve in Tampolo would be easier than in the other five areas.

Table 5: Demographic data for the six areas.

Area	**Human Inhabitants**
Tampolo	150
Tanjona	263
Tanjokantafana	454
Cap Masoala	1069
Ambatofotsy	1904
Cap Est	2105

3.6 PROPOSED MARINE RESERVES ON THE MASOALA PENINSULA

3.6.1 THREE MAIN MARINE RESERVES

The Tampolo, Cap Masoala and Cap Est areas have the highest overall ratings; Tanjona rated only fourth. However the amount of mangroves and unusual reef structures in Tanjona make it an important site for conservation. While Cap Est is undoubtedly worthy of reserve status, the delimitation team felt that the large human population would virtually prohibit establishing a reserve in this area. Therefore, the three areas recommended for marine reserves are Tampolo, Cap Masoala and Tanjona.

3.6.2 THE TAMPOLO AREA

Tampolo is the most pristine of all the areas. It is flanked by the proposed terrestrial reserve, it contains the largest coral deposits on the Bay Side of the Masoala Peninsula, and relatively few people live there. It is, however, being targeted for exploitation at an increasingly rate: fishers come from as far away as Maroantsetra and Mananara to fish for weeks at a time; at Antsirakisoihy we came upon two men from Ambanizana who were hunting reef fish with spearguns and collecting sea anemones.

We recommend that the area from Ambatomanasy (Pineapple Rock) to Sahaleno, and including the latter with its beautiful river and almost closed estuary, be declared a full reserve. The reserve should extend 3 km into the sea, and no motorized craft or harvesting of any marine organisms should be allowed. A large scale map is included in the marine reserve delimitation report. Pirogues may travel closer to the shore but should not be allowed to land or overnight anywhere in the reserve except for the long sandy beach at Antalavia. This means that local people must travel two to three hours in their pirogues when traversing the Tampolo marine reserve. It may be necessary to allow pirogues additional passage rights in the reserve on windy days when waves make it dangerous to travel further into the Baie d' Antongil.

The exact boundaries of the terrestrial park flanking this marine reserve have to be determined, but the marine reserve should extend at least 500 meters onto land where it does not abut the terrestrial park. The island of Nosy Ndrendra should be included in the reserve; it belongs to a family in Ambanizana who use it in the ceremony of *rasahariana,*[90] but these ceremonial activities need not conflict with full reserve protection as they are not detrimental to the ecology. However, it may be necessary to voluntarily resettle the sizeable village of Ambodiforaha, which is serviced through frequent boat landings on the beaches north of

Ambatomanasy. Such activities are in conflict with a reserve as they can be detrimental to the ecology, and may provide an avenue for smuggling out marine products. Forced removals are not recommended whatsoever; an alternative may be to involved the people in this area in ecotourism development.

3.6.3 THE CAP MASOALA AREA

Cap Masoala contains extremely diverse habitats, including one of very few exposed rocky shores in the region, significant mangrove stands, sandy beaches, a variety of islands, and sizable lagoons. Most strikingly, the area encompasses the transitional zone between the Baie d' Antongil on the west side of the Peninsula and the coral reef system on the east.

The exposed rocky shore is on Anjagnaharibe, a very holy site consisting of an unusual rock formation including the holy rock called Vato Masigny, which has considerable cultural significance. On an earlier occasion, the *Ampijoro* visited the site with Dr F Odendaal, Dr C Kremen and various assistants to request the *Jagnahari 's* blessings for their study

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of marine resources. The authors believe the *Ampijoro* and his associates will agree to have the Anjagnaharibe area with the Vato Masigny and the surrounding littoral forest included in a marine reserve. The rock formation has both exposed and sheltered aspects and contains a variety of tropical rocky shore organisms, including a species of sea urchin that has adapted morphologically to live in the exposed swash, and was not observed by the team anywhere else on the Peninsula.

The area is breathtakingly beautiful, ideally situated for access, and contains two lighthouses and four other concrete houses that could easily be converted to accomodate both ecotourists and park management while providing ready observation points for whale-watching and reserve monitoring. A Cap Masoala marine reserve could become the highlight of ecotourist routes originating from Maroantsetra, Antalaha, Cap Est, or Ile

St Marie (via Mananara). *Eco-Africa Expeditions* has already been approached by a whale watching concern interested in developing a package that will include the Baie d' Antongil, Ambodiletra and Cap Masoala.

However, the village of Cap Masoala is strategically positioned as a stopping place for boats on routes to and from regional centers such as Maroansetra and Antalaha., as well as boats coming across the bay from Mananara. It would be both difficult and improper to deny boats access to one of the very few safe landing spots near the tip of the Peninsula, or to deny the Cap Masoala settlement its traditional access to marine food resources.

Therefore we recommend that the Cap Masoala area be declared a marine reserve consisting of two zones: a totally protected area where all fishing and motorized craft are prohibited (except under emergencies and then under the discretion of the park manager); and a multiple use zone where motorized craft and traditional fishing methods are permitted, but the use of nets is prohibited (Figure 4). Permitted fishing methods would be spearing from boats (not to be confused with underwater speargunning by divers), and two kinds of traps: *vitrana* (long reed fences along which fished are chased into a holding area), and *vovo* (a platted container with a one-way opening). As both kinds of traps are fixed structures, their use can easily be monitored.

The reserve area should extend from the slight protrusion into the sea near the village of Ambavazaha, around the tip of the peninsula beyond the holy site of Anjagnaharibe, and extend three kilometers into the next lagoon system, to the mouth of the small Beankoraka River that flows past an inland settlement of the same name (Figure 4). People from Vinanivao use this river to visit Beankoraka; its mouth would be a clear reserve boundary. The inclusion of both sides of Anjagnaharibe will facilitate

The totally protected zone should extend from the mouth of the Beankoraka River in the northeast to a border extending a straight line from the protrusion known as Cap Baldrisy, south of Nosy Nanto, to the northern tip of Nosy Behentona (Figure 4). The northeast border at Beankoraka ends at the edge of the barrier reef, and for the time being does not need to be extended further into the ocean as most boats give the reef a wide berth. However, from Nosy Behentona to Beankoraka the reserve should extend 3 km into the ocean beyond the edge of the reef as the number of motorized craft in the area will increase in coming years, and they must be kept away from the barrier reef breaks where many large fish and marine mammals such as dugongs reside. The totally protected zone should extend at least 200 meters inland, so that the fringe of

mangroves is thoroughly protected. Fishing of any kind should be prohibited in the totally protected zone, although pirogues may be allowed to pass between Cap Baldisry and Nosy Behentona since the seas around the southern tip of the island can be very dangerous, particularly in the vicinity of a rock formation known as Nosy Bekaka.

The limited use zone should extend from the protrusion near Ambavazaha and the line between Cap Baldrisy and the northern tip of Nosy Behentona. Motorized craft would be allowed, in this zone, and traditional fishing methods (spear and traps), could be used between the string of islands and the shore. Fishing with nets of appropriate mesh size can be permitted immediately outside the reserve. These fishing grounds should be enriched by their proximity to the totally protected and limited use zones of the Cap Masoala Marine Reserve.

All of the islands between Ambavazaha and Vato Masigny should be incorporated into the reserve. Nosy Behento, with its small lighthouse affording 360 degrees of excellent view, has terrific potential as an administrative or accommodation center for the park, and belongs to the government. Also noteworthy are Nosy Nanto, which is privately owned and was recently offered for sale for a thousand dollars, and Nosy Nepato, which may be owned by the government.

In addition to a 200 meter fringe along the shore of the totally protected zone, we strongly recommend that certain additional land areas be included in the reserve:

- A mangrove-fringed river runs along the base of a promontory from which Ambodiletra (literally, "under the rock") derives its name. The reserve should extend inland several hundred meters from the base of the cliff to include both sides of the river, as well as a concrete house from colonial times which would make an excellent administrative

center or research base. An impressive lighthouse sits on the hill overlooking the lagoon, Nosy Nepato, and the ocean beyond. This structure could be renovated as a park management observation point, a whale-watching point, or simply to provide visitors with a rare view of the peninsula. Next to the lighthouse are several concrete houses that could serve as excellent tourist accommodation. These structures already belong to the government.

- The reserve area around Anjagnaharibe, with its holy forest and Vato Masigny, should be extended inland to include several lowland swamps, walking trails, and mangroves between the hill and the mouth of the Beankoraka River.

- Near Ambavazaha are about 15 hectares of littoral forest which belongs to, and is already is under controlled exploitation by the community council known as the *fokontany,* the president of which has indicated to Dr F Odendaal and Jaomanana already that he is very eager to incorporate the forest into some type of reserve.

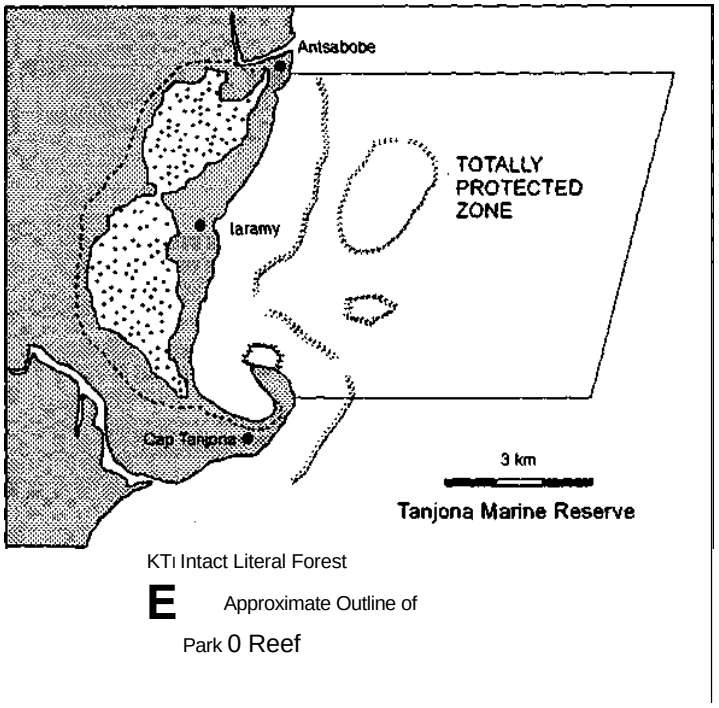
Including these areas and their historically interesting structures in the reserve will help conserve biodiversity, facilitate administration of the reserve, and greatly enhance its attraction as a tourist destination.

3.6.4 THE TANJONA AREA

The Tanjona area contains an unusual and diverse reef structure, an extensive mangrove forest, and a considerable amount of reasonably intact littoral forest near the coast. There are several barrier reefs and lagoons at varying distances from the shore, some lying behind one another in a direct line from the shore to the open sea. As a result, there are a number of deep breaks between barriers, and wide, deep channels in the lagoons containing impressive coral deposits. The mangrove forests are the most extensive on the peninsula, and are in reasonably good condition, as far as

we could tell by observing them from boat and airplane. The large patches of littoral forest in the Tanjona area are worth preserving in their own right, but are also part of the strategy for protecting the marine reserve, since deforestation has well-known detrimental effects on coral reef systems.[32,94,95]

Figure 4: Map of Tanjona Marine Reserve.



We recommend establishing a marine reserve from immediately north of the village of Tanjona to immediately south of the village of Antsabobe (erroneously marked on the 1:100,000 maps as Anjanazana) (Figure 4). The lagoon (15° 48' 42" South, 50° 20' 29" East) opposite the village of Tanjona is severely damaged and probably not worth protecting, so the reserve should start at the break just north of this lagoon, and should include the break and small reef between the outside barrier and the mainland. The eastern border should extend 3 km beyond the seaward edge of the barrier into the ocean.

Although Cap Tanjona is densely populated along its eastern shore, the proposed reserve contains relatively few people and villages (see data below).

Village:	Inhabitants:	Fishing Families:
Tanjona	80	23
Iaramy	50	13
Antsabobe	12	4

3.7 OTHER MARINE RESERVES

This proposed delimitation of marine reserves benefits four of the six subdivisions which were examined in detail. Although the delimitation team felt that the large human population in the Cap Est area would prevent successful establishment of a marine reserve there, it is undoubtedly worthy of reserve status. Other alternatives should be sought within the framework of a regional MPA for bringing some protection to Cap Est. The possibility of a private reserve also should not be discounted, and is under investigation by members of the delimitation team.

3.8 A SANCTUARY FOR MARINE MAMMALS AND REPTILES

We strongly recommend that the entire Baie d'Antongil be declared a sanctuary for marine mammals and reptiles. Existing law prohibits killing whales, dolphins, dugongs, and sea turtles, but neither protects their habitat nor provide safe areas where they can breed. A simple prohibition on hunting these animals is hard to enforce, and turtle of mysterious origin is frequently served for dinner by locals. The term marine sanctuary encompasses a variety of possible protection measures: these can be adjusted by managers to fit new circumstances.

There are many reasons for declaring a sanctuary for marine mammals and reptiles in the Baie d'Antongil:

- It is an ideal breeding area and refuge for marine mammal and reptile species, whose populations are dwindling the world over. The Baie d' Antongil is close to Ile St Marie where whales also breed for several months each year. The influence of a sanctuary in the bay may well be to consolidate these two areas for whale breeding.

- The budding whale-watching business at Ile St Marie could easily be extended into the Baie d' Antongil, greatly increasing the attraction of ecotourism destinations such as Nosy Mangabe and others on the west coast of the Masoala Peninsula.

- Designation as a sanctuary, in combination with MPA status, will facilitate regulation of international commercial fishing activity, whose extremely harmful effects on fish populations in the Baie d' Antongil have been detailed elsewhere.[8,11] Without any official recognition of the bay's extremely high biological importance, local interests likely will continue to be powerless to stop the continuing non-sustainable exploitation of fishing stocks in the bay by outside interests. Fully protected reserve status for the entire bay would be too severe, however, since the local fishers by the hundreds would abruptly lose their livelihood. Demonstrating the connection between sanctuary status, reduction of outside exploitation, and replenishment of fish stocks reserved for local exploitation, will serve as a powerful example to educate and develop goodwill among the regional inhabitants; as previously noted, these are essential components of any viable strategy for overall management of a region's marine resources.

3.9 A MALAGASY FIRST: THE MASOALA MARINE PROTECTED AREA

It is well-known that setting aside reserves is not enough to protect marine resources. On land, sizable reserves may well prove sufficient to protect terrestrial ecosystems and resources, but the same generally does not hold for coastal and marine resources. The forests of Masoala constitute one very large but fairly closed ecosystem; even the watersheds are rather discreet entities. Therefore, the terrestrial park should succeed in preserving the forest ecosystem even if conditions outside the park deteriorate. The marine environment, on the other hand, is an open system: events outside the borders of a reserve can directly influence conditions inside. Management and control of the entire coastline is therefore essential.

Only three small fully protected reserves have been delimited: Tampolo, Tanjona, and Cap Masoala (the latter consisting of a totally protected zone and a limited use zone). Together, these three reserves, excluding Cap Masoala's limited use zone, make up less than 10% of the coastline of the Masoala Peninsula. As a general rule, at least 10% any coastline should be set aside as fully protected reserves. This goal is not met on the Masoala Penninsula, let alone the coastline of Madagascar, on which there are presently only two tiny biosphere reserve, at Nosy Tanikely and Nosy Antafana. The three proposed marine reserves incorporate far less of the coastline than the corresponding percentage of land that is earmarked for conservation, yet many more people depend on marine resources than the forest for their livelihood. Ensuring that all marine resources are used in a sustainable manner, including those outside the reserves, is of critical importance to a large number of people.

It follows that neither Project Masoala, CARE, ANGAP, DEF, nor any other group that is party to recommendation and decision-making can

afford the illusion that establishing three marine reserves and a sanctuary will be sufficient to protect the marine resources of the region. We strongly recommended that, in addition to the proposed marine reserves and sanctuary, the entire remaining coastal region of the Masoala Peninsula, extending beyond Cap Est at least as far as Antalaha, be officially declared a MPA. The delimited areas must be viewed within a comprehensive management context to protect the coastal zone of the Masoala Peninsula. The following coastal zone components need to fall within its borders:

- the entire coastline, extending seaward and beyond the barrier reef to the 50 m isobath (which is marked on the 1:100 000 topographic maps);

- the entire coastline, extending landward to include all major mangrove and littoral swamp or forest stands.

The MPA is therefore available for the application of a variety of management techniques, including those applying to small-scale pelagic fisheries. Within the broader MPA the three marine reserves function as core areas for conservation and stock regeneration while the Baie d' Antongil is available to whales, dolphins, dugongs and turtles as a sanctuary where they may not be harmed or their habitat degraded. It also functions as a nursery area. The proposed Masoala MPA and its component parts are shown only schematically in Figure 6, as the land and seaward borders can be drawn in detail on large-scale maps.

If our proposal to designate the entire coast of the Masoala Peninsula as a MPA sounds drastic, one must remember that the management of marine resources is notoriously difficult, even in so-called developed countries with long histories of marine management.[27,97] Basic biological

information necessary for management is usually difficult to obtain, resources are difficult to monitor, undeclared catches and other irregularities are difficult to curb, and rights of exploitation are seldom clear so that marine resources are usually treated as a commons,[27,98] or liquidated for quick profit. ' The only reasonable chance for success is a comprehensive managment effort enlisting significant support throughout the region.

Obtaining the support of local people is a realistic goal: they are well aware that their own catches have been diminishing. With the proper approach, they should readily understand that the purpose of the MPA is not to discriminate against people in the interest of conservation, nor to put anyone living in the region at an economic disadvantage, but to protect the coastal marine resources for sustainable harvesting by the inhabitants of the region. Management of marine resources does not mean that local people will have to leave the area or live in a radically different manner, but rather, that they will be able to work with MPA managers to gain more control over their own future.

Several advantages of MPA status are immediately apparent:

- MPA status means that the government acknowledges the many problems surrounding the use of marine resources in the region;

- MPA status provides a convenient framework for educating fishers and other users of marine resources. The mere existence of a MPA heightens awareness of the fragility of resources in the area, and emphasizes that exploitation must be sustainable if it is to continue;

- MPA status means that the activities of unfavorable outside interests can be drastically curbed when necessary;

- MPA status opens the road to the implementation of innovative management regimes, such as rotational harvesting between different lagoons or establishing minimum net mesh sizes. Without MPA status, consent might be required from a myriad of affected parties each time a new technique is applied.

- MPA status makes it possible to regulate people and their activities within the borders of the MPA, which is ordinarily not practical in

open access public areas. Management of marine resources is largely a misnomer; what is usually meant is management of people who use marine resources or otherwise affect the marine habitat.

- MPA status entails certain advantages for local people. For instance, they can become license holders, allowing them access to the MPA while keeping outsiders out. On land the equivalent will be a system of land tenure which gives its holder a sense of ownership and responsibility to a property an area. Likewise, marine license holders can be expected to help police areas in which they have a stake against outsiders.

Guidelines for managing the Masoala MPA are detailed in later sections of this report. It suffices to mention here that some options, such as regulating mesh sizes of nets, will probably be uniform throughout the MPA, while others will pertain only to selected areas, such as rotating harvesting between certain lagoons. The point is that the way of life of the fishers does not have to drastically change after the declaration of the MPA; rather, MPA status should facilitate cooperation between fishers and managers. The approach should always be to work with the people, never around them or against them. However, simply teaching local people how to catch more fish, sharks, or otherwise increase their harvests would be disastrous; rather, they must understand the necessity of using their marine resources wisely on a sustainable basis. Education will play a critical role in MPA management. People must be won over to a new way of looking at marine resource exploitation; regulations which are seen as being imposed by outsiders will almost certainly fail.

Debate has raged among officials of Project Masoala on the relationship between marine resources and conservation of the forest, particularly, whether the management and sustainable development of marine resources will benefit the forest. That some relationship exists is beyond

doubt. However, there is no reason to believe that a healthy marine resource base inhibits destructive exploitation of the forest; people who have become wealthy from marine resources are in no way detered from buying chain saws and hiring others to clear land on their behalf. On the other hand, if marine resources fail, the people will have no alternative but to exploit whatever forest resources they can reach. In any case, the argument is moot: marine resources must be preserved in their own right whether or not they have any effect on preservation of the forest.

3.10 THE ROAD AHEAD

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The marine reserves have been delimited and will soon be declared. It is therefore imperative that specific management plans be written for the three core reserves before they are offically declared and hence will start to function as parks. Such management plans need to include the following:

- Guidelines on how the local inhabitants can be incorporated in park management, or be included as guides, guards or other service providers;

- An analysis of all aspects relating to tourism development in the three core reserves such as tourist requirements (routes, accommodation and other requirements), and methods of lessening the negative impact of tourists;

- An analysis of management plans of similar marine reserves in the developing world so that mistakes are not repeated;

- Ways be found to optimally utilize those environmental characteristics that are unique to each reserve;

- Guidelines on how to minimize the impact of infrastrucure on the environment;

- A monitoring system that will detect the impact of tourists as well as other short- and medium term changes;

- Guidelines on all management issues;

- Clear maps and guidelines on what activities are allowed where.

Delimitation of reserves is the easy part: the road ahead will be fraught with difficulties requiring immense courage and hard work from everyone involved. After official declaration of the Masoala Marine Protected Area, borders must be marked precisely and reserves established, with managers soliciting the approval and understanding of the local people. Most importantly, the new MPA managers will have to find innovative ways to take the MPA off of the map and into the real world of ecology, society and economics. If they are successful, we expect that the Masoala MPA will inspire similar actions elsewhere on the Madagascar coast: developing sustainable ways of exploiting marine resources is clearly in the national interest, and the need to conserve Madagascar's priceless underwater environment is felt globally.

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22 Interviews done all over the Masoala coastal regions point to a considerable decline in shark numbers. This decline has also been noted by G van Schalkwyk at Cap Est who fishes for sharks as well as buying shark fins from local fishers.

23 Most targeted shark fishing is done with gill nets, resulting in a high bycatch of other species (turtles, marine mammals, skates and rays and fish). Mesh size is small, resulting in the capture of many small shark with fins that have no commercial value. Sharkfishing is unregulated and little if any catch data is available. Unprocessed Shark fins are sold on the Masoala Peninsula for between 5000 FMG - 15 000 FMG/kg to traders. These fins are then processed and exported, primarily to Hong Kong, where the best quality fins can fetch up to $100/kg (or about 350 000 FMG).

24 Dr Michel Vely is a veterinarian surgeon with considerable experience in marine mammals pathology and he has conducted aerial surveys in Mauritania. He is currently continuing ship-based surveys of marine mammals and has initiated a photo identification study in the Bay d' Antongil, in conjunction with the Centre for Dolphin Studies, Port Elizabeth Museum, South Africa. Much of the anecdotal information on marine mammals, particularly whales, was provided by Dr Vely.

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CHAPTER 4

PREREQUISITES FOR DEVELOPING AN INTEGRATED MANAGEMENT PLAN FOR THE COASTAL ZONE OF THE MASOALA PENINSULA, MADAGASCAR

4.1 INTRODUCTION

Sustainable development starts with two pivotal processes: the organization of users, and the education of local communities in marine resource management[1,2,3] and without these even the most well-conceived management plans will be incomplete and ineffective.

Coastal zone management in the region requires the full support and cooperation of the entire human population that lives along the coast. It also requires the active participation of resource users. Ultimately artisanal fishermen must be recognized as the *de facto* managers of the resource[1,2] and thus need to be thoroughly educated as to the nature of their resources. The better their understanding of management issues and proposed actions, the better the chances that they will give the Integrated Coastal Zone Management Plan (ICZMP) their full support.

4.2 EDUCATION

The current strategic plan for the management of coastal resources emphasizes the need for a comprehensive educational program that will include the following components:

4.2.1 THE BASIC ECOLOGY OF CORAL REEF SYSTEMS

Resource users in the region are largely ignorant of the basic biology of their resources. Very few fishermen have had the opportunity to look at ecological interactions under water, which will give them insight into a system composed of highly interdependent components. When people do not understand why certain actions have a negative impact on the resource base, they cannot be expected to refrain from these actions, particularly if they derive immediate gain from it. A case in point is the mutually dependent relationship that exists between coral and fish communities. Fishers frequently damage or destroy coral heads in order to catch the coral fish. Few of them realize that by destroying the coral they are damaging the foundations of their resource. Unfortunately the intricate workings of coral reef systems are known mostly to scientists who have the opportunity and equipment to study the system under water. The coastal population should be given access to this basic ecological information as soon as possible.

4.2.2 THE RATIONALE BEHIND THE BROADER MPAS

The impression of the authors, gleaned from numerous conversations with resource users, is that local inhabitants would be willing to support the establishment of reserves and other MPAs. However, resource users need to

understand the role of the three core reserves in the overall management of marine resources. They need to be provided with the with the following:

- an explanation for the establishment of marine reserves;
- a description of the three core reserves with a short rationale for their localities, shapes and sizes;
- clear maps showing the boundaries of the reserves;
- clear guidelines as to what types of activities are allowed near or inside the reserves.

4.2.3 DETAILS OF THE ICZMP

The rationale behind an ICZMP outside the reserves need to be explained to the inhabitants of the coastal zone. Resource users are much more sympathetic to regulation when they understand the need for it, and are clear as to what is expected from them both as a group and as an individual. The project staff need to introduce the concept of resource management outside reserve areas to all sectors of the community. This can be achieved by assessing their situation through the identification of problems, opportunities, constraints, and means of overcoming these constraints. The process must be continuous and dynamic: when certain problems are solved, new ones must be identified and addressed. Informal community leaders and fishers who have already expressed an interest in the project are good starting points.

4.2.4 METHODS OF EDUCATION

The educational process should emphasize the importance of the participation and cooperation of local resource users in all coastal management initiatives.

The direct involvement of fishermen of the Central Visayas community in the Philippines helped them realize that they themselves can significantly improve what many have regarded as a hopeless situation. The situation in Central Visayas shares many similarities with the Masoala Peninsula, and there is no reason why the latter one cannot be managed equally successfully.

The following methods of education are realistic for the Peninsula:

- *The showing of films:* CARE has previously commissioned a film aimed at fishers in the region. The film shows fishing and makes note of the growing concern among members of the fishing community about the dwindling of resources. It points out certain problems and discusses reasons for the decline in fishing stocks. The film also illustrates the relationship between fish and coral. The reaction from two showings in Maroantsetra confirmed the use of videos as a highly effective educational tool. People on the Masoala Peninsula are eager to watch videos when they have the chance. Copies of the video should be made available to video equipment owners who show video cassettes of popular films in the streets, shops and sometimes private homes. Two such persons, one in Antalaha and one in Maroantsetra, indicated that they would be prepared to include the film with the showing of commercial videos. One has a video show that travels between Antalaha and Abohimahery.

- *The distribution of booklets that are clearly written and illustrated:* It is recommended that a popular booklet be written in local dialect and designed to follow in the wake of the film. This booklet should clearly illustrate, in comic book-style, the relationship between the health of the resource and different methods of exploitation. Unfavourable practices and their effect on the resource could be illustrated, but examples of wise resource use must be shown to emphasize the long-term gain that comes

from sustainable practices.[4] Many people in the region read sufficiently well enough to understand the message being conveyed. Younger people in particular are desperate for reading material of any kind.

- *Traveling workshops for fishers:* Traveling workshops on the Peninsula are likely to be popular and effective in the dissemination of information. These workshops can be run by an educational officer who is versed in the subject of marine management. This officer's tools will be films, booklets, and participatory group discussions.

- *Grassroots education in schools.* There are several official schools on the Peninsula and a larger number of informal arrangements between teachers and groups of parents. Basic teaching aids such as books and pencils are very scarce in the region so that conservation-minded literature will be welcomed and easily digested by students and teachers alike. Children can be taken down to the lagoon and be given a chance to look at the fish and coral under water.

4.3 REGULATION OF RESOURCE USERS

The integrated conservation and development process must begin at the most basic, but most important, level, that of the fishing community. The fishers of the Masoala Peninsula have proven to be very interested in the well-being of their common resources, and when properly organized they will make ideal participants in the management of their resources. Several principles have been developed elsewhere concerning the management of common resources:

- the solution to common resource problems starts with the control of the access to the resources;

- increasing production from a common property resource depends on the conservation of the resource base;

- the sustainable utilization of a resource is closely connected to the use of appropriate technology for the harvest of that resource;

- local-level management improves prospects for the sustainable use of a common resource.

The management of coastal resources to a great extent means the management of individuals and entities that make use of coastal resources. For regulations to be effective and for coastal management to be successful, the total collection of resource users need to be organized into management units. Only when a community is properly organized in relation to resource exploitation, will they stop to view the resource as an open-access system that can be exploited in an uncontrolled manner. To treat the entire area as a single management unit will deny many demographic characteristics of the human population there, and will be a dangerous mistake.

It is therefore recommended that the region's coastal zone be divided up into smaller units for the purpose of effective management. Smaller units are easier to manage than large ones. The division of the region into units must take into account already existing resource use patterns. Each unit must serve the common interests of the users inside that unit, as well as to promote the conservation of resources used by them.

It is appropriate to make mention of Hardin's landmark paper titled *The Tragedy of the Commons*[1] In this paper the author introduces a powerful concept of resource use which graphically explains what happens when a number of people have open access to a common resource. Consider a tract of pastoral land to which a number of farmers have equal access. Such an area is referred to as a commons. Each farmer gains from having his or her livestock graze on the tract of pastoral land. If the herd sizes are equal, each farmer benefits equally from open access to the commons. But the cost of grazing equally, through decreased carrying capacity, is also borne equally by each farmer. The problem comes in when a farmer adds an additional head of cattle to a herd. Now the benefit of the additional head of cattle goes entirely to that particular farmer, while the cost of this addition is shared by all the farmers who use the commons. Other farmers quickly follow the example. When enough of them add more head of cattle to their herds, the land becomes overgrazed and the commons is eventually destroyed.

The inhabitants of the coastal zone of the Masoala Peninsula presently view the region's marine resources as a commons, and treat it accordingly. There is little difference between Hardin's pastoral commons and a typical lagoon. Fishers have equal access to the lagoon and would exploit resources as hard as they can. Many of their actions parallel the additional head of cattle in Hardin's commons. The benefits of removing a school of large parrot fish from a reef break, for instance, goes to one or two fishers with spearguns but the cost is borne by all. When a fisher breaks the coral on the reeftop to harvest an octopus, the benefit goes to this fisher but the costs are shared by all. When one fisher collects a large number of undersized lobster in a lagoon the benefits goes to the perpetrator of this action alone, but the cost is shared by everyone.

Many problems arise from open access to the lagoons and reef tops. The situation is further taxed by the arrival of new migrants. Emerging markets add further incentives for actions by entrepreneurs that will eventually lead to the liquidation of the resource.[8] For instance, nothing prevents individuals from hiring fishers for a nominal fee or equipping divers to spearfish for them on a profit sharing basis. A typical end scenario in that type of situation is that the main perpetrators of the resource liquidation make enough money to move on to new ventures while the rest of the population remains in poverty.

One way to prevent the deleterious impacts that arise in a commons situation is to instill in the local users a sense of communal *ownership.* Only those users who are geographically linked to a particular unit have access to the resources occurring there. They will not only be the managers but also the guardians of the resources in that unit and any threat to the resource will be regarded as a threat to the whole community. The following steps are recommended:

- patterns of resource use need to be determined with the help of the users;
- the geographic borders of a unit are determined in conjunction with the users;
- users in a particular unit are issued with photo identity cards which gives them access to the resources inside the area outlined

4.3.1 MANAGEMENT UNITS

Decisions on the number and shape of individual units must not be arbitrary. Units should, insofar as it is possible, be cohesive and their limits determined by processes that take into account geographical, social, and biological

features. Until such information has been gathered and the appropriate meetings held, the areas in the box below are listed only as examples of potential management units. They make sense in terms of numbers of fishing families (Appendix One), the geography of the coastline, and the positions of the marine reserves. However, their exact borders need to be decided in conjunction with the resource users.

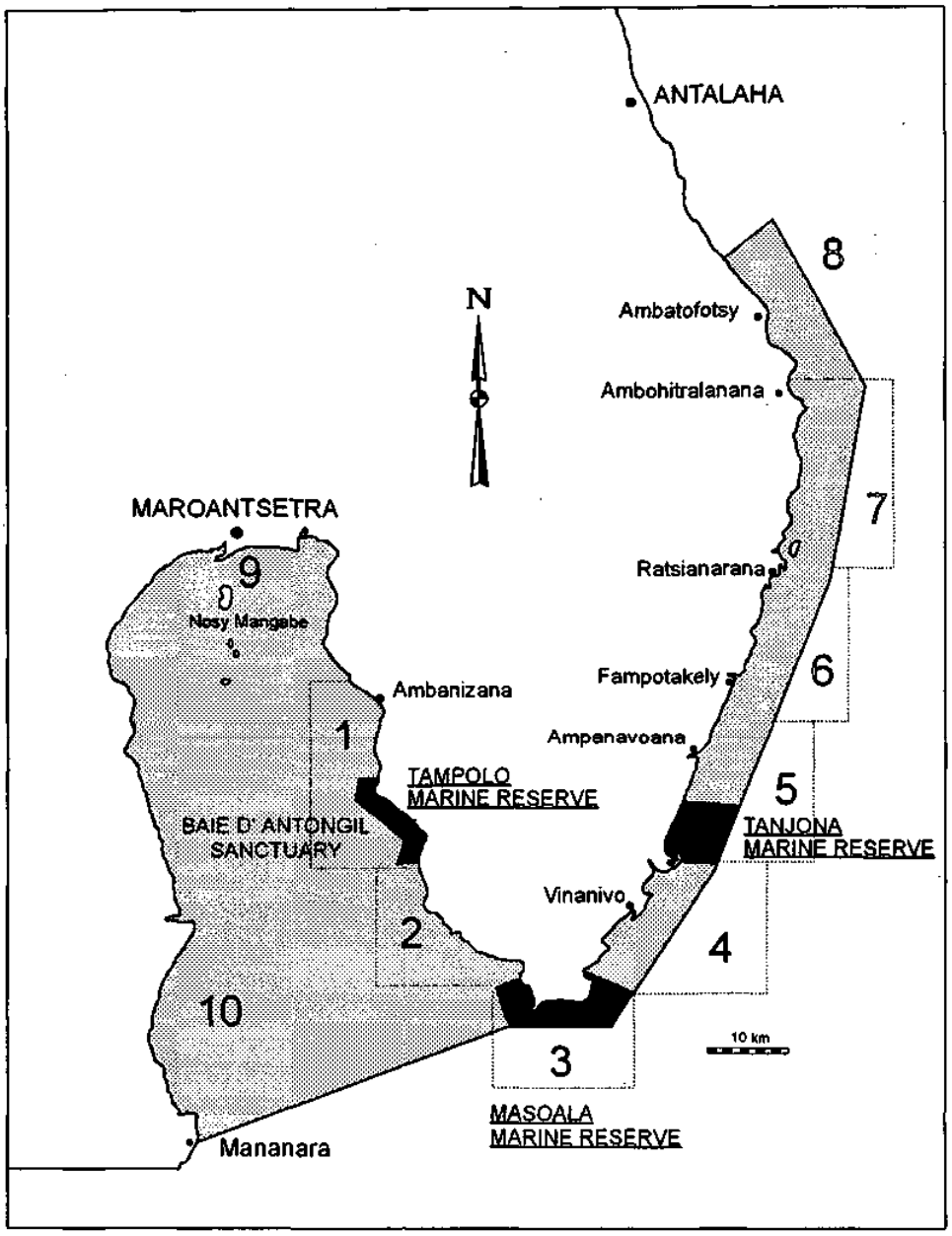
Unit 1	**From Nandrahanana to Ambodiforaha, including Tampolo Marine Reserve.**
Unit 2	**Sahaleno to Ambavazaha**
Unit 3	**The Masoala Marine Reserve**
Unit 4	**The northern border of the Masoala Marine Reserve to the southern border of Tanjona Marine Reserve**
Unit 5	**The southern border of the Tanjona Marine Reserve to Ampanio, *so* that the section without reefs is divided equally**
Unit 6	**Ampanio to Ratsianarana**
Unit 7	**Ratsianarana to Ambohitralanana**
Unit 8	**Ambohitralanana to northwards toward Antalaha**
Unit 9	**The northern end of the Baie d'Antongil**
Unit 10	**The western side of the Baie d'Antongil**

4.3.2 Further Advantages of Management Units

There are other advantages to the organization of fishers into management units that extend beyond fishing rights. Management units:

- are the building blocks that make up higher levels of representation without loosing grassroots support;

Figure 1: Proposed localities of management units.



- can function as local lobby groups so that fishers never become alienated from higher levels of management;

- can function as marketing entities for the benefit of the fishers that are in them;

- are discrete entities in which other technologies can be tested or deployed, such as the installation of limited pelagic fishing fleets;

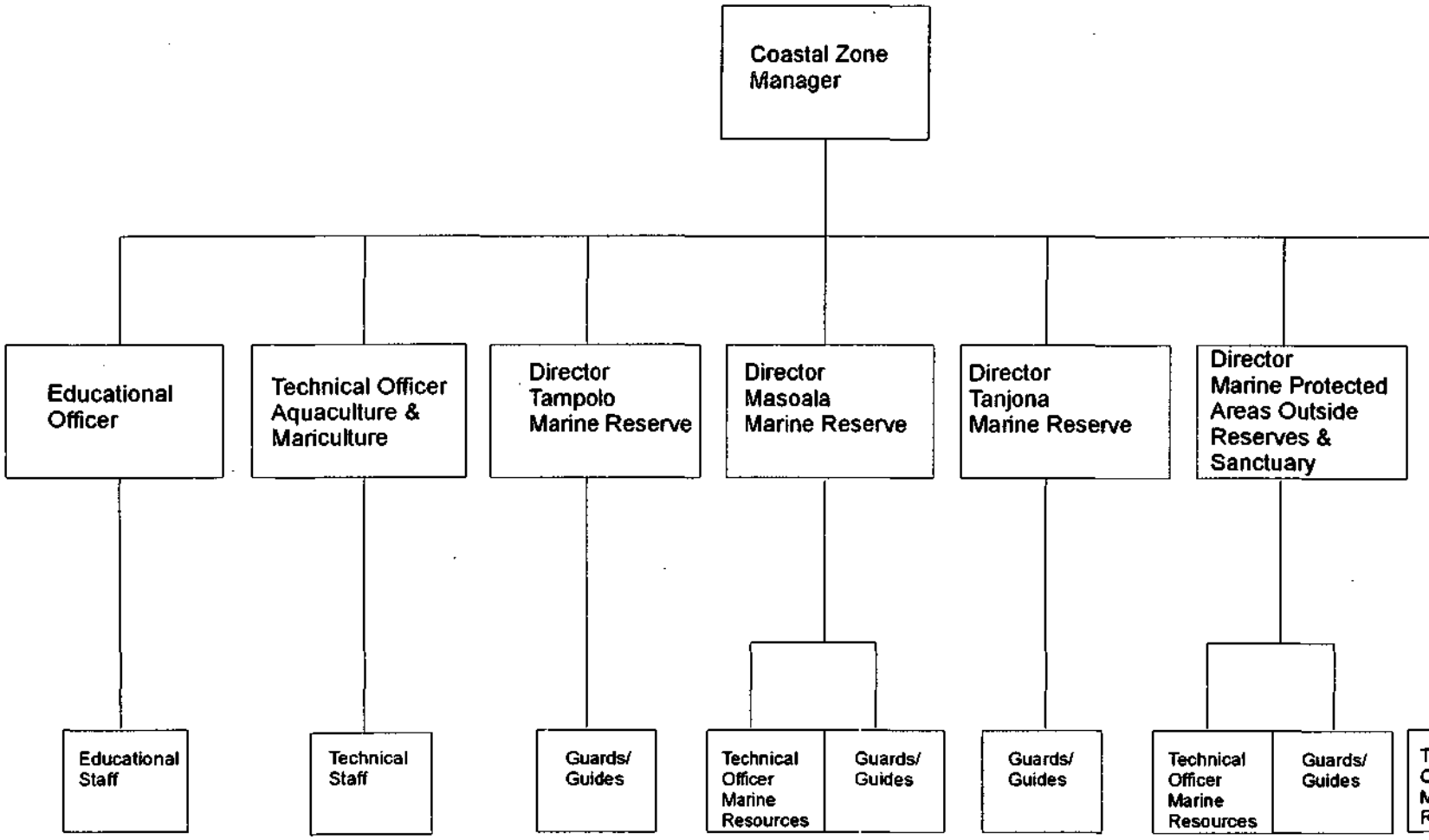
- can play a most useful role in aspects of development other than fishing, such as the development of ecotourism.

Project activities should begin on a small scale. They need not be the same in all units. As resource management techniques begin to work for one unit, others will see their positive results and thus can learn from successful units.[1] Fishers from one unit can be encouraged to visit other units where appropriate technologies are already in place. Units are loosely linked by having a single representative promote the cause of fishers with higher authorities.

4.3.3 THE COASTAL ZONE MANAGEMENT AUTHORITY

Management units will not arise spontaneously. The local resource users will likely need some assistance in organizing themselves into these units. After the concept has been introduced to the local resource users, the formation of the units will have to be encouraged and periodically assessed by the Coastal Management Authority that will ensure they function optimally. To this end it is recommended that a Coastal Zone Management Authority be put in place as soon as possible. This Management Authority will not only attend to the individual units but will also coordinate collective action across between units.

It is proposed that the Coastal Zone Management Authority be set up so as to include the following components (Diagram overleaf):


Coastal Zone Manager
Educational Officer
Technical Officer Aquaculture & Mariculture
Director Tampolo Marine Reserve
Director Masoala Marine Reserve
Director Tanjona Marine Reserve
Director Marine Protected Areas Outside Reserves & Sanctuary
Educational Staff
Technical Staff
Guards/ Guides
Technical Officer Marine Resources
Guards/ Guides
Guards/ Guides
Technical Officer Marine Resources
Guards/ Guides

1 *The Masoala Peninsula Coastal Zone Manager*

This manager oversees all aspects of management along the region's entire coast.

2 *The Directors of the three marine reserves*

These directors each oversee the management of their allocated reserves. It will be helpful if a director hails from the same region where the reserve is located. Project Masoala already has promising individuals on their staff who can be trained for these positions.

3 *The Director of the Baie d 'Antongil Marine Sanctuary*

This director oversees all integrated conservation and development activities in the sanctuary, as well as monitor and regulate all commercial activity in the area.

4 *The Director of the MP As that fall outside the reserves and sanctuary*

This director oversees all actions in the MPA outside the reserves and sanctuary. This will be a particularly challenging position as the individual will be involved in many conservation and development activities, including the introduction of new technologies of resource enhancement.

5 *An Aquaculture/Mariculture Technical Officer*

This officer will establish and manage several aquaculture/mariculture projects that will include the farming of both salt and fresh water species for commercial use and restocking purposes and installing and maintaining artificial reefs.

6 *An Educational Officer*

This officer will run workshops, initiate educational programs in schools, and oversee all educational and training initiatives, including that of park guards and promising individuals in local management units.

The above management structure needs to have a certain amount of executive power. A precise description of the duties of each portfolio needs to be written before candidates are appointed. Three broad entities therefore need to be involved in choosing the individuals who will occupy the different portfolios:

- of the Malagasy Government and in particular the Eaux et Foret Department, needs to make the appointments or at least officially sanction the choices;

- the broader NGO community and Project Masoala need to find suitable individuals for the positions;

- local resource users must agree with the appointments and good access to the Coastal Zone Manager must be guaranteed at all times.

It is important to involve the individual management units as intimately as possible in all levels of resource management. A rift between local management units and the Coastal Zone management Authority must never be allowed to develop. The management of marine resources by higher authorities is fraught with problems, and these problems are magnified in multi-gear fisheries[10] such as on the Masoala Peninsula: therefore the foundation of management in the region needs to be by the resource users themselves[2,7]. The building blocks making up this system are the individual management units. The Coastal Zone Management Authority must make full use of this facility and in that regard must function in an advisory capacity rather than adopt authoritarian attitudes.

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Dr F Odendaal and Ms B Berge, an ecotourist who came on both trial runs, donated children's books to the *fokontany* of Ampanavoana. These books were extensively used and many more requests were received for reading material from this and other villages.

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CHAPTER 5

A STRATEGIC PLAN FOR THE MANAGEMENT OF TROPICAL FISHERIES ON THE MASOALA PENINSULA, MADAGASCAR

5.1 INTRODUCTION

Coastal fishing activities are very important on the Masoala Peninsula: they provide food, income and employment for the rapidly growing coastal population. There are many issues facing fisheries management,[12] but the two most critical to the Masoala Peninsula are overfishing and habitat destruction. These two processes are presently leading to a diminishing resource base; if present trends continue unabated, the end result will be the destruction of the resource.

Multispecies-multigear fisheries are notoriously difficult to manage, even in countries with long traditions of fisheries management. Approaches that involve the enforcement of rules and regulations by law enforcement agencies or coastal authorities have not worked well even in western countries, and certainly will not work on the Masoala Peninsula. Therefore it is important to search for solutions that will be appropriate to this region. The overall aim of a fisheries management plan should be to guarantee the sustainable exploitation of coastal resources for all its users. In that respect it is essential that the local resource users play a major role in fisheries management on the basis recommended in Chapter 4.

5.2 MANAGEMENT OBJECTIVES

The objectives of a management plan for fisheries should be:

- To formulate plans that will discourage the overexploitation or inappropriate utilization of fisheries resources;

- To put in place emergency actions that will stem the present downward spiral of overfishing and habitat destruction;

- To gain the support and active participation of all the coastal resource users in the implementation of management actions;

- To encourage community-based management of resources rather than make laws that cannot be enforced;

- To rehabilitate depleted resources through use of appropriate technologies;

- To put in place a fisheries structure and ownership pattern that will promote the sustainable exploitation of resources;

- To eliminate conflict between traditional and commercial fishers;

- To promote the development of responsible offshore fisheries;

- To improve the technical and economic efficiency of marketing sectors;

- To increase opportunities for village employment in the harvesting and marketing sectors of fisheries.

5.3 MANAGEMENT ISSUES AND PROBLEMS

The two major problems that threaten fisheries are overfishing and habitat destruction. Maximum Sustainable Yield (MSY) levels can only be determined when appropriate fish population and catch data are available, but the trends listed in Chapter 2 and 3 are convincing indicators that the MSY is

being exceeded by present levels of exploitation. That means that the exploitation effort, as quantified by the Human Impact Index (HII) on the reef and the number of fishers and boats, clearly exceeds that which can be sustained by current resources.

The problem of overfishing is greatly aggravated by the habitat destruction. When mangroves are destroyed the breeding and nursery areas are reduced, with the result that fewer fish will breed. When the coral is destroyed their ability to find food and shelter is further diminished. Habitat destruction affects the size and composition of fishing stocks and leads to a lower MSY which can be more easily exceeded. The lower MSY means that fishers will have to work harder for the same amount of fish. By increasing their effort and using destructive methods, the MSY lowers. Thus the vicious downward spiral continues until the resource is finally depleted. The bad effects of overfishing and habitat destruction are intricately linked, and becomes more so as the health of the resource declines further. That is why the rate of recovery of the resource will be very much slower in a thoroughly destroyed habitat than a healthy one, even when all fishing activity has ceased.

The guidelines presented in this strategic plan take into account both the problem of overfishing and habitat destruction. Underlying these guidelines is the realization that uncontrolled access to a common resource is the root of most fisheries-related problems.[12] It is therefore highly recommended that fisheries management initiatives proceed along the lines of the social organization into management units as proposed in Chapter 4. This system will allow resource users to manage fisheries at their expense but for their own benefit.[12]

5.4 EMERGENCY MEASURES AGAINST DESTRUCTIVE PRACTICES

Time is needed to collect the data needed for the writing of a specific management plan that will include management techniques such as the manipulation of catch and effort In the meanwhile the following emergency measures are recommended to alleviate the negative effects of the most destructive practices. It should be remembered that education of resource users is a forerunner to other initiatives. Therefore managers need to make sure that fishers know why the various emergency measures are necessary.

5.4.1 ADDRESSING DESTRUCTIVE PRACTICES

The following are destructive practices that need to be addressed as a matter of urgency:

- *Small mesh sizes:* Use of nets with small mesh sizes leads to increased catches of juvenile fish, reducing the population's future breeding component. Mesh sizes should conform to proven international standards, in order that juvenile fish be protected. It is recommended that the minimum size be progressively increased every year over a five year period. Such a system will reduce the economic pressure on fishers as they can increase mesh size when they would normally need new nets. After five years the minimum mesh size should be 5 cm.

- *Spearguns.* These cause damage to fishing resources in a number of ways, ranging from habitat destruction to overfishing. The problem is particularly bad in the case of coral fish as many of them are territorial and slow-growing. The examples set in Mauritius and the Seychelles should be followed, and spearguns should be banned from the region.

- *Reeftop fishing:* When people walk on the reeftop the coral is severely damaged. This practice should be banned outright until fishermen are properly educated so that they will make an effort to curb damage to the coral.

- *Sharkfishing:* This should be strictly controlled and only be practiced using longlines. Gillnets for sharkfishing should be banned (see Chapter 6).

- *Lobster fishing:* A size limit should be established for the harvesting of lobster, and the implementation of a licensing system should be investigated.

- *Nursery areas:* Areas such as mangroves and estuaries should enjoy full protection as outlined in Chapter 9.

- *Education:* Broad-spectrum educational programs targeting the entire population should start as soon as possible as outlined in Chapter 4.

- *Trawling:* Trawling as presently practiced inside the Baie d'Antongil Sanctuary should only be allowed further than 10 km from the shore.

5.4.2 The Role of Regulations and/or Common Agreements

Rules and regulations are often difficult to enforce. Instead common agreements between fishers inside one management unit will be far more effective than laws imposed on them from the outside.[7,16] There are a variety of rural participation techniques available to help bring about common agreements by fishers.

5.4.3 Control of Outside Interests

Outside interests can cause great damage to fishing resources. Not only do they consider the resources to be open to all but, unlike the local resource users, they quickly move to new areas after the resource has been liquidated. Outside interests often bestow no benefit on the local population, except sometimes as a temporary source of employment but even that is rare. The resource is almost always damaged by outside interests. There are several examples[15,17] of damage being done on the Masoala Peninsula by outside interests. Therefore the following four recommendations pertaining to outside interests are suggested:

- All activities by outside interests in the marine protected area (MPA) along the east coast should be prohibited until a comprehensive management plan for fisheries is in place;

- All trawling operations in the Baie d'Antongil should cease immediately on account of the area being a sanctuary for marine mammals and reptiles;

- All motorized craft that fish in the Baie d'Antongil should be duly licensed as commercial fishing vessels. A set of rules and guidelines for their operation needs to be drawn up and must include the mandatory keeping of log books and declaration of catches. Only those boats currently operating should be granted licenses until a feasibility study can be done which will include the calculation of MSY for the Bay. On the east coast licenses should be granted only to current boat owners or people who have lived in the area for a minimum of five years. All licenses should be tied to a particular management unit so that fishing stocks will no longer be viewed as open access resources.

- Before any outside interests can be active in the region they will have to submit a complete proposal on a standardized form to be drawn up and reviewed by the Coastal Zone Management Authority in conjunction with those management units that will be affected by the proposed activities.

5.5 TECHNICAL RESEARCH INTO METHODS OF RESOURCE USE

The abolishment of destructive methods will leave a temporary void that needs to be filled by inventing new technologies or modifying existing ones.

5.5.1 THE IMPORTANCE OF APPROPRIATE TECHNOLOGIES

The importance of modifying or developing appropriate technology has been stressed many times.[18,19,20] Technologies used in the developed world are often too expensive to install or maintain in the developing world; furthermore, fishermen are familiar with their own technologies and are receptive to improvements of these methods that they are familiar with. Their direct involvement as primary implementors of appropriate but successful technologies in Central Visayas, Philippines, made them realize that they themselves can significantly improve what many have regarded as a hopeless situation.

5.5.2 THE NATURE OF APPROPRIATE TECHNOLOGIES

Appropriate technologies relate not only to good returns for effort, but also to sustainability. Materials that are already available, or can be made available on a regular basis to fishers, need to be considered. Whether a technology is appropriate can be judged based on the following characteristics:

- It must improve the sustainability of the resource, or at least not affect it negatively;

- It must be habitat-friendly and thereby help to protect the resource base;

- It must reduce or not change fishing effort;

- It must focus on the quality rather than quantity of the catch;

- It must lead to the better utilization of existing resources.

5.5.3 Improving Existing Methods of Artisanal Fishing

Artisanal fishing is a small-scale and usually traditional fishery usually utilizing low-cost low-energy gear. Artisanal fisheries are typically multi-gear and multi-species fisheries Many people on the Masoala Peninsula practice this type of fishing (Appendix Two). Several improvements ' can be made to existing methods of fishing:

- Rotational harvesting is one technique that may provide temporary relief to a specific area. Rotational harvesting will likely aid the recovery of target areas or at least stem their decline. A rotational harvesting system can be worked out as soon as resource users have been organized into community-based fisheries management units. Fishers have often indicated their willingness to try out rotational harvesting to Dr F Odendaal.

- Better fishing gear can be provided to properly organized management units. Good handlining gear, for instance, can be provided as compensation for people giving up their nets.

- Different species can be targeted on a time-rotational basis to give other species the time to recover. Specific schedules need to be worked out for specific areas, depending on their biological characteristics.

5.5.4 Research into New Methods

Technical research into different methods of sustainable resource use need to be continued. Below follow some possibilities which need to be investigated.

- The installation of a handlining rig that can be operated from the beach between Ampanavoana and Fampotakely. This section of coast lacks a barrier reef but it may be possible for people to take their lines out during good spells in the weather and then pull them in from the beach.

- New methods for harvesting octopus that are not destructive, need to be worked out. Octopus is probably one of the resources with the highest potential to be sustainable since these organisms are fast breeders that are limited only by available hiding. Pods in which organisms can hide can be built locally. It is likely that the carrying capacity of a specific area for octopus can be greatly increased through appropriate technology.

- Lobster are also limited by shelter availability and the carrying capacity of a specific area can be increased by use ofappropriate technologies. Traps that will only catch large individuals need to be investigated.

- Appropriate technologies to breed mangrove crabs need to be investigated.

- Appropriate technologies to preserve marine products need to be investigated.

5.6 POTENTIAL FOR PELAGIC FISHERIES

Unfortunately there exists the impression that the open sea is an inexhaustible source of fish. This is no more true than the statement that Africa is full of large antelope that can never be exhausted through hunting. Fisheries the whole world over are experiencing severe problems of exhaustion and many countries find species that were once common have disappeared from their waters. The open sea does not contain a homogenous collection of species that. respond in the same way to fishing pressure. Some are more fragile than others and require different methods of harvesting. Open-sea fishes occurring in the vicinity of the Masoala Peninsula can be broadly categorized into two types: true pelagic fish that occur in shoals, and demersal or bottom-dwelling fish that are often solitary or occur in aggregations of varying sizes. These two groups demand different considerations when it comes to designing open-sea fishing practices.

5.6.1 ADVANTAGES TO INSTALLING A SMALL PELAGIC FISHING FLEET

The advantages and some guidelines for the installation of a pelagic fishing fleet have been discussed in an earlier report.[17] They include:

- The widening of other management options: fishers who currently exert pressure on inshore resources will be able to make significant catches elsewhere, and may therefore be more willing to practice stringent conservation measures in lagoons and on the reefs.

- The presence of more boats will lead to a better transport infrastructure from which the entire region may benefit. No boat on the Masoala Peninsula is used for one purpose only. Fishing boats can also be used to transporting products and people when not engaged in fishing activities.

- The ownership of a fishing boat by a management unit will help maintain the economic cohesiveness of the unit.

With regard to the feasibility of deploying a pelagic fishing fleet the following steps are recommended:

- All the possibilities and social ramifications [7, 22] of giving boats to management units must be thoroughly investigated and incorporated into a management plan that should be written specifically for open-sea fisheries.

- Three pelagic boats be installed for a trail period in three different management units.[17] Following the successful operation in these experimental units, more pelagic fishing units can be established or one unit can acquire a second boat.

- That marketing constraints be investigated, such as the existing infrastructure to transport products to the market, as well as alternative methods of preparing or preserving products.

- That estimates of pelagic fishing stocks should be made in order to calculate fisheries management parameters such as MSY, before any fleet is installed.

- The use of nets and handlines needs to be regulated by guidelines that take into account the target area and nature of the resource.

- The catch and effort of individual fishing boats that are run by management units need to be carefully recorded by the captain of the boat or a person designated by the unit, so that data for the optimal future

exploitation of the resource can be gathered. Such data are essential when management decisions relating to aspects such as fleet expansion need to be made.

5.6.2 Sustainable Harvesting of Demersal (Bottom-dwelling) fish

Demersal (bottom-dwelling) open sea fishes are largely restricted to reefs and they have in common many of the same characteristics that make lagoon-based tropical fishes a fragile resource. These characteristics are notably the tendency to be territorial and the achievement of sexual maturity late in the life cycle, leading to slow breeding and growth. However, some demersal species can be caught commercially.[13] Their habitat is fragile but less impacted upon than inshore fisheries because of the greater depth of outer reefs in the open sea. Presently few fishers get there by boat. It is recommended that no netting be allowed in the MPA, the latter extending seaward to the 50 m isobath. However, fishing by handline may be encouraged. In fact this method is popular among fishers who have access to craft that can negotiate the open sea safely.

5.6.3 Fish Aggregation Devices (FADs)

Fish Aggregation Devices (FADs) have been deployed successfully in many parts of the world.[18] At Toliara they provide an incentive for fishermen to go there rather than fish on the reef. FADs can be obtained from fisheries-related NGOs or could be made locally using appropriate designs with local materials such as palm leaves. Several advantages of FADs need to be taken into account when making an open-sea fisheries management plan:

- They can lure fishermen away from more to less sensitive areas;

- They can increase catch sizes without damaging the habitat;

- They can provide useful census data on the resource;

- Individual FADs can be owned and administered by individual management units.

5.7 THE ROLE OF MARICULTURE AND AQUACULTURE

5.7.1 THE MARICULTURE AND AQUACULTURE POTENTIAL

Mariculture is the farming or growing of marine products by humans, usually for the purpose of marketing a product. Aquaculture refers to all such projects in water, but is generally used to indicate freshwater cultivation as we do in this publication.

Coastal mariculture and aquaculture ventures have spawned an industry that involves billions of dollars on a global scale. Fish farming and other activities play increasingly larger roles in many developing countries. There are areas that are loosely comparable to the Masoala Peninsula, such as South Johore in Malaysia, where various types of mariculture are commonly practiced: pond cultures of penaeid shrimp *{Penaeus monodon);* cage cultures of seabass *(Lates calcarifer),* groupers *(Epinephelus* sp) and snapper *(Lutjanus* sp); and raft cultures of mussel *(Perna viridis).*

There is little doubt that scope exists in the region for the development of this industry. However, a full impact assessment study needs to be conducted before an industry is developed. Conversion of wetland and mangrove areas for aquaculture could lead to loss of productivity in the coastal zone that in turn could directly affect the fisheries.

5.7.2 IDENTIFICATION OF MARICULTURE AND AQUACULTURE PROJECTS

Several possibilities exist for mariculture: shrimp fisheries at the northern end of the Baie d' Antongil, crab fisheries at Nosy Fanala near Ratsianarana, and lobster farms at a number of selected sites along the coast. The potential of aquaculture projects such as the farming of freshwater fish and the harvesting of mangrove crabs, should not be overlooked. Current and past fish fanning operations elsewhere in Madagascar can provide useful study cases that may be applicable to Masoala. The potential harvesting of several species of mangrove and other land-based crabs needs to be investigated as these creatures have a lot of meat and are relatively easy to cultivate. This source of protein has remained unexploited by the coastal zone inhabitants except perhaps in situations of dire need but even in difficult times not on a regular basis. The meat is edible and tasty but because the crabs occur in mangroves where people tend to go for sanitary purposes, it is considered very uncouth to eat these land-based crabs. This problem can be alleviated by breeding crabs in large enclosures where they will be uncontaminated by human faeces. Lastly, the economically viable culturing of marine algae needs to be investigated.

5.7.3 PROTECTING THE ECOLOGICAL INTEGRITY OF THE AREA

Great care needs to be taken in the selection of mariculture or aquaculture species when these organisms are not indigenous to the Masoala Peninsula. Alien species can do great damage to the stocks and biodiversity of indigenous species.

5.7.4 Developments Influencing the Mari/Aquaculture Potential

It would be wise to keep informed on future developments in the region from the point of view of their impact on mariculture ventures. For instance, several problems have hindered the development of penaeid shrimp fisheries in Java.[23] These problems have also surfaced to a lesser or greater extent in the vicinity of Maroantsetra, where perhaps the most suitable localities for shrimp mariculture in the region exist. The problems include siltation in nursery grounds, shrinking mangrove areas, excessive fishing effort, the use of nets with very fine mesh size, and deteriorating water quality due to pollution by human waste.

5.7.5 Mariculture or Aquaculture Pilot Projects

It is recommended that any promising mariculture idea be tested first by means of one or two small pilot projects before large amounts of money and effort are committed to unworkable ventures. Even pilot projects need to be preceded by an environmental impact assessment study.

5.7.6 Marketing Potential of Products

Even if target organisms can be successfully cultivated, no venture will be successful if it cannot dispose of the product at a reasonable cost within a limited time. Therefore the markets must be investigated and, when possible, new ones created. The growing political ties between South Africa and Madagascar is a positive step in this regard. The consultants have been approached several times in South Africa by people interested in marine products, who ranged from businessmen to restaurateurs. The possibility of establishing one or two community-run processing facilities using appropriate technology, such as vacuum packing techniques, need to be investigated.

5.7.7 Training of a Technical Officer

If the development of mariculture ventures appears to be a strong possibility in the future, a person needs to be identified and trained as soon as possible to fulfill the role of running various mari/aquaculture ventures. Numerous excellent educational and training opportunities in the fields of mari- and aquaculture exist and it will only be a matter of choosing an appropriate program in a training institution.

A management plan for mari/aquaculture will need to include aspects such as the establishment of management zones, impact assessments on the conversion of mangroves, water quality control, developments adjacent to aquaculture sites, and so forth. The experience and knowledge gained from pilot projects and examples of case studies in different but comparable parts of the world will be a valuable resource in writing such a management plan but, at least until potential mari/aquaculture ventures have been identified, it will be premature to do so.

5.8 ARTIFICIAL REEFS AS A MANAGEMENT TOOL

5.8.1 Introduction

Artificial reefs have been used in many parts of the world to enhance and restore living marine resources.[25,26,27] The purpose of artificial reefs is to increase the availability of fish habitat and thereby restore fish populations. Artificial reefs are generally considered to be any solid material which is not already a part of the natural aquatic environment, placed at the bottom of the aquatic environment, aimed at improving the fish habitat and stock and enhancing colonization by marine organisms such as algae, barnacles and shellfish. Studies on Singapore reefs have also shown that artificial

substrates may prove to be a factor in coral recruitment and growth.

Artificial reefs can also be fish aggregation devices.[30 31]

5.8.2 USES OF ARTIFICIAL REEFS: The

uses of artificial reefs are many:

- As a conservation strategy

Artificial reefs provides an appropriate environment for shelter, feeding, spawning, and orientation. There are strong indications that artificial reefs develop a complex marine ecosystem that mimic coral reefs within the area. Artificial reefs also help check trawling in the inshore area since trawl nets are caught in them are destroyed, thus contributing to reef conservation efforts and reducing impact on the reefs.

- As a strategy to increase the productivity and carrying capacity of an area

Fish rapidly school around and colonize artificial reefs. Studies have found that artificial reefs increased the ability of an area to support fish,[29] in such cases the increased biological productivity of an area has been attributed to the expansion of its surface area, allowing for the attachment of invertebrates and larvae.[25]

- As a habitat enhancement strategy

Research has indicated that artificial reefs can be used for habitat enhancement because the artificial reef in the area of the natural reef has doubled the carrying capacity and biomass there.[28]

- As a rehabilitation strategy

The use of artificial reefs in rehabilitating marine and estuarine areas that have been impoverished or are destroyed almost entirely has been illustrated in Biscayne Bay, Florida.[30] The positive effects were evident within six months of emplacement of the artificial reef.

- As recreational fishing areas

Studies showed that selective fishing can be carried out over the artificial reef after a period of as little as one year, and that artificial reefs provide improved recreational fishing areas. ' ' A good artificial reef may be a valuable attraction to fishing sportsmen.

- As commercial fishing areas

Coastal fishermen in Malaysia showed an increase in their earnings of up to 99.7% when fishing over artificial reefs that were made of confiscated boats, and up to 66% when fishing over reefs made of concrete structures. Artificial reefs can be expected to have positive effects on a variety of marine target resources other than demersal fishing stocks. For instance, the lobster population has seriously declined as a result of unsustainable practices by local artisanal fishermen as well as the efforts of a small-scale lobster fishery previously run by Frere Felix. Yet it is well-known that shelter is one important limiting factor in the abundance of certain marine organisms such as lobsters. A series of artificial reefs of the correct construction will provide a sanctuary for the breeding and survival of lobsters and octopus.

The selection of localities for the emplacement of artificial reefs on the Masoala Peninsula will be driven by human need as well as the status of

lagoons or parts of lagoons. It is suggested that artificial reefs be placed as a matter of urgency in areas that have already been severely damaged, where they will help to maintain the biological diversity and resource levels in lagoons.

The emplacement of artificial reefs will require proper planning with respect to their structure and manner of placement in the habitat, as such variables have shown to influence their success. For instance, pelagic and demersal or. bottom-dwelling species are attracted to high- and low -profile artificial reefs respectively. Invertebrates such as shrimp, crabs, and lobsters are attracted to small structures with small holes and crevices while large fish are attracted to high structures with numerous large crevices An artificial reef off St John contained a fish concentration eleven times higher than the two natural reefs in the area, and this difference has been attributed to additional food resources present in the surrounding seagrass beds.

It is suggested that an artificial reef program start with ten artificial reefs of different structures placed in different localities. A program to monitor impact, catches and use by local fishers should be launched so that an optimal future course can be planned. Types of material used thus far[18] for the construction of artificial reefs include items as diverse as old tyres, concrete blocks, bamboo rafts, and confiscated or derelict boats. The cheapest materials need to be considered. On the Masoala Peninsula artificial reefs can be made from baked clay, bamboo, or even discarded building materials from the Palm Oil Project in Ambodirafia.

5.8.3 Management of Artificial Reefs

Artificial reefs, like FADs, should be managed as habitat enhancement structures by the various fishers management units that are responsible for

their emplacement. They will need sporadic maintenance and the benefit of this labour should go to those individuals responsible for them.

5.9 OTHER MARINE PRODUCTS

The presence of other valuable marine products in the region's coastal zone needs to be investigated. For instance, Dr F Odendaal has been approached by a large pharmaceutical company in the United states who are interested in procuring samples of algae and sponges from the Masoala Peninsula. Such products would obviously belong to the people of the Masoala Peninsula and their exploitation must not be allowed to take place without permission from the Coastal Management Authority. It is recommended that an inventory be done on marine products other than the conventional ones.

5.10 MONITORING RESOURCE USE PATTERNS

5.10.1 THE IMPORTANCE OF A MONITORING PROGRAM

The monitoring of fishing resources is of the utmost importance. Long-term monitoring gives an indication of the success of various habitat enhancement techniques and provide valuable data for future planning. Several Malagasy students and Professor S Rakotofiringa from the University of Antananarivo have already done extensive work on the Masoala Peninsula and they can play key roles in a monitoring program. It is suggested that local fishers be trained to do monitoring over all the management units, and that the above academics be intricately involved in the process, particularly when it comes to data base construction and analysis. It is strongly recommended that the two students and the resource manager be sent to South Africa for an intensive training course.

5.10.2 MODELING FOR OPTIMAL RESOURCE UTILIZATION

Appropriate data from a long-term monitoring program both in the artisanal and pelagic fisheries will provide planners with opportunity to make predictive models for resource exploitation in the region. It is strongly recommended that Malagasy students be identified and trained in monitoring techniques.

5.11 TRAINING OF TECHNICAL STAFF

The training of all technical staff is highly recommended. The Coastal Zone Manager will benefit greatly from further training. In this regard there are many existing opportunites. Apart from formal training, it is highly recommended that the manager go to South Africa[34] or Philippines [34] to train at sites which have already proven to be successful.

5.12 FUTURE FISHERIES MANAGEMENT IN THE REGION

This chapter provides some guidelines for the management of fisheries on the Masoala Peninsula. These guidelines need to be expanded and formalized into specific management plans. Local resource users must have an input into these plans. It must be borne in mind that fisheries management is a dynamic process so that the solution of today need not necessarily apply to the future. One complication is that results are not always seen immediately. Managers will do well to retain a great deal of flexibility in the coming years.

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CHAPTER 6

STRATEGIC PLAN FOR THE MANAGEMENT OF THE ELASMOBRANCH FISHERY IN THE COASTAL WATERS OF THE MASOALA PENINSULA

6.1 INTRODUCTION

Chondrichthyans, which are distinguished by the possession of a cartilaginous skeleton, are divided into two subclasses; the Holocephalii (Chimaeras) and Elasmobranchii (sharks, skates and rays). The great majority of commercially important chondrichthyans are elasmobranchs.

Chondrichthyans have evolved a unique lifehistory pattern. They are typically slow growing, adults are large, display late sexual maturity and reproduction, and bear only a few well-developed young. This lifehistory pattern is very similar to marine mammals and reptiles.

Madagascar forms part of the subequatorial African region, the area delimited by the longitudes 10° W to 70° E and latitudes 0° to 90° S. The region has a rich and varied marine chondrichthyan life, with approximately 260 living species represented. This region has a high endemicity, approximately 79 species are area endemics.[3]

Very few elasmobranch fisheries have been subject to regulation or management.[4] Elasmobranchs, such as sharks, display characteristics normally associated with top predators, that is they are K-selected (long lived, slow growth and low fecundity) and thus have comparatively low abundances. These characteristics make them vulnerable to overexploitation.

Management of elasmobranch fisheries is seriously hampered by the lack of. adequate population theory. Biological and fishery data are essential for the assessment and management of any fisheries. Stock production models appear appropriate only when few biological data exist. Assumptions used in stock production models, such as an immediate response in the rate of population growth to changes in stock density or that the rate of natural increase at a given density is independent of the age composition of the stock appear not to hold for elasmobranchs. Although age structure models have been developed for the spiny dogfish, the biological data needed to develop these models are sadly lacking for the majority of elasmobranchs.

Sharkfishing, as it is currently practiced, is not sustainable. Most fisheries collapse within 5-12 years, usually due to poor management leading to over-exploitation. Since sharks are not abundant they are extremely susceptible to over-exploitation. Unfortunately once shark populations are over-exploited, they are very slow to recover.

6.2 SITUATIONAL ANALYSIS

6.2.1 SHARK FISHING METHODS

The preferred shark fishing method on the Masoala Peninsula is with gillnets. Polyamide monofilament line or nylon twine is used to construct the nets of up to 400 m in length and 4 m wide. Most nets are between 100 m and 200 m

long and 3 m wide. Mesh size varies, but usually ranges from 75 mm to 45 cm stretched. The nets are extremely expensive to manufacture and buy because most of the material is imported. Gillnets are known as 'walls of death' because they are extremely unselective, catching anything that swims into them. Whales, dolphins, turtles and birds are some of the animals often caught in gillnets. Usually there is a large by-catch of smaller sharks with poor quality fins, as well as skates and rays, most of which is considered superfluous and of no commercial value.

Although sharks are caught along the east coast of Masoala as a by-catch, there are also two operations targeting sharks, both using longlines. Both operations are conducted in extremely shallow water where many shark species are resident. Although longlines are far more selective than gillnets, thus minimizing the by-catch, this method rapidly wipes out territorial species such as black tip reef sharks, if repeatedly deployed in the same area, as often occurs.

Other more direct methods, such as spearing and handlines, are used to catch skates and rays in lagoons and shallow areas. Sharks are rarely caught oh nylon handlines, which they can easily bite through. However, skates and rays are frequently speared by fishermen.

6.2.2 ELASMOBRANCH CATCH IN THE SHARK FISHERY The removal of large numbers of reproductive females obviously has a tremendously deleterious effect on elasmobranch populations. Unfortunately catch returns indicate high landings of mature pregnant female tiger sharks. Other shark species which are landed include the Java, bull or Zambezi, hammerhead and various reef sharks. Large diamond spotted rays, guitar fish and bull rays are often caught, either in the gill nets or speared in the lagoons.

6.2.3 SOCIAL, ECONOMIC AND ECOLOGICAL ASPECTS

Fish catches in the Baie d'Antongil and the coastal waters of the Masoala Peninsula are declining. The ecology of Baie d'Antongil has been, and is currently being severely impacted upon by destructive human activities. Large scale removal of mangroves and riverine vegetation has increased the silt load into the bay. Fishing with small and micro- mesh nets in nursery areas occurs daily. Shrimp trawlers with small mesh nets are operating in shallow coastal waters, sometimes only a kilometer offshore. Whether this decline is as a result of trawling activities, over fishing or reduced productivity remains unclear. It is likely that all three contribute to varying degrees. Fishermen are now seeking alternative resources to exploit, such as sharks.

Many fishermen are lured to this fishery with promises of high prices for sharkfins. Although it is true that fins fetch a high price in the Far East, up to US$100/kg, fishermen in Madagascar get between US$2-5/kg. Unfortunately, they are using ecologically unsound methods, such as gillnets, to catch sharks.

The ecological costs of large mesh gillnet fishing are extremely high. Many endangered animals become entangled and die. All four turtle species occurring in the Masoala are endangered, gillnets are primarily responsible for their capture. Dugongs, East Africa's most endangered marine mammal, are close to extinction due to gillnetting.

It appears that the solution to increase fish stocks lies in the long term rehabilitation of the Baie d'Antongil to improve the water quality and thereby increasing the production of this water system. Therefore measures are required which will reduce both the siltation of the bay and the continued exploitation of the nursery areas in the bay.

6.3 MANAGEMENT ISSUES AND PROBLEMS

With the decline in catches of traditionally targeted fish, fishermen have been increasingly exploiting sharks. Now this resource is under threat mainly as a result of the following factors:

- Lack of a comprehensive coastal management plan;
- Lack of fishing regulations or ignorance of such regulations;
- Absence of control and enforcement of fishing regulations;
- Lack of appreciation of the importance of elasmobranchs in the ecosystem;
- Ignorance of the ecological damage caused by harmful fishing practices, such as large mesh gillnets.

Current legislation concerning the exploitation of marine resources needs to be revised to ensure that adequate protection is provided to both the resource and the users

Non-commercial shark fishing can probably be sustainable but only with strict adherence to conservation methods. Unfortunately there is very little information on the extent of shark fishing in the Masoala and Baie d'Antongil. Enforcement of any conservation methods is likely to be very difficult. Therefore it is paramount that education and the provision of alternative fishing methods be offered; this will encourage the fishermen to adhere to the recommendations.

6.3.1 MANAGEMENT OBJECTIVES

Shark fishing has the reputation as a boom and bust fishery and most uncontrolled shark fisheries have collapsed within a few years of inception. Therefore, objectives should aim to ensure the sustainable exploitation of the resource. The following objectives can be used as a starting point:

- to provide a management plan that will ensure the sustainable utilization of the elasmobranch resource;

- to initiate research into the fishery potential of elasmobranch stocks through non-destructive means;

- establish strict enforcement regulations that will prevent illegal or destructive fishing practices.

6.3.2 MANAGEMENT ZONES

The Baie d'Antongil and the coastal waters of the east coast of the Masoala Peninsula, should be managed as a limited utilization zone. All large mesh gillnets (> 110mm) should be prohibited from these waters. Additionally, the coastal waters should be placed under the supervision of the Coastal Zone Management Authority.

6.4 MANAGEMENT RECOMMENDATIONS

Detailed information about the extent of shark fishing is essential to the formation of a management plan for the shark fishing industry. Therefore, research should be initiated to gain information on all aspects of the fishery. This should commence as soon as possible. Even so, a detailed research project will only produce results in several years. In the interim, the following measures, based on a review of other shark fisheries, are recommended as

short term management guidelines until a fully fledged management plan can be compiled. A ban should be placed on all large mesh gillnet operations in the Baie d'Antongil and the coastal waters of the Masoala Peninsula. Since the fishermen depend on this catch, a two month amnesty period is suggested. During this period, Coastal Zone Management Authority officials should launch a education drive to explain the advantages of the new legislation to the fishermen. All large mesh nets must be handed over to the Coastal Zone Management Authority, however, the fishermen should be compensated the expense incurred in obtaining or manufacturing the net. Any large mesh net found after the amnesty period should be confiscated without the option of compensation. Instruction into new methods of fishing such as long lining and bottom fishing or fishing for pelagic species could be offered in compensation for the nets. The following specific guidelines are recommended:

- Existing laws governing the exploitation of marine resources in Madagascar must be evaluated to ensure that adequate protection is provided both to the resource and the users.

- Due to the unsustainable history of shark fishing operations, research should be initiated to determine the fishing impact level that the elasmobranch stock can sustain. Non-destructive and more selective fishing methods should be investigated.

- A moratorium should be placed on all large mesh gillnet operations in the coastal waters of the Masoala Peninsula.

- A small number of shark longline permits (not more than 10 or one per management area) can be issued for limited periods, with closed seasons in the shark breeding season (September - February) and limits on number of hooks and hook size.

- Fishing operations must be carried out at least one kilometer from shore, outside the reefs

- Mandatory catch return data and controlled checks on gear for longline license holders.

- Research into methods to improve utilization of elasmobranch species caught.

The proposed recommendations can be reviewed once sufficient data are available and methods that ensure the sustainable utilization of elasmobranchs are established The intended shark fishing management plan should receive legal status as part of a coastal management plan.

6.5 FURTHER RESEARCH

Research should be directed at fishing methods that will ensure the sustainable utilization of the elasmobranch resource. Included in the proposed research should be improved utilization of sharks, such as ways to increase shelf life of shark meat. Alternative food resources and habitat enhancement, such as the use of artificial reefs, should also be investigated.

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CHAPTER 7

STRATEGIC PLAN FOR THE MANAGEMENT OF OCTOPUS ON THE MASOALA PENINSULA

7.1 INTRODUCTION

World-wide, octopus is a traditionally under-exploited resource, representing only 14 % of the total world cephalopod catch. While there is a growing export market for octopus, the biomass available for utilization is unknown. The only available data for southern African waters are from the east coast of Natal, South Africa, where the estimated biomass was found to be 2,3 g.m.[1] Extrapolation of this suggests a biomass of approximately 2 000 kg.km, but there is, as yet, no accurate information available to verify it. There are, however, indications from the literature, that octopus may merit investigation as a potential fishery. The octopus catch in deep sea trawls in South Africa has increased from 43 tons in 1990 to 140 tons in 1993, representing an increase of almost 200 % .[3]

In Madagascar octopus appears to be a major artisanal fishery. Most octopus is caught by fishers walking on the reeftop at low tide. Densities of up to 18 people/km have been observed for some sites such as Tanjokantafana, a not uncommon number on other sites. The trampling effect on the coral reef is potentially much more destructive than the actual removal of octopus. A small

pilot survey was undertaken to investigate the effect of the octopus fishery on the stock and on the coral reef itself.

7.2 SITUATIONAL ANALYSIS

7.2.1 METHODS

The consultation team drew up a questionnaire and interviewed people in Malagasy about the fishery. The following information was collected: number of octopus species collected; time spent collecting octopus; the mass of octopus collected; the season of best and worst octopus availability; the intended end purpose of the octopus and the selling price of octopus. The sampling was random and both fishers on the beach and people in villages were interviewed. Although the sample size is not large, certain trends are evident.

7.2.2 RESULTS

Of the 21 people interviewed, only a single respondent did not catch octopus. Approximately 50% of respondents specifically targeted octopus; 85% of people on the reef targeted octopus. Respondents recognised three different types of cephalopods. Two were octopus species and the third was identified as cuttlefish and squid. Respondents did not distinguish between cuttlefish and squid since both have the same common name. Although octopus was hunted throughout the year, winter was the best season. Average monthly catch per person was 34,5 kg and on average 15 days per month were spent by fishers gathering octopus. An average of 2,3 h/day was spent collecting octopus. The calculated octopus catch per unit effort (cpue) was 2,5 kg/h. Average number of octopus per boat or person was 5,3 and with a size range of 0,1 kg to 1,5 kg, the average mass being 0,46 kg. Most octopus are caught to be sold, approximately 84%, at just under US$0,30/kg. Almost

40% of people depend on the sea for more than 50% of their income. All respondents acknowledged a decline in octopus stock.

An earlier set of interviews with fishers along the east coast indicated a similar trend in octopus stocks, although the decline in octopus is thought to be less serious than that noticed in most other marine organisms in the region.

Octopus is clearly an important target species and but the extent of this fishery has serious economic and biological implications. The damage to the reef top by octopus fishers occurs mainly in the following ways: by trampling when looking for octopus; boats breaking the coral; and when the octopus is speared coral is broken to remove it from its hiding place. The trampling of coral by the fishers is difficult to quantify, because a certain amount of natural breakage, caused by wave action and storms, occurs. Additionally, it is extremely difficult to find any reefs that have not been impacted upon by humans. However, the trampling effect is probably significant because most people on the reefs are hunting octopus. Although the sample size is very small, extrapolation from data available indicates that if a fisher walks at a rate of 1 km/h for 2,3 h/day for 15 days (the average number of days/month spent octopus hunting), a distance of 34,5 km is walked on average by each fisher on the reef each month. At densities of up to eighteen fishers per kilometer, this fishery is bound to be extremely destructive to the reeftop corals.

7.3 MANAGEMENT GUIDELINES AND RECOMMENDATIONS

The destructive methods used in the octopus fishery has serious implications for the rest of the coral ecosystem. Fish species diversity appears to be severely affected by coral degradation (see Chapter 2), the majority of which

is caused by octopus fishing activities. The problem of reeftop coral destruction is not only limited to trampling by fishers, but also by boats being poled across the reeftop and shallow areas. This damage is apparent at lowtide: the relief of the reeftop is flat with few healthy corals as opposed to coral reefs in areas with little impact. Therefore one important reason for managing the octopus fishery will be to protect the coral reef itself.

For reasons previously discussed, practices that are harmful to corals should be discouraged. The present destructive fishing practices used in collecting octopus:

- walking on the reef top should be prohibited along the entire coastline included in the MPA;

- boats being poled across coral areas should be forbidden in the reserve areas of the MPAs, however methods not destructive to coral, such as rowing or sailing, should be permitted;

- the use of spears near the reef top or coral outcrops should be discouraged.

Fortunately several alternative methods can be used to catch octopus. These include the use of traps, pods or shelters and lures. Pods can be made of inexpensive natural material, such as bamboo or clay, while lures can be made of fabric. The traps can be deployed behind the reeftop, in the mosaic and transitional zone, and lures used when octopus are spotted. Traps have already been used successfully as evidenced by the growth of new, small scale fisheries, specifically targeting octopus, which has increased around the world. Octopus catch rates range on average from 0,24 kg/pot in the Mediterranean to 0,25 kg/pot in South Carolina.[7] The catch rate did not diminish in either study.

The reasons for prohibiting some octopus fishing methods should be explained to the local inhabitants. Only when they understand that by using destructive octopus fishing methods they are adversely affecting fish stocks, can any coral conservation methods be successful. The sustainable use of these resources should advocated because many people depend economically on this resource. Fortunately most fishermen are aware of the decline in fishing resources and should be eager to be involved in education programs as well as the introduction of appropriate technology.

7.4 NEED FOR FURTHER RESEARCH

Research should be aimed at investigating appropriate technologies to collect octopus without harming the environment. Some non-destructive fishing methods that can be investigated have already been mentioned. A more in-depth study on octopus utilization and the socio-economic aspects of this fishery should also commence as soon as possible. Together these data should be employed to formulate a management strategy for the octopus fishery in the MPA.

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CHAPTER 8

STRATEGIC PLAN FOR MANAGEMENT OF MARINE MAMMALS AND REPTILES IN THE COASTAL WATERS SURROUNDING THE MASOALA PENINSULA, MADAGASCAR.

8.1 INTRODUCTION

8.1.1 BACKGROUND

The coastal waters of the Masoala Peninsula harbors a number of marine mammals and reptiles. These include many species of dolphins, whales and turtles. Coastal systems are under threat world-wide from development and over-exploitation ' and those of the Masoala Peninsula are no exception. One of the greatest threats to these animals is the practice of gillnetting. Gillnets are used both in lagoons and the open sea. In most areas of the world there has been a drastic decline in the numbers of marine mammals and reptiles in areas where coastal gillnets are used.

8.1.2 RARE AND UNIQUE ANIMALS

The proximity to the continental shelf makes the Baie d'Antongil a highly complicated, diverse marine system. It is quite likely that several more cetacean species occur there, in addition to the six species of Cetacea and one species of Sirenia already identified.[3,4] Dugong numbers are continually declining at an alarming rate throughout their range ' and there are clear

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grounds for regarding them as vulnerable to extinction. ' Dugongs are probably Africa's most endangered marine mammal. They are completely reliant on seagrass for food. Therefore their habitat must be protected in order to ensure their survival.

Similarly, the four turtle species known to occur in the Masoala region, " are listed as vulnerable, as their numbers are declining worldwide. The Indian Ocean island states of Seychelles and Mauritius are actively protecting the turtles and turtle nesting sites.

8.1.3 ENVIRONMENTAL DEGRADATION

Both dugongs and turtles depend on seagrass as their primary food source, and they likely play an important role within this community. Seagrass beds are a highly productive coastal ecosystems that support major detritus-based food chains and faunal assemblages. ' ' Disruptions in the seagrass ecosystems can have far reaching effects, both economically and environmentally. Protecting individual species is not enough if their habitat is not protected as well and it is here that dugongs can play their most important role. They are entirely dependent on seagrass for food. The seagrass - mangrove ecosystem is the most productive biological system and apart from supporting major detritus based food chains, it also provides nutrients for invertebrates and fish. Seagrass beds are strategically positioned between coral reefs and mangroves, where they act as buffers and export nutrients to

other ecosystems. If this system is destroyed, not only will the dugongs disappear, but the coral and fish stocks will be irreparably damaged.[17]

Unfortunately this appears to be the case in Madagascar. Bad fanning practices, such as slash and burn agriculture on mountain slopes, the removal of riverine vegetation and mangroves for rice fields have led to erosion and increased waterborne silt. This influx of silt is affecting the water quality in the Baie d'Antongil and the lagoons on the east coast of the Peninsula. With a decline in water quality, primary production decreases which detrimentally affects all other organisms, including the fish stocks. The silting up of seagrass beds and corals aggravate this situation.

8.1.4 Indian Ocean Sanctuary

In 1994 the Indian ocean was declared a whale sanctuary by the International Whaling Commission (IWC). No activities that are harmful or potentially harmful to whales are permitted in this area. Madagascar, a non-member of the IWC, has control over a large area, their Economic Exclusive Zone (EEZ), that falls outside this sanctuary. The country should therefore be encouraged to promote whale conservation in suitable areas such as the Baie d'Antongil.

8.2 CURRENT STATUS

8.2.1 Threats to Marine mammals and Reptiles

Several shrimp trawlers are known to fish in the Baie d'Antongil. Fishermen report that sometimes up to five trawlers are operating simultaneously in the Baie d'Antongil. They report that many fish are dumped and complain that the boats do not hire local people as crewmen.

Many artisanal fishermen operate in the coastal waters of the Masoala Peninsula. Fishing methods employed range from large mesh gillnets to fish traps. The most intensively fished areas are the lagoons on the east coast of the Peninsula and the Baie d'Antongil.

Entanglement in gillnets is the major cause of marine mammal fatalities. The large scale shark gillnet fishery operating in the Baie d'Antongil is not only harmful to the ecology by removing apex predators, but seriously endangers marine mammal and turtle populations. This was well illustrated when a whale was entangled in a gillnet near Maroantsertra in 1994 and was killed when it could not be untangled.

The presence of shrimp/prawn fishing trawlers *per se* will not harm the whales. However their fishing operations disturb whales with young calves in the bay. Young calves can become easily disorientated by loud noise generated by boats. Fishing operations may severely impact on turtle species. In the gulf of Mexico, where there is a similar fishery to that in the Baie d'Antongil, turtle exclusion devices (TEDs) had to be fitted to nets after an alarming decline in turtle numbers.[19] There is almost no data published on the by-catch of the Madagascan shrimp fishing, which is probably the country's largest foreign currency earner. Such data would be necessary before recommendations can be made.

Many turtles are also captured in gillnets.[4] Turtle sightings in the Peninsula area are encouraging as this area is probably not prime turtle breeding area, the coastline being too exposed and the beaches very narrow. This indicating that capture rates are probably not as high as the west coast of Madagascar where up to 19 000 turtles are caught annually. However, four species of turtle forage in this area and as their numbers are declining throughout Madagascar, a sanctuary area would benefit the stock greatly. Madagascar is

a signatory of the Convention on International Trade in Endangered Species of Wild Fauna and Flora in 1975 (Decree 75-014) and a further decree (88-243) in 1988.[10] However, this law is not enforced and licenses to sell turtle meat are given in some areas.[10] On the Masoala Peninsula the catching of turtles and selling of meat occurs without licenses.

8.2.2 THREATS TO THE ENVIRONMENT

Water quality in the Baie d'Antogil is being adversely affected by the influx of river-borne silt. The silt load of the water is increasing because the normal silt traps, mangroves, have been destroyed in most major watersheds leading into the Bay. This increased silt load will eventually bury and smother the seagrass beds which are areas of high productivity and serve as nurseries for numerous fish species. Loss of water quality adversely affects fishing stocks. Although there are no data available on the changes in the water quality of the Bay, it can safely be assumed to be declining with the removal of the mangroves. After rainstorms large silt plumes, often many kilometers in diameter, are observed at river mouths in the Baie d'Antongil.

8.2.3 WHALE WATCHING

Humpback whales use the Baie d'Antongil as a nursery area. The fact that whales can be encountered on a regular basis has many positive implications for ecotourism and therefore, the local economy. Whale watching generated US$ 320 million worldwide in 1992 and the industry is growing at 49 % per annum.[21] Whale watching trips are already undertaken from Ile St. Marie. There were 150 whalewatchers in Madagascar during 1991 and they generated a total revenue of US$ 21 000.[23] This number has increased since then and is now much higher. However, it is imperative that this nursery area be protected from activities that are harmful to whales. Whale watching

can be a non-destructive method of exploiting a renewable resource, and can provide job opportunities and potentially draw people to an area.[23]

8.3 MANAGEMENT ISSUES AND PROBLEMS

Like in most other economically disadvantaged countries, development takes place mostly at the cost of the environment, thereby threatening not only the environment itself, but also new, as yet, untapped sources of income for local people, such as ecotourism. Most of the problems associated with marine mammals and reptiles are one of perception, that is, the lack of perception and long term planning. The potential gain generated from conservation is not realised by the government and the people engaged in environmentally unsound utilization practices, such as gillnetting.

8.4 MANAGEMENT OBJECTIVES

Marine mammals and reptiles should be viewed as potential revenue earners, and need to be managed as a renewable resource. Money generated by marine-based ecotourism, including whalewatching, could far outweigh the short-term gains from the sale of turtle or shark meat. The first objective should be to establish a management plan specifically aimed marine mammals and reptiles. Objectives of such a specific management plan should be to:

- Obtain information on the current status, number and distribution of marine mammals in the coastal waters of the Masoala Peninsula;

- Evaluate innovative marine mammal and reptile conservation techniques that involve local communities;

- Determine management procedures that will ensure the non-destructive, sustainable utilization of marine mammals and reptiles;

- Evaluate existing legislation that could influence marine mammal and reptile conservation;

- Investigate options to improve the marine habitat and water quality of the Masoala Peninsula

8.5 MANAGEMENT ZONES

Because of the difference between the Baie d'Antongil and the east coast coastal zone, in terms of their ecology and human impact, it is recommended that the region be divided into two broad management areas. The Baie d'Antongil should be managed as a sanctuary area for marine mammals and reptiles, as outlined in Chapter 3. The coastal waters of the east coast of the Peninsula, from Cap Masoala northwards, should be managed separately by means of management units as outlined in Chapter 4. The Coastal Zone Management Authority should in control of both management areas.

8.6 MANAGEMENT GUIDELINES AND RECOMMENDATIONS

At present a management plan for marine mammals and reptiles does not exist. Yet some of the animals found in the proposed management area are on the brink of disappearing from Madagascar, particularly the dugong. Therefore the authors recommend management guidelines that should be implemented rapidly. These guidelines are an emergency measure and must not be regarded as substitutes for a proper management plan. After the completion of a formal and specific coastal zone management plan, these guidelines can then be evaluated and amended where necessary.

Interim guidelines for the protection and management of marine mammals and reptiles are:

- To declare the Baie d'Antongil a marine mammal and reptile sanctuary with the immediate cessation of any activities that could potentially be harmful to the marine mammals and reptiles in the area;

- No commercial fishing should be allowed inside the sanctuary area other than for shrimp, and then only in a limited season to be determined after the appropriate research has been conducted;

- A total moratorium should be placed on the granting of new shrimp licenses;

- Gear restrictions should be imposed on shrimp trawlers that will reduce the by-catch of teleost species, sea turtles and marine mammals;

- The ban on shrimp trawling closer than 10 km from shore should be strictly enforced;

- Shrimp boats should be randomly searched for compliance of regulations and mandatory catch returns that includes the by-catch, must be submitted annually;

- All large mesh gillnets or drift nets with a stretched mesh of more than 110mm, should be banned. However, the possibility of a reward for giving up such nets during a short amnesty period should be investigated as suggested in Chapter 6;

- The hunting or sale of turtles or turtle products and turtle egg collecting should be banned;

- The capture, hunting or sale of marine mammals, or products derived from them should be banned;

- All accidental caught marine mammals and reptiles, regardless of condition (dead or alive) should be released and reported to the Coastal Zone Management Authority.

The following guidelines pertain to marine mammal watching:

- A system for the licensing of all whale watching tour operators and whale watching boats needs to be designed and implemented;

- Observers appointed by the Coastal Zone Management Authority must be allowed aboard at any time to monitor activities of operators;

- No harassment of marine mammals by any individual should be allowed and this rule must be enforced under penalty of the law.

- The following distances are recommended to minimize the possible disturbance of marine mammals:
    - ♦ 300m distance must be kept between all moving craft and the animals;
    - ♦ 100m distance must be kept between craft moving at "no-wake" (< 2 knots) speed and the animals, except where calves are present, where a 300m distance must be kept at all times;
    - ♦ If whales surface closer than 100m, the craft should move away at "no-wake" speed until the minimum distance (100m) is reached;

- ♦ No swimmers or divers should be within 30 m of any animal.

- A maximum of only three craft within 300m of any animal or groups of animals should be allowed;

- No craft should steam across the direction that the animals are moving in;

- The Coastal Zone Management Authority should reserve the right to revoke an operator's license if the above guidelines are not adhered to;

- The guidelines recommended above should also apply to all other marine mammals.

8.7 NEED FOR FURTHER RESEARCH

Innovative community-based conservation projects exist where turtle eggs are collected and hatched in villages. The hatchlings are bought by conservation authorities and released. One such project is operated on Bazaruto island, Mozambique, and has done much to improve the turtle population and the local economy. Tourists pay for guided tours of the facilities by villagers and thereby help to contribute to the upkeep of the hatcheries. The feasibility of similar projects on the Masoala should be investigated. Fishing practices that eliminate the possibility of catching endangered marine mammals and reptiles should be investigated

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CHAPTER 9

STRATEGIC PLAN FOR THE MANAGEMENT OF MANGROVE FORESTS AND SEAGRASS BEDS OF THE MASOALA PENINSULA

9.1 INTRODUCTION

9.1.1 BACKGROUND

Mangrove forests are unique intertidal ecosystems which are dominated by evergreen broad-leaved halophytic trees.[11] Although sometimes found far inland, they are never totally isolated from the sea. Less than fifteen species are reported for Madagascar, with most occurring on the west coast. At least six mangrove species have identified on the Masoala Peninsula. Seagrass are angiosperms that are fully adapted to the marine environment. At least four seagrass species have been identified from the Peninsula.[4] Although they form discrete ecosystems, mangroves and seagrasses rank higher in gross primary

productivity than many other ecosystems. ' Seagrass is regarded as an important ecosystem as it provides a nurturing habitat for fauna and is responsible for a high faunal productivity. Mangroves are disappearing rapidly; annually, one million hectares of mangroves are lost worldwide.

9.1.2 MANGROVE-SEAGRASS ECOSYSTEM

There is a close association between mangroves and seagrasses. They are linked via physical, nutrient, animal migration and human impact interactions.[9] Specifically, seagrass beds create a low-energy zone favored by mangroves by acting as a hydrodynamic barrier which dissipates wave action. Seagrass beds trap, stabilize and produce sediments, these activities are of extreme importance to mangroves as they prevent abrasion or burial of the parts of the tree necessary for aeration. Fringe and basin mangroves act as sediment binders and regulate coastal freshwater flows, buffering changes in salinity that would otherwise affect the seagrasses adversely. Mangroves and seagrass beds export or "leak" nutrients, thereby ensuring optimal growth and development for both.

9.2 SOCIAL, ECONOMIC AND ECOLOGICAL CONSIDERATIONS

The mangrove-seagrass ecosystem plays a unique and vital role in the socio-economic well-being of coastal communities that depend on harvesting mangroves and other resources contained in them. Before management actions can be considered the effect thereof on local communities should be examined.

9.2.1 FOREST PRODUCTS

Mangroves forests and the organisms found in them can be used in a variety of ways. On the Masoala Peninsula, uses of mangroves include: floor polish extracted from the bark of some species, building material for boats and other

structures such as drying racks and poles, and timber for charcoal production. Food and bait collecting is also a major activity in the mangrove forests. In other developing countries, such as south east Asia, major mangrove stands have disappeared as the result of unsustainable logging practices for charcoal production. In the Toliara region of Madagascar most of the once large mangrove forests have been destroyed for charcoal production. However, several innovative logging practices, such as coppicing, are being conducted sustainably in the Caribbean. Coppicing is a forestry harvesting method where only one or two branches are cut from a tree. This forestry method was developed by the local inhabitants of the area who needed to ulise the mangrove resource on a sustainable basis.

9.2.2 NURSERY, BREEDING AND FEEDING GROUNDS

Mangroves serve as habitat for many species of fish, invertebrates and birds, and they are major producers of detritus that contribute to offshore productivity. However, the ability of mangroves and seagrasses to enhance fisheries may not be directly as a result of their high productivity, but rather that they stabilize the physical environment, to provide refuge for other organisms and contribute to the detritus food chain. These attributes help to maintain ecosystem stability. This is illustrated by the disappearance of many fish and invertebrate species in areas where seagrass has been destroyed.[12] Animal migrations also link seagrass and mangroves, leading to an exchange in energy between feeding and sheltering habitats.[!] Various fish (Haemulidae and Lutjanidae) spend the early part of their lives in the mangroves and seagrasses before moving to other systems. The fisheries resource of many tropical areas are nutritionally and physically dependent on mangroves and seagrasses. This fact is brought home in a study which showed that 550 000 ton fish caught in Indonesia in 1978, and worth US$ 194 million, were species directly linked to mangroves and estuaries.[13]

9.2.3 Coastal Erosion

With their strategic position between coral reefs and mangroves, seagrass meadows act as buffers, reducing wave energy that would otherwise cause erosion of the coastal zone.[1] Mangroves perform several functions that prevent coastal erosion and improve water quality: they aid soil formation by trapping debris; they filter land runoff and remove terrestrial organic matter. The removal of the buffer zone mangroves between the land and sea can lead to severe shoreline regression.'[4] This in turn can lead to ground water contamination by the advancing sea water.

9.2.4 Water quality

Much of the mangroves have been cleared from rivers around the major population centers such as Antalaha, Maroantsetra and Ambanizana. The effects of this short sighted activity can be seen every rainy season as tons of valuable topsoil are washed away. The rivers carry an increased silt load to the oceans because the silt traps (mangroves) are absent. Silting up of coral and seagrass beds is extremely deleterious to fish stocks in these habitats, leading to reduced production.

9.2.5 Loss to Fisheries

Damage to the mangrove-sea grass system will directly affect the coastal communities as this will result in reduced fish production and lower catches. This stems not only from the loss of nursery area but reduced production due to nutrient shortage and increased water turbidity as a result of silt influx from erosion.[1,4,13]

9.2.6 Aquaculture

Aquaculture is a rapidly expanding industry and contributes a significant proportion to the annual world fish consumption. Aquaculture is usually seen as an easy, fast and cheap method of providing protein in developing

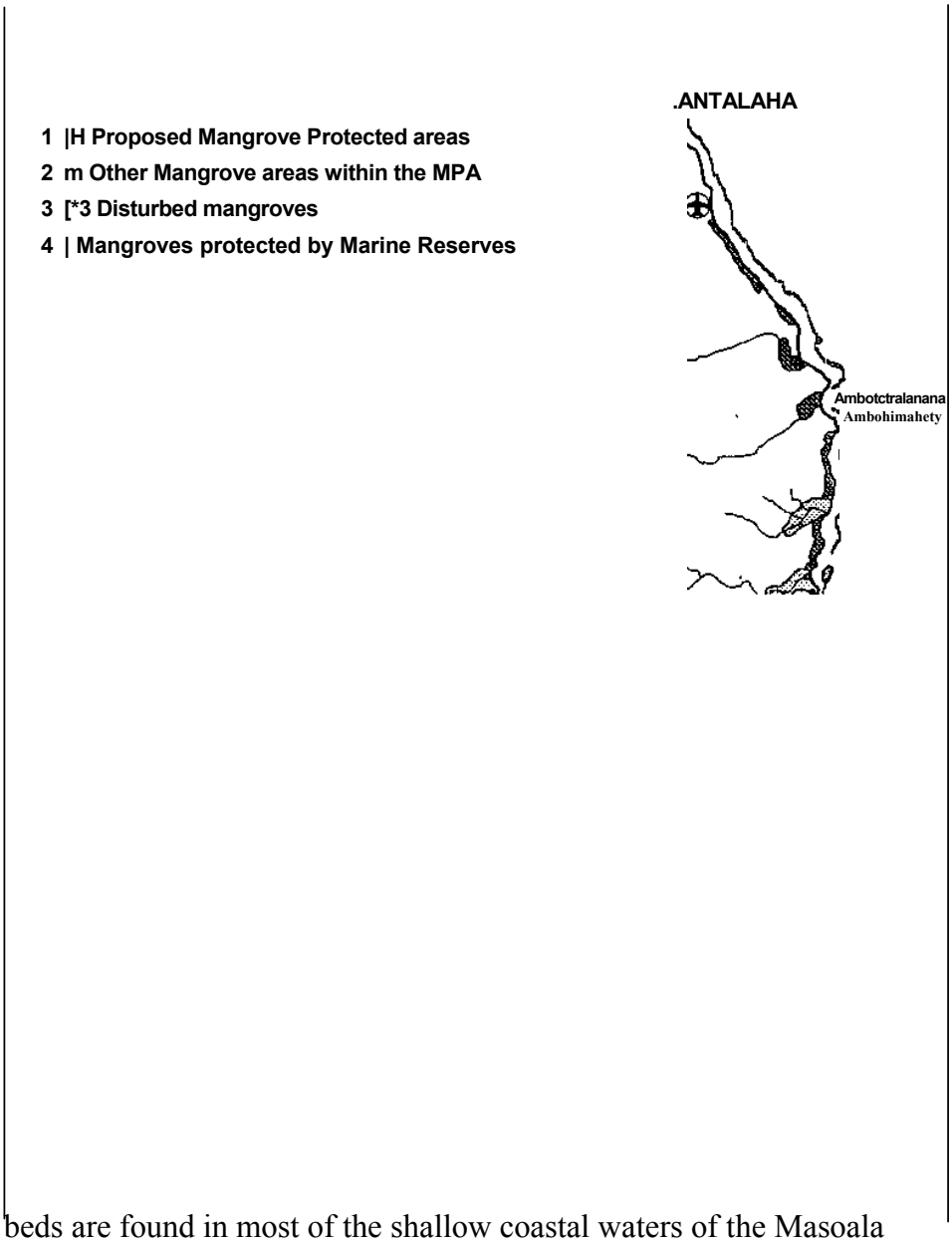
countries. This scenario only occurs with extremely good management as there are many problems in making aquaculture profitable. In many developing countries mangroves are seen as unproductive land and is converted to aquaculture industries as in south east Asia. As clearly illustrated above, mangroves are an extremely important factor in the coastal ecosystem and their destruction can influence coastal fisheries negatively. Therefore, mangrove conversion to aquaculture ponds has to be undertaken with extreme caution.

9.3 CURRENT STATUS

9.3.1 DISTRIBUTION OF MANGROVES AND SEAGRASS

Mangroves are predominantly found on the east coast of the peninsula where several large stands occur. Mangrove forests occur along riverbanks in the floodplains of the most rivers, with fringing mangroves occurring along virtually the entire coast of the peninsula (Figure 1). Not all mangrove stands shown on the map were visited due to time constraints. Some were observed during the aerial survey and others while traveling by boat between study sites. Therefore, the map represents only an approximation of mangrove distribution in the region. Mangrove stands associated with rivers usually extend several kilometers inland. The coastal fringing mangroves are between 50 m to 100 m wide. Mangroves are found on the west coast, along the banks of all rivers in strips not more than a few trees wide. The gradient on the west side is very steep so that the rivers are usually short and fast flowing and not conducive to the formation of mangrove forests. However some larger and wider mangrove stands occur where there are small estuaries such as at Nandrahanana, Tampolo and Antalavia. Other large mangrove stands on the west coast are associated with the Ambanizana and Fampotabe rivers although these are already heavily impacted upon by human activity. Large seagrass

Figure 1: Map of mangroves of the Masoala Peninsula



beds are found in most of the shallow coastal waters of the Masoala Peninsula. The most extensive beds are found in the sheltered lagoon system

on the east coast of the peninsula. Large stands of seagrass also occur in the Baie d'Antogil.

9.3.2 THREATS TO THE MANGROVES AND SEAGRASS OF THE MASOALA PENINSULA

Mangroves are used in a variety of ways, from charcoal to timber used in building boats. These activities are expanding and eroding the edges of the mangrove stands in the region. A more serious threat is the destruction of mangrove stands to make way for rice fields. This has already led to the destruction of most of the mangroves in the Maroantsetra area. Similarly, Nandrahanana also has large areas where mangroves have been destroyed for rice fields. However, mangrove soils are poor agricultural soils as acidic sulfates forms after the soil, previously under water, is exposed to air. The loss of mangroves as a nutrient exporting pool and nursery area is reflected in the poor fish catches that fishermen are currently reporting for the area.

There are no direct activities that threaten seagrass beds. However, other activities may decrease their productivity. The erosion from slash and burn farming methods leads to the silting up of these beds. This condition is aggravated with the removal of mangroves. As the seagrass-mangrove system functions together, measures taken to protect the mangroves will also protect the seagrass.

9.3.3 MANAGEMENT ISSUES AND PROBLEMS

As mangroves play a vitally important role in the coastal ecosystem, it is essential that they be protected. However, both the biological components of mangroves and the physical area these ecosystems occupy, are subject to increasing destructive activities that threaten not only this natural resource itself but also the role it plays in maintaining coastal ecosystems integrity. The management of the mangrove-seagrass system should not be confined

only to the protected areas, but to the Masoala Peninsula as a whole. As the population increases, more demands will be made on these fragile ecosystems. The developmental pressures on the mangroves are a result of the following:

- Increased land demand for food production, mainly rice cultivation, but also for coconut plantations;

- Ignorance of the essential ecological roles that the mangrove-seagrass system plays;

- Incorrect perception of the non-marketable and off-site services that mangroves provide, such as shoreline and habitat protection;

- Under-evaluation of the long-term benefits of mangroves versus the short-term financial gain from their destruction.

These conditions are aggravated by the lack of legislation regulating coastal zone development. Future impact on mangrove forests are likely from aquaculture development and increased charcoal production. These practices are generally destructive, but with careful planning and management, they can be performed sustainably, so that little damage is inflicted on the forests and the ecological role of mangroves stays intact.

9.4 MANAGEMENT OBJECTIVES

At present, a coastal development plan or management of mangroves is non-existent on the Masoala Peninsula. This probably true for the rest of Madagascar. As mangroves play a vitally important role in the coastal ecosystem, it is essential that they be protected. A management plan has to be established with the following objectives in mind:

- to manage mangrove forests on a sustainable basis so that that their economic and ecological benefits can be optimised;

- to minimize non-sustainable exploitation of mangroves and lessen the impact of all types of development bordering mangroves;

- These objectives are proposed to achieve the following goals:

- to maintain mangrove stands fringing the shoreline and rivers;

- to maintain the mangrove-seagrass ecosystem in order to sustain marine fish stocks;

- to maintain and protect the livelihood of coastal communities that utilise mangrove dependent resources;

- to ensure that the ecological functioning of mangroves are not hampered.

9.5 MANAGEMENT RECOMMENDATIONS AND GUIDELINES FOR THE SUSTAINABLE UTILISATION OF THE MANGROVE-SEAGRASS ECOSYSTEM

9.5.1 RECOMMENDATIONS FOR THE MANGROVE-SEAGRASS ECOSYSTEM The establishment of a mangrove management plan, as part of a coastal zone management plan should commence immediately. Only once such a detailed action plan has been established can the management guidelines set out in this report be reviewed and amended to suit local conditions. The mangrove management plan should aim to:

- set aside critical and biologically diverse mangrove habitats as protected areas, both to fulfill their ecological role but also to provide alternative opportunities, such as tourism, research and education;

- restore degraded mangrove areas through rehabilitation and/or reforestation;

- educate all users and other role players both government and civilian, such as the Government and Coastal Zone Management Authority, as to the importance of mangroves;

- establish a legal framework for protecting the mangrove-seagrass system as a functional unit of the coastal ecosystem.

The most important management principle should be to educate the people using mangroves. Park management of the mangroves should be sensitive to the needs and expectations of the local community and flexible enough to link utilization and development to long-term sustained use.

The removal of sea cucumbers *(dinga-dinga)* is unsustainable at present and the numbers of many species appear to have declined drastically. Until further research is done to establish the total allowable catch for *dinga-dinga,* it is suggested that a total moratorium be placed on their harvesting. The removal of mollusks from the seagrass beds should be discouraged.

9.5.2 MANAGEMENT ZONES FOR MANGROVES

The majority of mangrove forests occur outside MPA boundaries, and will therefore have almost no protection against exploitation. The current boundaries of the proposed marine parks include mostly fringing mangroves, but no significant mangrove forests. It is therefore recommended that all

mangrove stands (including areas where stands have been impacted on) be included in the MPA and be managed by the Coastal Zone Management Authority and be give legal status as protected ecological entities (see Figure 1).

Where mangrove stands extend into, or border the proposed marine reserves, it is suggested that they be included into the legal boundaries of the proposed marine reserves. Mangroves forests thus included in proposed marine protected areas must be viewed as core or reserve areas, with no utilization except for tourism, research and education. It is further recommended that three major mangrove stands currently falling outside the proposed marine reserve boundaries be managed as mangrove protected areas within the MPA. These are the mangrove forests at Ambohimahery, Ratsianarana and Ampanio. These mangrove areas are still relatively pristine and must be viewed as reserve areas, with no utilization except for the purposes of tourism, research and education (see Figure 1). However, historical access rights of local inhabitants of the immediate area need to examined.

Mangrove forests occurring outside the proposed marine reserves and the mangrove protected areas should be managed as limited utilization areas by the Coastal Zone Management Authority (Figure 1). However, strict monitoring should be done to ensure the continued health of these stands and prevent over-exploitation.

9.5.3 SPECIFIC MANAGEMENT GUIDELINES FOR THE MANGROVE-SEAGRASS ECOSYSTEM

A management plan for the mangrove-seagrass ecosystem on the Masoala Peninsula does not exist currently. In order to draw up such a plan, site visits to significant mangrove forests and seagrass stands are necessary so that pressures can be evaluated properly. In the interim the following suggestions

are given to help curb a further decline in the mangrove-seagrass ecosystem and *to* safeguard the quality of the environment for its users. These suggestions are not intended as a substitute for a management plan, but should rather be viewed as emergency recommendations until a management plan is in place:

- No development (industrial or agricultural) be allowed in mangrove protected areas, except tourism, research and education.

- The following distances between mangroves and various types of development are recommended:
    - Industrial development - 1000m
    - Housing *or town* development - 500m
    - Tourism development - 100m
    - Agricultural development - 100m

- Access through mangrove areas along historical routes must be allowed for local inhabitants, but the making of new routes should be prohibited.

- Should aquaculture be considered in the limited utilization mangrove management area of the MP A, the minimum size of the untouched part of the mangrove forest should be 15 ha with a minimum width of 400m. The pond size should have a ratio of 1: 4 to the mangrove forest area (in a 15 ha mangrove forest plot 3 ha can be used for ponds leaving 12 ha as bufferzone) .

- Any development (industrial, agricultural or aquaculture) in a mangrove area or an area that could affect mangroves, should be preceded by an environmental impact assessment study and approved by the Coastal Zone Management Authority.

- Destruction of existing mangrove stands should be halted immediately, regardless of reasons.

- Vegetation, including mangroves, on river banks should be retained as erosion barriers, for at least 100m from the rivers edge, or from the most landward mangrove, whichever distance is the furthest.

- Where river banks have been denuded of mangrove forest, efforts should be made to rehabilitate the area.

- Strict pollution controls should be enforced to prevent runoff or leaching of effluent into the mangrove systems.

- Where villages are situated next to mangrove areas, primary sanitation should be encouraged.

- Bait collecting by hand only, without nets or traps, within the limited utilization mangrove zones may be allowed; however, if it becomes apparent that these resources are being over-exploited, this practice should immediately be halted.

- No development, farming or aquaculture practices should be allowed within 100m from the mangrove edge, floodplains, or on river banks.

- No development or farming practices (such as coconut palm or vanilla plantations) should take place within 100 m of the high watermark on the coast or the landward edge of mangrove stands, whichever distance is the furthest.

- Rehabilitation of degraded floodplains that are now within the boundaries of the mangrove protected areas should be initiated.

- Provision must be made in the mangrove limited utilization zone for sustainable forestry, following either a rotational or coppicing pattern, with no clear cutting of areas allowed.

- The sale of mangrove products must be forbidden, including charcoal, unless it comes with a Coastal Zone Management Authority permit.

9.6 NEED FOR FURTHER RESEARCH

Urgent research needs to be conducted to determine the extent that local inhabitants rely on mangroves or mangrove related activities on the Masoala peninsula. There are several innovative community based aquaculture and forestry activities that could be employed on the Masoala. These need to be investigated to determine their suitability for conditions on the Masoala.

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CHAPTER 10

A STRATEGIC PLAN FOR THE MANAGEMENT OIF ECOTOURISM DEVELOPMENT

10.1 INTRODUCTION

10.1.1 THE MASOALA PENINSULA AS AN ECOTOURISM DESTINATION

The Masoala Peninsula is one of few areas in Madagascar where a considerable amount of pristine environment still exists. In addition to tropical rainforests there are a variety of coral reefs and other coastal zone systems making this region very special. Therefore the Masoala Peninsula is a

very valuable and important national asset of the Republic of Madagascar. Presently sections of the marine as well as terrestrial environments in Masoala are being delimited for reserves.

The proposed terrestrial National Park and the system of marine reserves flanked by other protected areas, will only succeed if the local population accrues some benefit from their establishment. ' The key to benefits for the local population lies in the development of ecotourism. Ecotourism, when properly planned, will infuse money into a variety of sectors of the local economy, and can provide employment and training to inhabitants of the region.[3] Revenue from ecotourism can provide funds for the management of the various protected areas. ' There are many other advantages to responsible ecotourism development. ' In various parts of the world ecotourists and operators form important lobby groups that have enough strength to influence

government decisions at high levels. ' Local inhabitants that are involved in ecotourism operations often play a role in the conservation of an area.

The Masoala Peninsula can be a highly successful ecotourism destination. The region has numerous attractions that will be of interest to the ever-growing ecotourism industry. Unfortunately no long-term planning exists for the region in spite of urgent calls for a cohesive strategy.[1] '" Numerous examples can show that this lack of planning would lead to the degradation of resources, ' ' alienation of the local people,[15] and the eventual demise of the industry. ' Without proper advance planning the positive influence that ecotourism may have on the region will not be realized. Instead the region will fall prey to the many bad sides of irresponsible ecotourism development.[4,17,1]

10.1.2 THE RELATIVE ECONOMIC IMPORTANCE OF ECOTOURISM Considering the frequent inconsistency and sometimes total lack of funding for developing regions, the importance of ecotourism development should be viewed relative to other types of development. Survey results from seventy World Heritage sites revealed the following statistics on how local populations earn their living:

ECONOMIC ACTIVITY	% RELATIVE EARNINGS
Hunting	16
Industry	21
Fishing	29
Trade	29
Stock Farming	33
Agriculture	51
Tourism	53

It should be noted that tourism boosts virtually all other sectors of society as well. For instance, food needs to be produced to sell to tourists and home industries can be organized to sell weavings such as mats and baskets to tourists.

10.2 SITUATIONAL ANALYSIS

10.2.1 CURRENT STATUS

Tourism is a relatively new phenomenon on the Masoala Peninsula. There are no quantitative estimates available on the number of visitors to the region, except perhaps for Nosy Mangabe,[19] but until a few years ago few outsiders have ventured beyond the two main towns of Antalaha and Maroantsetra, and

the island of Nosy Mangabe. Commercially organized tours to the region were rare indeed, but several operators have recently made an appearances in the region and are listing the region among their offerings. Several of these operators even extend their tours as far as Ambanizana. This village is listed by name in a current advertisement placed by Madagascar Adventures in *Getaway Magazine,* a South African publication which has a readership of almost 300,000 outdoor enthusiasts. The route going all the way around the Peninsula is becoming increasingly popular. Smaller groups are infrequently . seen outside the main centers and although no information has been collected about such groups, some of them may in fact be commercially organized. There is no doubt that interest in the coastal route is rising. Local inhabitants reported that in October 1994 a group of about twenty tourists landed at Ambodiletra but no, information is available on them. There currently exists only one unofficial monitoring point along the coastal route, namely at Aime's hotel at Cap Masoala, where Dr F Odendaal installed a visitor's book in which the hotel's proprietor encourages visitors to write down their names. Approximately six tourists passed through Cap Masoala in 1992, but three years later this number has risen five-fold to over thirty in 1995, excluding the group of ecotourists on the trial run. Most of the visitors to Cap Masoala came from the directions of Maroantsetra or Antalaha, but several of them had crossed the Baie d'Antongil from Mananara and were on their way to Antalaha or Sambava.

Presently the centers of ecotourism activity appear to be:

- The general surroundings of Maroantsetra, including Nosy Mangabe and Ambanizana, and the Maroantsetra-Antalaha walking trail across the interior.

- The general surroundings of Antalaha with visits as far south as Cap Est.

- The coastal route between Antalaha and Maroantsetra. Dr F Odendaal has been approached by local business people in Antalaha for information on diving sites and beaches that are suitable for tourism. He has also been approached by business people from He St Marie who are interested in sections of the coastal route.

- Other routes that are opening up, such as an overland route between Ambohitralanana and Maroantsetra promoted by a hotel at Cap Est.

10.3 ECOTOURISM TRIAL RUNS

Dr F Odendaal strongly promoted ' the use of ecotourism trial runs as a tool for testing the viability of ecotourism development in the region. The first trial run, consisting of five participants, was run in November 1994. Two of the five ecotourists returned to the Masoala Peninsula for the second trial run. A third participant is planning to go back on his own in the near future. It was the success of the first trial run that inspired the second one.

A separate report is being prepared for the second ecotourism trial run, and what follows is only a short summary. The second trial run, consisting of nineteen participants, was an advancement over the first one in several respects. Only local people were contracted to provide services such as the preparation of meals, the moving of luggage and other equipment, as well as leading ecotourists through the forests at various locations, and up the Ampanavoana River in pirogues. Local people also cooked and sometimes played the role of guides. Input from participants on the second trial run, as well as the views of local inhabitants, strongly support the notion that the Masoala Peninsula can be developed into a most desirable ecotourism destination. A contract between CARE INTERNATIONAL (MADAGASCAR) and Eco-Africa Environmental Consultants stipulated that

Dr F Odendaal would organize and run the second ecotourism trial run on a voluntary basis while Project Masoala would provide sea transport.

The trial run started when the ecotourists arrived in Sambava. They were transported overland to Cap Est, and finally made their way around the Masoala Peninsula by boat. Some participants walked from Antsiramiana to Tanjokantafana, and seventeen walked the trial from Tanjokantafana to Ampanavoana. After a visit to Nosy Mangabe the group arrived at the town of. Maroantsetra from where they departed for Antananarivo.

Three main problems were encountered. The first was a last-minute change of schedule by Air Madagascar that cut short the time on the Peninsula itself by three days. This chance of schedule meant that tourists had to be moved around the Peninsula much faster and that they were not able to complete the program at the pace that was initially envisaged. The second problem was that both engines of the boat provided by Project Masoala broke down in spite of the fact that they had been serviced the week before. Finally the group of ecotourists were transported around the Peninsula in a private boat owned by a local inhabitant of the Peninsula. The third problem was unseasonably bad weather which further slowed down progress around the Peninsula.

The trial run was most successful from the point of view of identifying pitfalls and developing guidelines for future trial runs. Most participants were extremely helpful in terms of giving feedback. Initially one out of nineteen participants wanted a portion of his money back, and after this member had meetings with others, the number grew to four. Twelve participants indicated their desire to be informed about future developments on the Masoala Peninsula. Several of them want to be involved in future ecotourism development in the region.

Putting the group together required an enormous amount of hard work and expenditure beforehand. Administrative services were allocated specifically for the trial run. Brochures had to be written and produced. Advertisements were placed in two outdoor magazines, one in South Africa and one in the United States. Enquiries were processed and potential clients screened as far as possible and signed up. Clients were recruited as long as six months ahead of time. Other expenses involved mailing out brochures, sending faxes, and making phone calls. Airline and hotel bookings had to be made. The average client required seven phone calls before arrangements were finalized.

Over sixty individuals from South Africa were interested in signing up, and about twenty people from the United States . Nineteen South African ecotourists paid a package fee of R 4990 each, from which all direct and indirect costs had to be covered. Certain unexpected costs arose due to a rise in the cost of living in Madagascar that happened in the period between the two trial runs. The scheduling changes by Air Madagascar required the addition of an extra leg to Perinet Reserve so that participants did not have to spend four days in Antananarivo. These additional expenses were paid by the trial run so that expedition members did not suffer an increase in the tour cost.

The income and expenses in South African Rands (US$1 = R 3.6) from the trial run are listed as follows:

Inflows	
Trip **2**	94,810.00
Interest	126.48
Refund	111.70
Outflows	
Accommodation	2, 687.78
Accounting Fees	250.00
Advertising"	1,340.28
Bank Charges	308.68
Brochure Prod	1,959.49

The profits shown by this trial run were small because of three factors: extra and unforeseen expenses were incurred; the price of the trial run was very cheap in comparison with other two-week excursions to Madagascar; and the indirect costs were covered by the organizers themselves and subtracted from the profits. The indirect costs would normally be covered in whole or part by travel agents, wholesalers, and other marketing mechanisms. When indirect costs are carried by marketing agencies, and the trip is offered at a more realistic price, a profit of at least $ 500 per participant is quite realistic. Therefore a profit of about $ 5000 can be made from a group of ten people. There is no doubt that considerable revenue can be accrued through ecotourism on the Peninsula, particularly when the park and reserves are set up so that they can provide most services themselves.

10.3.1 THE NEED FOR AN ENVIRONMENTAL, ECONOMIC AND SOCIAL ANALYSIS

When ecotourism is not properly developed, it can have many serious effects on the environment as well as the social fibre of indigenous communities. An analysis needs to made specifically for the Masoala Peninsula, and this needs to be done quickly as tourism development is proceeding in an uncontrolled fashion in the region. Many of the problems experienced elsewhere can be avoided by the proper steering of development. A survey of tourism related problems at seventy World Heritage sites, as perceived by local populations, are related to the following activities:

SOURCE OF PROBLEMS	% RESPONSES
Destruction of Vegetation	17
Increase in Illegal Practices	22
Risk to Wildlife	22
Lack of Respect for the Site	23
Development of Infrastructures	35

The management plan for ecotourism needs to take into account types of problems such as those listed above, so that actions can be taken to avoid or minimize them. There already are several hotel constructions occurring on the Peninsula.

10.4 TOURISM RESOURCES, AND TOURISM RESOURCE ZONES

Tourism resources are defined as all of those resources available to tourists visiting a particular region; tourism resource zones can be broadly categorized for a given region, based on the existing demand for and supply of these resources for tourism purposes. The zonation is based on environmental

considerations, management objectives and existing facilities. In the case of the Masoala Peninsula it is recommended that considerations for the zonation of tourist zones also take into account the numbers of local inhabitants that will benefit from ecotourism development. It is recommended that ecotourism development be tied to management units as proposed in Chapter 4.

Current tourism resources in the region include the following:

- Coral Reefs and Lagoons

  The region contains a large variety of coral reefs, lagoons, and other areas where coral colonies grow in profusion. Some of these sites are comparable to the best in the world with respect to what they offer in terms of ecotourism.

- Littoral and Other Forests

  There are several beautiful littoral forests that are ideal for visits lasting a day or less. Some of these are listed in relation to the delimitation of protected areas in Chapter Two. They include the forest at Ambavazaha that belongs to the *fokontany,* the littoral forests that are recommended for inclusion in the Tanjona Marine Reserve, and the swampy forests between Ambodiletra and the Beankoraka river that are recommended for inclusion into the Masoala Marine Reserve. There are a number of other suitable littoral forests to which tourists can have reasonable access, such as two sizeable forest fragments near Vinanivao, the forests inland from Ratsianarana, and smaller fragments near Cap Est.

- Islands and Pristine Beaches

  A number of islands and pristine beaches exist that have excellent ecotourism potential. Most of the pristine beaches are located on the west side of the Peninsula, and most islands are near the tip. Important

exceptions are several islands near Vinanivao, Nosy Fenala near Ratsianarana, and the island opposite Cap Est. The latter island is privately leased on a long-term basis. There are several other islands in reserves such as Nosy Ndrendra in the Tampolo Marine Reserve, and Nosy Nanto, Nosy Nepato and Nosy Behentona in the Masoala Marine Reserve. Nosy Nanto is leased from the government to a private individual on a long-term basis.

- Sites of Historical and Cultural Interests

  There are a number of points of interest such as Anjagnaharibe near Ambodiletra, three light houses, several burial grounds, and a variety of holy sites. Visitors tend to find the Malagasy culture and religious customs fascinating, and limited access to some of the historical and cultural sites can be arranged.

- Rivers, Estuaries and Mangroves

  Rivers, estuaries and mangroves open up a range of potential outdoor activities to ecotourists, such as cruises by pirogue or inflatable boats, bird-watching, and educational walks. All the large rivers along the eastern shores are suitable for journeys lasting a day or longer. These include the Andranotsimanga, the Anaovandrano, the Ampanio, the Fampotakely, the Ratsianarana and Onive rivers. The journey up the Ampanavoana to the Fotodrena rapids proved most popular with participants on both ecotourism trial runs. This journey can be extended as far inland as Arantavato where the *fokontany* has shown Dr F Odendaal numerous points of interest that will be attractive to outsiders. There are swimming holes, rapids, islands, and the hill of Vohibe that towers over the countryside. The Ambohimahery river offers a half-day trip that goes through dense mangrove stands of various types and up side-alleys. The west side have fewer large rivers with the Ambanizana and Fampotabe

rivers being the most suitable for longer journeys. However, there are a number of rivers, including the Sahaleno, Marofototra and Antalavia rivers inside the Tampolo Marine Reserve, that are suitable for lovely half-day journeys. The Marofototra river can be followed up by kayak through the lowland forest to a gorge in the sides of the mountain. Five hours walk from Ambodiforaha is a waterfall that allegedly plunges hundreds of meters down the mountainside but none of the consultants have seen this waterfall for themselves. The Antalavia river has an estuary of clear water which is suitable for swimming and bird-watching.

- Villages and Other Settlements

  A number of villages and settlements on the Peninsula welcome outsiders. Participants in both trial runs were impressed with the reception they received in Ampanavoana and Vinanivao, as well as smaller settlements such as Antsiramiana, Ratsianarana, Ambodiletra and Cap Masoala.

- Existing and Potential Infrastructure

  Contrary to popular believe among outsiders some infrastructure does exist on the Masoala Peninsula. When the diesel engine of the *Perseverance,* hired by Project Masoala for the first trial run, failed, a local boat was sequestered within hours at Ifaho to carry ecotourists on the rest of their journey. When the outboards provided by Project Masoala failed on the second trial run, ecotourists were transported on a boat based at Vinanivao, the *Marie-Joseph,* organized beforehand as a back-up boat. A number of other boats operate around the Peninsula, and there are boats based at Maroantsetra, Antalaha, Cap Masoala, Vinanivao, Ratsianarana, Ambodirafia, and Cap Est. There are a number of highly experienced boat captains and mates on the Peninsula.

- Tourism Accommodation

  The two main town Antalaha and Maroantsetra have a variety of hotels that can accommodate tourists. There also exists the potential for hybrids between regular hotels and guest houses of which the Hotel Tropical run by Madame Costo is an example. There already is a gradient of other accommodations on the Peninsula itself: a hotel at Ambanizana, a small bush hotel at Cap Masoala, a local style hotel at Ambodirafia, several bungalows at Vinanivao, a bungalow at Ifaho, and a western style hotel at Cap Est.

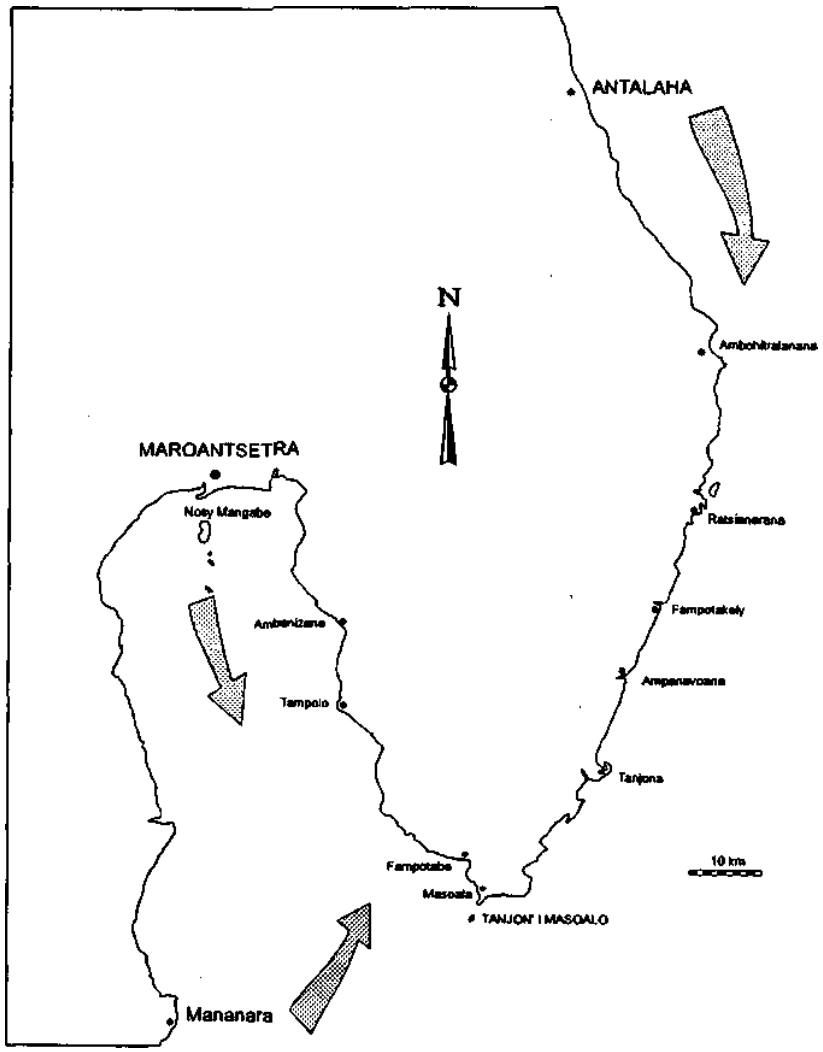
- Community Tourism Accommodation

  There is a great potential for the community to provide tourism accommodation. The types of accommodation would include already existing *fokontany* guest houses, as well as privately owned houses that are sporadically made available to visitors free of charge or for a small fee. Local people can be contracted to prepare food and other services. Both trial runs made extensive use of these facilities. Community tourism accommodation add a cultural and social dimension to the overall experience that is sought after by many ecotourists.

10.4.1 SEASONALITY, GATEWAYS, ACCESS ROUTES, AND TRANSPORTATION The Masoala Peninsula is a high rainfall zone with an annual precipitation of 4 meters or more in certain parts. The best months for visiting the region are from September to December, with October and November probably being the most suitable period. However, excellent weather for as long as two weeks at a time can be had until early May. From late May to August the weather is frequently poor with extended periods of little or no sunshine. The argument is sometimes put forth that the weather on the Masoala Peninsula is not good enough for extensive ecotourist development. The view of the current consultants and that of certain researchers who have stayed on the Peninsula

year round do not support this view. It should be noted that many regions in the world have far less favourable weather regimes than the Masoala Peninsula but support successful ecotourism industries. Besides, the weather on Masoala is no worse than in many other tropical environments with flourishing ecotourism industries.

There are three main gateways to the Masoala Peninsula (Figure 1):



THE MAROANTSETRA GATEWAY

Maroantsetra is regularly serviced by Air Madagascar with small to medium-scale aircraft. One problem is the absence of a fully-fledged Air Madagascar office in this town. Instead there is only an agency that handles business on behalf of the airline. Communication between the agency and the airline offices in Antalaha and Sambava appears to be based on messages carried by arriving and departing airline staff and is inadequate. The result is that airplanes are sometimes overbooked and passengers stranded for several days in town. The problem appears to increase with the size of visiting groups as in the case of the second trial run and the October 1994 Project Masoala Conference. Maroantsetra is an ideal gateway to the west side of the Peninsula which can be reached by several boats that are based in the town. Prices are not regulated and can sometimes be excessive for voyages even as near as Nosy Mangabe.

THE ANTALAHA GATEWAY

Antalaha is also regularly serviced by Air Madagascar with small to medium-scale aircraft. This town, however, does have a proper airline office which facilitates travel arrangements. One major advantage of Antalaha as a gateway is its proximity (80 km) by road to Sambava which is well-connected to other parts of the country by Air Madagascar. Sambava is serviced by large Boeing aircraft which can operate in poorer weather than smaller craft. The town also has a major airline office. Antalaha is connected by road to Cap Est but this road is in a poor state so that the 40 km journey can take as long as four hours, even under good conditions. There are few people in Antalaha who are willing to take travels to Cap Est by car, and those that are tend to ask exorbitant prices. The major problem with this gateway is that access to the west side of the Peninsula involves going around the tip of the Peninsula. Not only are large distances involved, but part of the voyage is on the open sea so that good weather and sound craft are essential requirements.

THE MANANARA / ILE ST MARIE GATEWAY

Mananara across the Baie d'Antongil from the Peninsula is another potential gateway to the region. This gateway would require traveling across the bay to Cap Est. This gateway has the potential to become very important if it becomes connected to tourism activities on He St Marie, such as whale watching, that can be extended into the Baie d' Antongil itself. Mananara is an attractive town with hotel accommodation and is serviced regularly with small aircraft.

Based on the above gateways to the region potential ecotourism routes can be listed as follows:

- From Maroantsetra to Nosy Mangabe continuing to the terrestrial National Park at Ambanizana, then southward to Tampolo Marine Reserve and Masoala Marine Reserve, and finally back to Maroantsetra.

- From Maroantsetra to Nosy Mangabe continuing to the terrestrial National Park at Ambanizana, then southward to Tampolo Marine Reserve and Masoala Marine Reserve, and finally proceeding to Tanjona Marine Reserve, Cap Est, and Antalaha.

- He St Marie to Mananara, then crossing the Baie d'Antongil to Cap Masoala and continuing northwards to Tampolo Marine Reserve and the terrestrial National Park, crossing to Nosy Mangabe and finally ending at Maroantsetra.

- He St Marie to Mananara, then crossing the Baie d'Antongil to Masoala Marine Reserve and continuing to Tanjona Marine Reserve, Cap Est, and Antalaha.

- Antalaha to Cap Est, then proceeding to Tanjona Marine Reserve and Masoala Marine Reserve and back to Cap Est, or continuing on to Nosy Mangabe and Maroantsetra.

Various perturbations of the above routes exist, some of which may include long or short excursions into the interior and/or walks across the Peninsula. Eco-Africa Environmental Consultants is currently compiling a list of interesting walks in the region. Different modes of transport can be used to further enhance the experience. These include travel by boat, pirogue, kayaks, mountain bicycles, or on foot. The Baie d' Antongil is excellent for traveling by sea kayak, particularly as access to many of the small bays and beaches is difficult by motorized craft. Trails and derelict roads suitable for mountain biking run all the way from Antalaha to Cap Masoala. Walking trials run all the way along the west side of the Peninsula. The above diversity of routes and potential modes of transport provide the groundwork lattice that can be used for the design of innovative packages.

10.4.2 PROJECTIONS FOR THE INDUSTRY

There has been a noticeable rise in numbers of visitors to the region in the last few years. Madagascar is becoming a popular destination for South Africans. In South Africa itself ecotourism is rising sharply, and it is entirely possible that the countries can be linked in terms of marketing. Eco-Africa Expeditions, a division of Eco-Africa Environmental Consultants used for the marketing and running of trial runs, regularly receive inquiries from overseas visitors who are interested in extending a South African visit to Madagascar. Whilst travel books for many years virtually ignored the Masoala Peninsula, except perhaps for a fleeting mention of Nosy Mangabe and Maroantsetra, later editions as well as new books promote the region to the same extent as some other popular destinations in Madagascar. The March 1995 issue of

BBC Wildlife lists the newly delimited Masoala Peninsula terrestrial park. The establishment of a National Park and marine reserve system will be a major drawing card and there is every reason to expect the number of annual visitors will continue to increase exponentially.

10.5 GENERAL MANAGEMENT GOALS AND OBJECTIVES

The goals of the management of ecotourism development must be conceptually clear, relatively simple, and sufficiently practical to be implemented. The overall goal of any strategic management plan should be to provide guidelines for the management of tourism as an environmentally and socially sustainable industry. The objectives of all strategic development or management plans should be to:

- minimize the negative impacts of ecotourism development on coastal ecosystems;

- aid the terrestrial National Park, marine reserve system and other protected areas to become financially self-sufficient;

- preserves areas of outstanding natural beauty as well as sensitive coastal, marine or estuarine habitats that are not included in protected areas;

- guide current and future development pressures so as to lessen their impacts in any particular area(s);

- ensure that all development proposals are evaluated so that they do not adversely affect the environment;

- minimize negative influences and promote positive influences on the social and cultural fabric of local communities in the region.

10.6 SPECIFIC MANAGEMENT ISSUES AND PROBLEMS

10.6.1 LACK OF VISION

The biggest problem facing ecotourism development is the lack of vision by virtually all interested and affected parties. Local inhabitants understandably have no idea what tourism is about or what it holds for them. Those organizations and people involved in integrated conservation and development initiatives have thus far adopted a wait-and-see attitude towards ecotourism development. This is to some extent understandable as the development of ecotourism in a region like the Masoala Peninsula is a daunting concept to people who are not familiar with the process. However, to not take the opportunity to steer the industry at an early stage will be irresponsible. Steering a fledgling industry is immeasurably easier than trying to mold it at a later stage. Needless to say it will not be possible to plot an appropriate course of development without a clear idea of where the industry should be heading. Several local businessmen have already been looking at ecotourism as a potential source of income for some time. Some of them are building cottages and hotels, even at localities as remote as Ambanizana, Vinanivao and Ifaho. The integrated conservation and development community urgently needs to take up the leadership role in ecotourism development. It is imperative that a workshop of interested and affected parties be organized and held as soon as possible to work out the aims and guidelines for development. A responsible ecotourism industry does not evolve spontaneously, nor does it appear overnight, but often takes years to develop. Further delays in this regard will increase the risk of losing this rare opportunity to get in at the ground level so that the benefits from ecotourism

can be maximized for the proposed National Park, the marine reserve system, and the local community.

10.6.2 Lack of Regulations

Currently very few regulations, if any, exist to control what is and is not allowed on the Peninsula even in terms of development. This is apparently true even for major developments such as hotel construction. For example, a hotel was recently constructed at Ambanizana inside the thin corridor that lies . between two large sections of the terrestrial National Park. As far as could be gathered, the building of this hotel was uncontrolled in terms of siting or materials that were used. Developments such as this one obviously can be very difficult and expensive to undo or curb at a later stage. The idea behind regulations is not to make life difficult for developers. Instead their role is to help safeguard natural resources for all the parties involved in, or otherwise affected, by development.

To a large extent regulations will depend on the aims of development and the vision that all interested and affected parties hold for the region. There will need to be a set of rules and regulations for developers not only inside the protected areas but everywhere on the Masoala Peninsula. Until these rules are established the region will remain a free-for-all target for entrepreneurs from near and far. Most of them will pursue their goals without regard for the local inhabitants or the conservation of the area. There are many examples of uncontrolled development in developing countries, and the unfavourable effects on previously promising ecotourism destinations are well-known. It should be borne in mind that the key does not lie as much in the enforcement of regulations as the proper planning beforehand of all types of coastal zone development.[33]

10.6.3 LACK OF MONITORING

A comprehensive monitoring system of tourism activity in the region needs to be put in place as soon as possible. Such a system need not be costly nor complicated. Reliable monitoring points has to be to set up at key points in main centers and along the various access routes. Information on the numbers and flow of tourists is an essential component of planning. There are various techniques that will be helpful in monitoring different aspects of ecotourism development. ' Without the proper implementation of these techniques an assessment of the impact of tourism development cannot be made, and the balancing of economic and social benefits and environmental costs will not be achieved. It is recommended that a monitoring system be devised and implemented as soon as possible. A key principle of the assessment exercise will be the need to solicit and incorporate early and continuous public and local involvement in the impact assessment process. There are many advantages to local participation ' ' ' in a project, and these need to be brought to the attention of project managers at all levels. It should be remembered that local people are more familiar with their environment than outsiders, and that they therefore will be able to detect changes more quickly, even those that are not readily detected by rigorous scientific methods. Furthermore, there has often been inadequate consideration of the carrying capacity of local communities to accommodate the development of tourism.[15] International donor agencies also should assume a more assertive role in promoting or encouraging comprehensive assessments of project impacts during sectoral and regional planning stages when considering funding requests.

It is recommended that:

- A public participation program in monitoring the effect of tourism be developed;

- A environmental and social assessment team be put together to assess the impact of tourism;

- Information be reviewed regularly so it can be duly incorporated into strategic planning at an early stage.

10.6.4 Legal and Institutional Arrangements

The role of the different legal and institutional structures in the budding ecotourism industry is unclear. Roles, responsibilities, and the relationship between role players in ecotourism development need to be defined or a climate may evolve that will foster undesirable phenomena such as bribery and other forms of corruption. The following entities may all play a potential role in ecotourism development, although this is not an exhaustive list:

- Local government structures may play a role in issuing permission for conducting tourism operations, permits for the construction of hotels and other facilities, and may inspect such facilities sporadically;

- Traditional structures such as the *fokontany* can undoubtedly play an important role in organizing services, particularly away from main centers, or by regulating services provided by local people;

- The Malagasy Police (Gendarmes) are potential role players in regulating tourism, dealing with emergencies, and providing recourse to law enforcement when necessary;

- Fisher associations are potential service providers in the form of knowledgeable guides or boat owners;

- Local business communities or organizations are obvious catalysts in ecotourism development;

- Various government department departments such as DEF, entities such as ANGAP, and the large collection of NGOs involved in integrated development and conservation initiatives are obvious role players, but the relationships and power balances between them are sometimes not clear and has to addressed.

10.7 TOURISM DEVELOPMENT

The low level of ecotourism development that currently exists on the Masoala Peninsula is an advantage. Regions where ecotourism was planned and managed from the start are more likely to develop into socially and ecologically sustainable destinations than those regions where development took place before planning.

10.7.1 AN ECOTOURISM DEVELOPMENT MASTERPLAN An ecotourism development masterplan needs to be drawn up as soon as possible. The masterplan needs to have a management part for the reserves as well as the area outside reserves. It needs to include a separate section for whale watching and other marine mammals and reptiles. Finally, it needs to include a business plan for starting up a responsible ecotourism industry. It is recommended that Project Masoala appoint one or several technical officers who will specifically be concerned with ecotourism development. These officers will need to work with a knowledgeable consultant appointed by Project Masoala in constructing an ecotourism development masterplan that will incorporate all the aspects of ecotourism development mentioned in the current report. It is strongly recommended that the ecotourism development officer(s) be accompanied by the consultant on an extensive tour to

comparable ecotourism destinations elsewhere, such as Northern Natal in South Africa, Costa Rica, and Mozambique, before the masterplan is finalized.

10.7.2 Improving Accessibility of tourism resources

Much can be done to make the current ecotourism resources more accessible to visitors:

- Coral Reefs and Lagoons

  Eco-Africa Environmental Consultants is able to put together a map of such sites of interest with their viewing potential, but for the sake of the survival of these unique biological features such a map will be released only when proper mechanisms of protection and regulation are firmly in place. Requests for information on diving sites have been received from two local business people as well as one overseas operator. The masterplan needs to include rules and regulations regarding ecotourists that come on their own initiative as well as regulations to which operators need to adhere to. The plan also needs to examine access to the sensitive reefs, because boat anchors and effluent from engines can cause damage. An access route to the totally protected part of the Cap Masoala Marine Reserve needs to planned which may involve transport by local pirogues. Local pirogue owners need to be educated as to how they can minimize damage to the resource when taking tourists there.

- Littoral and Other Forests

  Access to littoral and other forests can be improved by making maps available of existing trails. Great care should be taken in making new paths, and such developments must be guided strictly by a managed planned approved by the Coastal Zone Management Authority. Access can further be improved by making guides and porters available as during

the second ectourism trial run. Management units can play a role in organizing and regulating guides and porters.

- Islands and Pristine Beaches

  Islands are important resources that need stringent regulation of their use by humans. They have great potential as camping sites with a low level of development, preferably making use of temporary structures brought in from elsewhere, or in the case of Nosy Behento as a site for a basic hotel run by the Masoala Marine Park. It is recommended that a special action management plan be drawn up for each island where development will take place, and that no development be allowed on any island without a management plan. There are several spectacular beaches on the Peninsula and specific regulations need to be drawn up that will govern development on or near beaches. No development should be allowed near beaches without a proposal that will be properly evaluated to assess the impact of the proposed development.

- Sites of Historical and Cultural Interests

  A number of points of interest such as Anjaniharibe near Ambodiletra, three light houses, and a various holy sites exist. The utmost care needs to be taken if cultural sites are made accessible to ecotourists as these can easily develop into problems. It is also recommended that historical artifacts, relics and locations be identified, restored and promoted. These items would include the three light houses on the Peninsula. Oral traditions should be recorded and presented in interpretive exhibits in such as hotels. Any development should be carefully managed to minimize its impact on historical and cultural points of interest and therefore on the tourism industry.

- Rivers, Estuaries and Mangroves

  Rivers, estuaries and mangroves are fragile environments and any improved access to them needs to follow strict guidelines outlined in a management plan. Most of the large rivers are suitable for low level development such as constructing temporary shelters and making available facilities for refuse disposal. No mangrove forests should be converted for tourist development (buildings adjacent to mangroves, meaning with a buffer area of less than 400 m, can still affect the mangrove environment through changes in drainage patters, soil erosion and pollution run-off), and any access to mangroves for ecotourists should be carefully planned;

- Villages and Other Settlements

  It is recommended that the ecotourism development officer(s) and consultant visit these villages to sequester the views of villagers toward ecotourists and ecotourist development. There are standard time proven checklists and questionnaires available that can be modified for the Masoala Peninsula. An inventory of villages and the facilities in them that pertain to ecotourism development need to be made. For instance, Dr F Odendaal has had extensive discussions with the *fokontany* and *reamanhny* in Ampanavoana and found that in this village exist several areas that can be made available for the construction of a *fokontany* hotel, as well as other facilities that can be upgraded such as a landing strip, a clinic, and a fleet of pirogues to carry tourists upriver. Ways need be investigated in which such facilities can be used so that the community accrues as much benefit from ecotourism activities as possible. The authors believe there is great scope on the Peninsula for community-based, and community-run ecotourism.

- Existing and Potential Infrastructure

  An inventory of existing infrastructure on the Peninsula needs to commissioned. Boats for hire at the main centers and further afield need to be listed and classified in terms of their seaworthiness. Regulation of prices would be useful and would prevent the overcharging of short journeys such as the 4 km one from Maroantsetra to Nosy Mangabe.

- Tourism Accommodation

  It is recommended that an inventory be made of available accommodation on the Peninsula. A basic rating of accommodation might be useful to tourists. As pointed out before, there are several hotel construction projects taking place on the Peninsula. Guidelines for such activities need to be established urgently. The following recommendations are only a few examples of regulations that must govern hotel construction in the coastal zone:

  - ♦ There needs to be a construction setback of 60 m from the high water mark for all buildings to avoid erosion and to protect the beaches;

  - ♦ There needs to be a minimum distance from freshwater sources to avoid pollution and contamination of these sources;

  - ♦ There need to be adequate facilities for sewage disposal and outfall should be located far enough from the shore and in such a location that the effluent does not affect any sensitive habitats such as coral reefs and seagrass beds;

  - ♦ Solid waste receptacles need to be provided for refuse such as plastic bags or other containers;

- In areas such as Cap Masoala and islands where ground water is scarce, hotels should catch enough rainwater for consumption by their guests so that this limited resource is not exhausted further;

- There needs to be a proper plan for any construction or other development in the coastal zone and such a plan needs to be evaluated to assess the impact of the proposed construction;

- The carrying capacity of isolated areas, such as islands or sites adjacent to protected areas, should be assessed as part of the evaluation exercise for any development proposal;

- The local community should be included in all local tourist projects, either as a direct or indirect work force.

Community Tourism Accommodation

There exists scope for community tourism accommodation. It is recommended that an education officer be employed to offer advice to interested parties on how they can improve their accommodation for the ecotourist market and use local resources wisely. Local inhabitants on the Peninsula are not always aware of certain needs of tourists such as water for washing and drinking, as people there do not normally drink cold water but prefer warm rice water, which is an acquired taste. It is also highly recommended that local hotel or guest house owners be helped to catch rainwater to boost their freshwater supplies. This is particularly important in areas where groundwater is scarce, such as at Cap Masoala.

10.7.3 Tourism Resource Zones and Management Organization

The management units proposed for other aspects of coastal zone management in Chapter 4 also apply to the development of ecotourism. Tourism development zones need to take into account the borders of management units within which there are specific economic and environmental considerations and management solutions to address them.

10.7.4 Tourism Authority

It is recommended that a tourism commission be created that will have offices in Antalaha and Maroantsetra. The commission can be modeled after similar structures in developing countries such as Costa Rica, Namibia and developing regions of South Africa. The commission will fulfill the broad function of increasing the access of tourists to resources as well as the quality of their experience. The ecotourism commission can also be a central point for processing input from local communities.

10.7.5 Area-specific Actions

There are several important localities that fall outside reserves but need specific actions plans to promote both their proper development as ecotourism destinations and their conservation. These areas need specific action plans designed in conjunction with all the local interested and affected parties.

One such area, for example, is Cap Est. This site has several biologically unique features that warrant conservation measures, such as the swamps immediate inland from the point, fringing mangroves, an island, and the coral reefs and lagoons with their channels that are undoubtedly very important for the dissemination of fish larvae. Under easier circumstances these features would warrant the establishment of a fully-fledged reserve. However, another reserve on the Peninsula may very well stretch administrative and management resources allocated to the areas already designated as parks.

Therefore a separate action plan has to be worked out for the area. The participants in this plan would be the local fishers association, the hotel owners, the palm oil plantation administrators, and whatever other local authorities may exist. The hotel owners may play a definitive role. In discussions with the authors these individuals have indicated their willingness to build research and educational facilities as well as help with the funding and administration of a local marine reserve honoured by common agreement between all local interested and affected parties. In the view of the current consultants all the ingredients for constructing a local action plan are there, and it is recommended that the construction of such a plan, and its implementation, proceed as speedily as possible.

10.7.6 Community Involvement

Community involvement in ecotourism is central to the development and maintenance of a successful industry. Much is known in this regard from study cases elsewhere. The first two ecotourism trial runs indicated a large potential for community involvement. If local communities are not thoroughly involved, resentment will quickly build up and the resource will be destroyed. Community involvement can go as far as growing food or manufacturing products to sell to tourists. The tourism carrying capacity of different villages need to be studied carefully using already existing protocols. It is recommended that a special project be commissioned in which community involvement in ecotourism at all levels be researched in the very near future.

10.7.7 Private Operators

There are two potential types of private operators that may run tours on the Masoala Peninsula. One type would be outside operators that bring tourists to

the region from elsewhere. They can be either a blessing or a curse. Unfortunately they have proved to be a curse more often than not. A benevolent outside operator would make use of local services as far as possible and would provide local people with training opportunities and pay them decent salaries. Benevolent outside operators would also be involved in conservation initiatives as far as possible. Malevolent operators would bring little money to the Peninsula, and would be involved only in activities that further their own interests. Most people are in the ecotourism business for the purpose of making money so it is not surprising that actions and practices are more often than not driven by monetary rather than social or conservation considerations.

Malevolent operators have caused substantial damage in many parts of the world, with some of the most striking case studies in developing countries such as Peru and Brazil. Luckily, they are not too difficult to tell apart from benevolent operators, due to the efforts of a host of non-profit organizations of which. The Ecotourism Society is the biggest and best known. There exist today guidelines to help prospective ecotourists distinguish between good and bad operators before they sign up for tours. However, the people on the Masoala Peninsula also need guidelines to help them distinguish between good and bad operators, so that they can have some recourse in the form of petitioning the Ecotourism Commission in Antalaha and Maroantsetra so that access to the Peninsula and the park system of bad operators can be curbed or eliminated. \

Clear guidelines for outside operators need to be drawn up or the fragile coastal resources can easily be damaged or destroyed. Operators need to be thoroughly informed as to the local customs, and they need to select participants in their tours and keep some measure of control over their behaviour. Valuable lessons in this regard was learned during the second

ecotourism trial run. After a few more trial runs a set of guidelines for operators needs to be drawn up in conjunction with the local inhabitants in the region.

Local operators can also be good or bad. An emerging ecotourism industry often is witness to innovative locals starting up their own businesses as well as copycat locals who are in it for a fast buck. Unprofessional local operators can damage the budding industry as a whole. Local operators often need training to handle westerners and it is recommended that a training program be started as soon as possible. Such training programs can be highly successful. The consultants know a number of people that will be excellent local operators with some training. Local operators need to adhere to strict guidelines as well. The rise of local tyrants is a well-known syndrome in developing economies.

10.7.8 The Park System as an Operator

After the delimitation and establishment of parks and reserves they still need to be made to work financially. Parks and reserves that can pay for themselves, as well as bestow benefit on the local population, have a far greater chance of succeeding and surviving into the future. The most obvious, and perhaps only way, in which the reserves can become financially independent, is through the development of a responsible ecotourism industry which is controlled largely by the parks and reserves themselves. It is not enough for a park to make money from entrance fees only. When set up and run correctly, a reserve or park will be able to take a large cut of the operator's profit itself, money which normally goes to an operator at a locality far away from the park and therefore remain out of reach of the inhabitants. The parks and reserves can then receive a sufficiently a large slice of the profits to pay for park maintenance and management. A properly run park will often show profit beyond its own requirements. Such surplus income can be used for the establishment of new parks and for assisting parks that are going through

difficult periods. It is recommended that a training course be given to park managers and personnel, and that key individuals be given the chance to visit parks elsewhere where the park acts as operator.

10.7.9 COLLABORATION BETWEEN THE PARK AND OUTSIDE INTERESTS Potential collaboration between the park system and outside interests need to be investigated and encouraged. Even when the park system can provide a good service, it will still need help in recruiting participants in its programs. Dr F Odendaal has already recommended that feelers be put out toward the National Parks Board in South Africa and progress is being made in this regard. There are also other official entities that may be interested in joint marketing, such as the South African Tourism Commission. However, collaboration need not be restricted to official organizations. Should the park system on the Masoala Peninsula be in the position to provide an excellent service, there is every possibility of a joint venture between the park system and private businesses who can recruit and sign up prospective clients. The consultants suggest a two-step approach: the first step is for outside interests to use park facilities such as accommodation, but to provide most of the services themselves, particularly those that lie outside park boundaries. Through a system of trial runs the park personnel can be trained to provide services and progressively become more involved in this regard. Eventually the parks will provide not only the facilities but the services as well. There are a number of successful examples that came into being following this route. These possibilities need to be looked into as soon as possible as it takes time to raise money for joint ventures.

10.7.10 LEGAL AND INSTITUTIONAL ARRANGEMENTS

The role of the different legal and institutional structures in the budding ecotourism industry need to fleshed out as soon as possible. For instance, the following entities all play a potential role in ecotourism development:

- Local government structures may play a role in issuing permission for conducting tourism operations, permits for the construction of hotels and other facilities, and may inspect such facilities sporadically;

- Traditional structures such as the *fokontany* can undoubtedly play an important role in organizing services, particularly away from main centers, or by regulating services provided by local people;

- The Malagasy Police (Gendarmes) are potential role players in regulating tourism, or providing recourse to law enforcement when necessary;

- Fisher associations are potential service providers in the form of knowledgeable guides or boat owners.

All potential role players need to be identified so that appropriate relationships can be forged between them so as to minimize the occurrence of actions that affect the market negatively. Corruption and bribery has ruined these industries in several African countries. It needs to be established what happens in the case of emergencies, such as ecotourists that become lost, or evacuations in the event of natural disasters such as cyclones.

The relationships and power balance between the various government departments, ANGAP, and the NGOs involved in integrated development and conservation initiatives are not clear. The relationship between park

authorities and Eaux de Foret needs to be clarified so that visitor permits can be obtained locally at the park entrances and not only in Antananarivo.

10.7.11 The Role of Trial Runs

An useful way to start up a responsible ecotourism industry is to make use of trial runs. This means involving real ecotourists who join the tour with the understanding that they are embarking on an experimental route.

Trail runs have several advantages: they facilitate the gradual involvement of the parks and reserves in the process, they provide a real-life training ground for park guides and managers, they bring in real funds that can be applied to park management and other running costs and, most importantly, they provide word-of-mouth advertisement for the growing ecotourism industry which eventually can be almost entirely controlled by the parks and reserves and local inhabitants.

It is proposed that a program of trial runs be designed with the aim that after the last one the park system will assume full and unsupervised control of further groups of visiting ecotourists.

The following recommendations are made:

- That twenty trial runs be conducted over the next three years on the Masoala Peninsula.

- That the involvement of park managers and local inhabitants be increased progressively with each consecutive trial run;

- That the trail runs be adapted gradually to be a practical training ground for park guides and administrators;

- That routes be varied so the full potential of the region can be discovered;

- That the program be carefully monitored by ANGAP ecotourism officials;

- That marketing mechanisms be set up in South Africa, Europe and the United States.

- That the target would be to bring three hundred ecotourists to the Masoala Peninsula over the next three years. Not only will the park's involvement but also its income increase with each trial run.

- The expectation would be that after the last trial run the parks and reserves would be able to act independently, and provide a high quality service to prospective visitors. In such a scenario, a large percentage of the operator's profit would find its way into the hands of the parks and reserves themselves.

Agreements with one or more consultants and/or outside operators need to be made so that trial runs in which local people become progressively more involved, will continue as soon as possible. Several local businessmen are building cottages, and are looking at ecotourism as a potential source of income. The need to be brought together so that all aspects of ecotourism development can be discussed with them.

10.7.12 DEVELOPMENT OF EDUCATIONAL NATURE TOURISM Educational nature tourism is a fast-growing type of ecotourism that comes in the form of expeditions or excursions offered to the general public or specialist groups. Lately the marketing of educational nature tourism has been extending from more conventional marketing techniques into other effective

methods of reaching clients, such as electronic mail networks, and the publishing of bare-bone directories distributed via nature clubs and larger organizations such as societies, zoos, and educational institutions. The following recommendations are made specifically for the development of nature tourism.

- Tourism programs should be designed that highlight the commercial development of coastal activities such as aquaculture, pelagic fishing, agriculture, and traditional fishing villages. This would minimize the impacts and wastage of such resources and conflicts from their uses . This would also increase community participation in development and management efforts.

- A guidebook should be written and made available to arriving tourists through the offices of the Masoala Tourism Commission in Maroantsetra and Antalaha and other agencies further afield, including the capital and other popular destinations. Such a guidebook should be written in that particular style which is becoming increasingly popular: linking the text to particular landmarks that the reader will encounter on his journey that starts at a particular gateway and follows a certain access route. Apart from pertinent natural history information the booklet will include other points of interest. For instance, the tourism project staff should interview farmers and fishermen, and encourage them to establish a program whereby they will explain to the tourists how their farms or boats operate. If they are willing to do this, their names will be included in the booklet. The names and photographs of guides approved by the Masoala Tourism Commission will be listed in the booklet. This booklet can be an important promotional and educational tool to highlight human activities on the Masoala Peninsula.

• Educational programs promoting the various ecotypes and related activities in the region should be established. These programs need to focus on activities such as snorkeling, bird-watching, river cruising, fishing, and agricultural activity. Such programs will especially be helpful to tour operators and park guides (who will need to be thoroughly educated in these matters), the relevant non-governmental agencies and government officials (who make policies that influence the use of these resources), tour book writers (for promotional purposes), and local educational institutions such as schools (where the education of children can be augmented). It will be necessary for project staff to work with outside expertise to determine the best examples of the various resources that should be highlighted and promoted!

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19 Visits to Nosy Mangabe require permits which presently can be obtained at the Coco Beach Hotel. Unfortunately many visitors go to the island unauthorized, but there are guards on the island so that an estimation of the number of visitors to the island can be made.

20 This number was given to Dr F Odendaal by Mr Aime who has a strategically located hut where food is served to visitors. The number was confirmed by the shopkeeper who owns the boat *Flarina,* and the fishermen named Pierre. The six visitors were German and travelled by mountain bicycle.

21 Twenty serious responses were elicited in the United States but the expedition was already fully booked by South Africans before any of the American applications could be processed by Ocean Cruises in Connecticut.

22 Advertisements were placed over a six month period in Getaway Magazine

in South Africa as well as The Citizen newspaper.

23 Local Expenses included the hire of boats, provisions for the journey around the Peninsula, porters, runners, guides, various site fees such as well as two different donations to *ihefokontany*.

24 Four advertisements were placed in Outside Magazine. Marketing in the United States involved the setting up of a temporary administrative structure inside the offices of Ocean Cruises, the installation of a phone line particularly for the purpose of marketing this trial run, and the purchase of an answering machine. Eco-Africa Environmental Consultants have since opened a permanent office in North Carolina to market trial runs.

25 Brenda Berge came on the first trial run. She agreed to be a co-organizer whose duties included a variety of pre-trip activities. She also accompanied team members on their journey from South Africa, did bookkeeping inside Madagascar, and other tasks. In exchange for her work she stayed on another three weeks on the Masoala Peninsula at no additional cost.

26 Marcel Kroese was contracted as resident marine biologist and expedition guide in exchange for a plane ticket from Johannesburg.

27 H Kent took care of all administrative duties related to the trial run which ran over a period of almost ten months, including the processing of enquiries and applications.

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CHAPTER 11 THE ROAD AHEAD

The coastal resources of the Masoala Peninsula are currently locked into a process of degeneration. The pressure on them is increasing day by day. The resource users and conservation-minded interested and affected parties must be aligned to have one aim in common: the challenge to promote sustainable resource use in the region. On paper this aim appears clear. For instance, this report have provided strategic guidelines for the writing of specific management plans for the different resources. But this report is not enough. These specific plans must now be written in such a way that they can be implemented on a step-by-step basis. Not only must they be practical but they also must have the approval of the local resource users. Therefore, what is now called for is a properly funded, fully-fledged coastal zone project along the lines promoted by this report.

In addition to specific management plans, a coastal zone project will do well not lose track of the following perspectives during its deployment:

- Initiatives must work toward the integration of conservation and development. Conservation without development no longer is an option. Development without conservation is the route to unsustainable resource use. Furthermore, many of the resources on the Peninsula are potentially overlapping and conflicting in their current and potential uses, so that it will be imperative that a genuine integration and conservation plan be developed for the region. The main purpose of this plan which would be to maximize the benefits of the sustainable utilization of resources, and to minimize conflict between resource users.

- There has been a tendency lately for the international conservation community to gradually confer the responsibility for a country's conservation problems to local agencies such as the government itself or local NGOs. This shift in responsibility and power is long overdue; however, the transfer of influence over destiny must not stop there. Local agencies must do not everything they can to transfer responsibility and power to local people themselves. The people most affected by the resources are the local people themselves. They have the most to gain by sustainable resource use and the most to lose when resources fail. The guidelines provided in this report for a bottom-up approach need to be constantly examined and re-examined.

The single biggest threat to the future of Masoala's marine resources is the growing number of people in the region. If population growth continues to outpace the sustainable level of food production in the region, it is likely at some point in the future to render conservation of marine resources unmanageable: conservation strategies designed for a sustainable future simply cannot be expected to rate highly among the concerns of people who do not have enough to eat. It is not enough to examine patterns of immigration to the Peninsula: the issue of birth control and family planning needs to be addressed as well. Although considered a red herring by many NGOs, the local people have often taken the step to broach the subject of birth control and large families with the authors of this report. The link between large families and the welfare of the children in those families are abundantly clear to many inhabitants on the Peninsula, and a family planning program will be timely and well-received.

Masoala is not isolated from the rest of the country. Many of the problems in that region are not particularly unique. This is certainly true for the coastal

zone. It is the hope of the authors that the successful implementation of a coastal zone project on the Masoala Peninsula will spread around the entire coast of this large island on which so many people depends for their livelihood on the sea.

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APPENDIX ONE

	VILLAGES	DISTANCE FROM SEA	NUMBER OF PEOPLE	NUMBER OF FAMILEES	NUMBER OF FISHING FAMILIES	NUMBER OF BOATS	NUMBER OF BOATS WITH ENGINS
	AMBATOFOTSY						
1	Anjahamarina	1	497	-	-	-	-
2	Ambohitralanana	1	1407	~			
	ANBODIRAFIA						
3	Andrombazaha	0	29	12	3	3	0
4	Ambodifaria	0	238	61	17	24	I
5	Antsahamboto	0,5	165	71	-	-	0
6	Tanamboa Bezavary	0	136	40	-	-	0
7	Sahanjahana	0,5	326	104	-	-	1
8	Vohisna	0,5	60	21	-	-	0
9	Ambohimahery	0	136	80	23	21	0
10	Analalava	0	39	16			0
11	Miharavo	0	193	77	47	35	0
12	Fandropaha	0	49	10	-	-	0
13	Antanambiavy	0	16	7	-	-	0
14	Ankiana	0,5	72	19	-	-	0
15	Ampnotaka	0	16	7	7	5	0
16	Ratsianarana	0	630	184	12	42	1
	Ratsianarana area	0	850	238			
	ANTSIRAMIANANA						
17	Antsiramianana	0	21	8	8	15	1
18	Tanamboa-Hifina	0,5	127	30	5	10	0
19	Andranampaha	1	71	16	-	-	0
20	Tanjokolonana	0	37	11	11	8	0
21	Antsambavy	0,5	178	22	-	-	0
22	Tanjokontafana	0	91	21	16	9	0
23	Fampotakely	0,5	895	84	7	20	0
24	Ampanio	1	426	-	-	-	0
25	Ambodivarotro	5	623	-	-	-	0
26	Ambodimanga	5	1261	-	-	-	0
27	Ampanavrana	0	1342	215	15	59	1
	MAROFINARITRA						
28	Marofinaritra	0,5	564	74	4	32	0
29	Ambodipont	1l--------	----- -1054	-	-	-	0
30	Anjanazana Tonamboa	3|		-	-	-	1
31	Antrabobe	0	12	4	4	6	0
32	Iaramy	0	50	13	13	17	0
33	Tanjona	0	80	23	23	18	0
34	Ifaho	0	96	23	22	22	0
35	Rantokay	0	25	6	2	3	0
36	Hanorivola	3	215	52	5	-	0
37	Sahamalaza	3	587	172	6	-	0
38	Ambohombato	0	103	33	33	20	0
39	Vinanivao	0	2672	193	18	65	8
40	Anropatsopa	0	66	23	23	31	0
41	Ankazofosy	0	69	22	20	25	0

42	Ambinanibe	0	16	4	4
43	Ambatoarana	1	408	"	*
44	Beankora	2|		-	-
45	Ambotiletra	0	63	18	15
46	Ambatomikopaka	0	46	12	7
47	Andamponge	0	85	20	20
48	Masoala	0	ß^O		7
49	Ambavazaha	0,5	ojy	.	
50	Antetezampofana	0,5		-	-
51	Fampotabe	0,5		-	-
52	Namantoana	0	"11f		
53	Ratranavona	0		–	m
54	Ampamolahambe	0		-	-
55	Sohaleno	0	7	2	2
	ANTALAV1A				
56	Antalavia	0	22	7	2
57	Marrantoko - Marofotatra	0	32	13	2
58	*Manambia*	0,5	41	20	1
59	Anaravana	0	3	3	2
60	Ambodiforaha	0	45	16	5
61	Ambanizana	0	674	178	10
62	Rantabe	0	598	109	15
63	Nandrahanana	0	870	176	6
64	Andranovato	0	-	-	.
65	Iaraka	0	.	-	.
66	Maxindrano	0	.	.	_
67	Anjahana	1	-	-	.
68	Navana	0	.	-	_
69	Andranofoty	2	-	-	.
70	Maroantsetra	0	-	-	-

Autres du cote d'Ambohitralonana (Up the Onive river)

Ambohommisinjo	2,5	69	12	0
Ambatobe	2,5	229	59	0
Tanambao -1	2,5	247	59	0
Varony	3	26	6	0
Tanandava -1	3	23	5	0
Sahafary	3,5	76	39	0
Ambinan'i Sinda	3,5	12	2	0
Ambodimanya	3	27	4	0
Marovato	3	14	4	0
Ampisotnana	2,5	18	4	0
Antsordava	3	46	13	0
Antonandavahely	6	505	103	0
Sakahandrano	6	66	12	0
Anjia	6,5	24	5	0
Sohamaloza	6,5	248	68	0
Nanakona	6,5	44	8	0
Ambdimandresj	*1*	26	7	0
Ambanimangy	2	137	43	0

APPENDIX TWO

Participatory Rural Report

This appendix reports the use of natural resources in three pilot zones of the Masoala Peninsula, Madagascar, as investigated from January 1994 to March 1994. The study was conducted by assistant technique : Mr Jose Andrianisa, Ingenieur Forestier, Mr Jaomanana, Ingenieur Halieute, and Mr Sabe Felix Maitrisan,the Chief of Rural Animation Team and natural science and development agents of Project Masoala.

1. Ambanizana Region

1.1 Geographic background

Ambanizana is situated on the west coast of the Masoala peninsula. The rainfall in this region is higher than any another place in Madagascar. The humidity also is very high, never less than 60%. Primary rain forest, starting at the shore line, extends through out the region. However, some of this forest has already been transformed into farm land to cultivate rice, vanilla, cloves, coffee, sugar-cane and bananas.

1.2.Human Environment

This region is administrated by Firaisana Anjahana and Fivondronana Maroantsetra. There is three big villages:

Fokontany	Villages	Peoples	Family
Nandrahanana	Nandrahanana	870	176
	Rantabe	474	109
Ambanizana	Ambanizana	674	178
	Ambodiforaha	45	16
	Antalavia area	105	45
	Total	**2168**	524

Many other small villages are found up the Ambanizana River, but no data are available.

All schools were closed after a destructive cyclone, nevertheless one teacher is present in Nandrahanana but they do can not do anything without schools. There is no hospital in this area and people use medicinal plants to treat some illness. Population growth is approximately 4,2% per annum.

1.3. Exploitation of Resources

1.3.1 Land Usage

Rice:
The most important land use is for the planting of rice, which is grown in swamps **or** rice fields/paddies. The farming season is from May to December, when swamp or rice fields are prepared, planted and harvested.

The mean production is about 0,5 T/ha, not enough for the people living there. In Ambanizana, 20 % of families have enough fields for rice production, 80 % have a narrow field or no fields, in which case farms are rented from other landowners, for about half or more of the rice crop, or paid for with money.

Problems with rice cultivation are as follows:
- water for irrigation of rice field
- draining of swamps
  diseases

Cash crops:
There are many clove, vanilla and coffee farms in this region. The production is high, but price fluctuation discourages farmers to plant more.

Other crops:
Many other food crops, such as cassava, banana, yams and "sahono" are planted in this region. These are used during periods of food shortages or as animal fodder, mainly for pigs.

1.3.2. Animal Husbandry

The most important livestock is the zebu, which are kept in large pens, in clearings in the forest. Zebu are used to trample rice fields and are presented as offerings for some local taboo, or religious ceremonies, for example, exhumation. At present, pig farming is increasing. Pigs are slaughtered and the meat sold in villages for festivals like New Year's Day, Easter, National Independence Day on 26 June and Christmas. Poultry farming is not extensive because of disease, and theft.

1.3.3.Marine Resources

Some families depend solely on marine resources, about 10 % of families generate more than 50 % of their income from marine resources. The types of gear used in this region are: Seine and gill net, hook and line, speargun and spear.

Purse seine netting is usually done by a team of woman, to catch pelagic fish (bemasoa=sardine) in the shallow water. After landing the catch, they distribute the fish, for example, half to the net and half to the rest of fishers. The average is about 20 baskets per day (1 basket=10 kg) when the fish is along the coast. One purse seine net has a 1,2 cm mesh size and is 100 m long. The cost of one such net is Fmg 300.000. Gill nets, line and hook and spearguns are used near the village or fishermen move to the Tampolo region and catch there. The catch of this fishery is estimated at about one basket of dried fish a week, worth about Fmg 15.000 on average. Some fishermen dive for sea cucumber but there are no data available.

Problems with the fishing:
  declining catch, primarily as a result of large scale fishing by a commercial trawler from Tamatave fishing near the coast,
- expensive and scarce fishing gear.

1.3.4 Forest Resources

Access to the forest is not controlled or regulated. The forest is utilized to obtain timber for construction of houses, firewood, bilahy (bark of a special **wood** used to make a traditional beer), for hunting wild animals like lemurs, wild pigs and many species of birds. Other forest resources used include leaves for roofs and walls of houses, medicinal plants, honey and some tubers for food.

1.4 Suggestions by the villagers to remedy these problems include:

controlled access to nature resources additional lands for rice cultivation rebuilding of dams rebuilding of schools and hospitals • disease prevention and treatment of crops and animals help in obtaining fishing gear, technical improvement.

2. Anovandrano Region

2.1. Geographic Background

Anovandrano is situated at the south eastern coast of the peninsula. Many villages are situated on both sides of Anovandrano River, from mouth-stream up. There is Ifaho-Tanjona, Rantokay, Sahamalaza, Manarivola, Iketra. Tanambao Mahatsinjo is far from the river. The rainfall and humidity is lower man Ambanizana and almost all of lowland rainforests have been transformed into rice fields (tavy).

2.2. Human Environment

There is four big villages in this zone:

Fokontany	**Village**	**People**	Family
Sahamalaza	Sahamalaza	802	178
	Manarivola	215	52
	Tanjona area	201	52
Vinanivao	Tanambaomahatsinjo	216	46
Total		**1439**	**328**

Population growth rate is about 3,99 % in this region. There is no hospital in the region. One private school in Ifaho and one public school in Sahamalaza are the only schools in this area.

2.3. Exploitation of Resources

2.3.1.Farming

Rice:
There is two seasons for rice cultivation, called Rice Ririnina (April to August) and Rice Taono (September to June). During Rice Ririnina, the main cultivation takes place in "horaka" (swamp and rice fields) with planting commencing in May and harvested in December. In the Rice Taono period, rice is planted in "tavy" fields (new fields obtained by "jinja" (cutting down the forest and burning it)) from November to May / June.

The most important farming practice in this area is "jinja", where people start to cut down the forest in September, then burn the wood and start to plant rice from November to January, harvesting from May to June. The average yield is about 0,5 T/ha, and each family makes approximately 5 ha of new rice fields each year. The season and the method of culture of "horaka" is same as in the Ambanizana zone. This region has an enormous potential for rice cultivation, as swamps can transformed into rice fields like Ankona and Sahaniambana, 60 ha each, and many small swamps border both sides of the Anovandrano river.

Cash crops:
Similar to the situation in Ambanizana, people grow vanilla, cloves and coffee, but the fluctuation in price discourages farmers.

Other crops:
During periods of food shortage, people eat cassava, yams, "sahono" and sweet potatoes sometimes cooked with sugarcane juice. The production of these crops is not high.

2.3.2. Animal Husbandry

The zebu is the most important of all the animals. Problems exist with cattle disease and conflict with rice farmers. Poultry is just for consumption of the family, but sometimes a buyer from Antalaha visits this region to collect chickens and ducks.

3.3.3.Marine Resources

Fish:
Fishing operations are expanding in this area. All the families in the Tanjona area are full-time fishers. Additionally, many temporary fishers, from inland and other villages move here to fish during the best fishing season. Five types of gear are used: nets, fish-traps (vovo, vitrana), spears, spearguns and lines and hooks.

The number of gear and average production per month, for the Ifaho village is shown in this following table:

Gear	**Number**	**Production/month**	Total
Net	**16**	60 kg	960kg
Vovo	**68**	05 kg	340kg
Line	**11**	02 kg	22kg
Spear gun	**02**		
Vitrana	**01**	60 kg	60kg

Gill Net (Arato):

Mesh size varies from 1.5cm to 30cm and the length is about 150m on average. Problems are the high cost of maintenance, both in time and money for new material. Netting material is scarce and expensive. Consequently, the owners of this kind of gear are usually the rich of the village. Fishers rent a net for half of the catch.

Fish trap (Vovo):
This cheap gear is made from bamboo and is imported from Mananara and is easy to manipulate. One fisherman can visit about twenty fish traps a day. Unfortunatly its usefulness is short lived, about three months, and one costs about Fmg 1 500.

Fish trap (Barrage):
This trap consists of a long row of thin poles planted next to each other in the sand, from the intertidal zone upto 100m into the water. Sometimes woven reed mats are attached to the stucture, thereby reducing the "mesh size". It may contain one or many narrow mouthed enclosures where fish become trapped. At low tide the fishers then collect all the fish captured in each trap.

Hook and line:
Lines are used at night, during high tide, or just to while away the time when the nets are in the water.

Speargun:
Like nets this is too expensive for fishers to buy and they usually rent this from the rich for half of the catch.

Because of yearly decreasing catch, and in order to increase and optimize their catch, fishers reduce the mesh size of net, brake the reef or hit the surface of water to drive fish out of the coral.
Fishers rarely sell fresh fish, they make salted fish or dried fish and sell it to buyers or transport it directly to important markets like Mananara, Maroantsetra and Antalaha.

Octopus:
At each low tide people walk on the reef top to catch or spear octopus. The time spent catching octopus depends on the tide, but everybody, including children can walk on the reef top. On average five octopus per person per day is caught, all of which is dried.

Seacucumber:
Seacucumbers are collected in lagoons, at low tide or by diving at the reef break. There is seven species of seacucumber in this region: DINGAMBE-ANTOHISANGA-DINGAMBATO-MAHITSOHELY-DINGAMPARORATRA-LONTANANA-VALONONO.

Lobsters:
Lobsters are rarely exploited because they are difficult to transport to the markets. Therefore fishers are forced to sell their catch to buyers at half or less of the market value. Since the fishers need the money for their daily life they have no recourse but to sell at reduced prices.

In addition, fishers mink the decreasing production is caused by :

* violation of "fady", local forbidden practices like:
  fishing with seine net near the mouth of river,
- hitting the surface of the water with sticks,
  throwing ash or burnt-out wood into the sea,
* and by using methods and gear not allowed,

also fish behaviour can avoid many of kinds of traps,
nevertheless the catch is still high when the net is quite long.

2.3.4. Forest Resources

People use the forest for:

- wood to build houses,
- leaves for roofs and walls,
- firewood,
- precious wood like ebony, to sell, hunting (lemurs, wild pig and birds), obtaining bilahy, honey and medicinal plants.

2.4. Suggestions

- * control access to natural resources
- * improve agricultural and fishing techniques
  * diversify the activity
  * obtain more land for swamp reclamation.

3.1Agnobe Region

3.1. **Geographic Background**

This region is situated at the north-east part of the peninsula, on both sides of lagnobe river. The rainfall and humidity is the same as for the Anovandrano zone. There are only two ways to reach, the main area of Antalaha, by car and boat.

3.2. Human Environment

Fokontany	Villages	Nhabitants	Family
Ambohitralanana	Ambohitralanana	1407	414
	Anjahamarina-i	497	126
	Andromazaha	29	12
	Ambodirafia	238	61
	Ambanimangy	137	43
	Ambohimitsinjo	69	12
Ambatobe	Ambatobe	229	59
	Tanambao	247	59
	Sahafary	76	39
	Antsorilava	46	13
	Varony	26	6
	Tanandava-ii	23	5
	Ambodimanga	27	4
	Autres	44	10
Tanandavahely	Tanandavahely	505	103
	Sarahandrano	66	12
	Sahamalaza	248	68
	Manakana	44	8
	Anjia	24	5
	Ambodimandresy.	26	7
Total		**4008**	**1066**

This region is the most densely populated area on the peninsula, and the population is increasing rapidly at about 10,22 % per year. Additionally, many people immigrate to look for work, since the establishment of the Palm Oil Plantation Project.
Ambohitralanana is the principal village of this Firaisana, with a primary and secondary school, one hospital and drug- store.

3.3. Resources Exploitation

3.3.1. Agriculture

Rice:
There is two seasons of rice plantation, Rice Ririnina "horaka" from May to December and Rice Taono "tavy" from September to June.

The most important agricultural practice is the jinja', when people start to cut down the forest in September, burn wood and start to grow rice from November to January, and harvest from May to June. The average yield is about 0,5 T/ha, and on average each family makes 5 ha of field rice each year.

The horaka' is important, where people grow rice in swamp or rice fields. The season starts in May, when swamps and rice fields are prepared and planted; harvesting takes place in December. The average production is about 1 T/ha, a very unsatisfactory low yield.

Problems with rice production are:
- water irrigation for rice field
- draining of swamps diseases

Cash crops:

There are many clove, vanilla and coffee farms in this region. The production is high, but the price fluctuation discourages farmers to increase planting.

Other crops:
Many other food crops such as cassava, banana, yams and sahono are planted in this region and used when food shortages occur.

3.3.2. Animal Husbandry

The zebu is the most important animal. Problems exist with cattle diseases and conflict with crop farmers. Poultry is also important because buyers from Antalaha often visit this region to collect chickens and ducks.

3.3.3. Marine Resources

Fish:
Fishing is increasing in this area. Many families in coastal villages from Ambodirafia to Ratsianarana are full-time fishers and there is a lot of immigrant temporary fishers from Antalaha during the best fishing season. They use five types of gear such as nets, fish traps (vovo, vitrana), spears, spear guns and lines and hooks.

Nets:
The mesh size varies from 1.5cm to 30cm and the length is about 150m on average. The problem with nets are the high cost of maintenance in both time and money. Netting material is scarce and very costly. Consequently, the owners of this kind of gear are almost always the rich people in the village. The fishers rent **a** net for half of the catch.

Fish traps (VOVO):
This gear is made by the local fishers, but are also cheap to buy and easy to manipulate. One fisher can visit about twenty vovo a day. But it usefulness is short lived, about three months and the cost of one vovo is about Fmg 2500.

Fish Traps (Barrage):
The trap consists of a long row of thin poles planted next to each other in the sand, from the inter tidal zone up to 100 m into the water. Sometimes woven reed mats are attached to the structure, reducing the "mesh size". It may contain one or many narrow mouthed enclosures where fish become trapped. At low tide the fishers then collect all the fish captured in each trap.

Hooks and Lines:
This gear is very common and used by most fishers.

Spear guns:
Like **a** net this is too expensive to buy, and a fisher usually rents this gear from rich businessmen for half of the catch.

Since the catch is decreasing yearly, fishers reduce the mesh size of net, brake the reef or hit the surface of water to frighten fish out of their hiding places. Fishers sell fresh fish, they rarely make salted fish or dried fish because they make money on **a** daily basis.

Octopus:
Each low tide, people walk on the reef top to catch octopus with spears. The time spent hunting depends on the tide but everyone, even children, walk on the reef top. On average they catch five octopus per person per day; all of which are dried.

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Sea cucumber:
They collect seacucumbers in lagoons at low tide or diving at the reef break. There are seven species of seacucumber in this region: DINGAMBE-ANTOHISANGA-DINGAMBATO-MAHITSOHELY-DlNGAMPARORATRA-LONTANANA-VALONONO.

Lobsters:
Lobsters are very rare in this region. Many fishers from Antalaha have exploited them to the extent that the catch is now very low.

Transportation is problematic, forcing fishers to sell their catch to buyers at half or less of market value. Since the fishers need the money for their daily life they have no option but to sell at reduced prices.

Fishers think the decline in catches are caused by bad methods, illegal gear, and fish behavior that avoid many of kinds of traps. Nevertheless the catch is still high when the net is quite long, and the potential in the open sea is also is important.

3.3.4.Forest Resources

People use the following resources from the forest:

wood to build houses, leaves for roofs and walls,

- fire wood,

precious wood like ebony, to sell,
animals for hunting (lemurs, wild pig and birds),
bilahy, honey and medicinal plants.

2.4. Suggestions

control access to natural resources, improve agricultural and fishing techniques, diversify the activity.

- obtain more land, swamp reclamation.
- rebuild dams

resettle endangered species,
build a hospital