Status and Management of the Marine Protected Areas in Madagascar

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Table of Contents

Executive Summary

Rapid coastal area appraisal techniques were used to determine the status and management of the marine protected areas of Madagascar. Information was derived from structured interviews with stakeholders, existing databases, a literature review and observations at the respective case study sites. The objective was to conduct a critical analysis of the progress, including successes and failures of the management of marine protected areas in Madagascar since their establishment. The ability of the management process in maintaining the quality and quantity of biodiversity, the conservation and rational management of marine resources, protection of the ecosystem and improving the livelihood of coastal communities were used as objective criteria for the assessment.

There are 2 marine protected areas in Madagascar located on the north east coast, the Nosy Atafana Marine Park forms part of the UNESCO Biosphere Reserve of Mananara-Nord and the Masoala National Park has a complex of 3 satellite marine parks located off the adjacent coastline. They are managed as part of the neighbouring terrestrial parks, under an integrated community based participatory process, which is focused on a high level of co-ordination, communication and education. Both areas have a notable regional significance in that all of the principal habitats that typify the coastal zone of Madagascar occur within their boundaries and they are important as a marine resource base for fishing communities in adjacent villages. Furthermore, the marine parks are characterised by high biological diversity and representative habitats of endangered and endemic species. The cultural value of these areas is indicated by the presence of sacred burial sites.

The management of the Nosy Atafana Marine Park has been highly successful, enabling an improvement in the livelihoods of coastal communities whilst conserving resources and improving the integrity of biodiversity and ecosystems. An augmentation in the status of the habitats in the marine park has occurred since its creation including an enhancement of the forests through the removal of vegetation planted by the coastal communities. There has been a regeneration of coral on the reef flat following a decline in octopus fishing, and a regeneration of mangroves following a ban on the exploitation of wood to make fish drying racks. The objective of resource conservation has been met by the regulation of fishing activity resulting in an increase in catch rates within and outside the park and an augmentation in recruitment. The management process has also demonstrated the ability to resolve conflicts such as the competition for marine resources from migrant fishermen and loss of income following access restrictions.

The rationale of the process is based on relieving pressure on over exploited resources and sensitive habitats by facilitating alternative activities that are sustainable. Very little resources are required for successful surveillance and enforcement as these responsibilities are shared between the management authority and resource users. A major contribution to the success of the management of Nosy Atafana Marine Park, was the ability of the management authority to allocate property rights to the resource users via a ‘usage contract’. This unique approach has resulted in an increase in yields from the resource base and a ‘spill-over’ effect into adjacent areas. Furthermore, there is a high degree of compliance and resource users have developed their own initiatives in the husbandry, protection and conservation of resources. However, a threat exists in the fact that the marine park does not have a management plan and there is an absence of a permanent monitoring programme to assess the impacts of current tourism developments.

Having been in place for only 3 years, the participatory management process for the Masoala Marine Parks has not achieved it's goals and was delayed by a change in the management authority 2 years after initial activities started. There has been some success in terms of the maintenance of biodiversity, conservation of ecosystems and sustainable use of marine resources illustrated by the successful management of Tampolo Marine Park. However, the process has not developed sufficiently to be able to resolve resource base conflicts. As a result, the marine resources of the Tanjona and Cap Masoala marine parks are over exploited and there is conflicting use between resident coastal communities and migrant fishermen. Furthermore, the integrity of biodiversity and ecosystems is jeopardised through the detrimental impacts of human activities. Habitat destruction occurs as a result of trampling by octopus fishermen and other fishing practices. The existing demographic structure of coastal communities indicates that the pressure on the resources of the Masoala Marine Parks will increase rapidly in the future. An acceleration of the existing management process through increased activities and the development of a capacity to resolve conflicting resource use are imperative in this context.

The major constraint to successful management is the lack of capacity in implementing activities within the management process. For the management objectives to be fully achieved there needs to be an increase in the programs and activities associated with the coastal communities adjacent to the Masoala Marine Parks. These should be orientated at developing alternative practices and reversing the deleterious impacts on habitats and resources. This should be accompanied by an increase in the current efforts of educating resource users in order to provide a catalyst to the existing management process. It is highly improbable that management goals and objectives will be achieved if the decision making process does not develop the ability to resolve conflicting resource use. A close dialogue between resource users, stakeholders and the management authority is crucial if conflicts are to be resolved. Improvements to the existing system can be made through incorporating the usage contract as a traditional social agreement (Dina) so that it is legally recognised and the management authorities need to create sections that are specifically responsible for the marine parks.

For participatory integrated coastal area management to be successfully applied to marine protected areas there must be synergy in the development of projects between regions. The effect of limiting access to the Nosy Atafana Marine Park successfully excluded migrant fishermen from outside the region. Whilst this was instrumental in resolving a major resource use conflict, it exacerbated the same conflict in the adjacent region where the management process was not yet in place. The mobility of marine resource users needs to be considered in the wider context during the decision making process.

The potential impact of current tourism developments without a comprehensive ecological monitoring programme and management plan is a major threat to the integrity of the existing marine parks. The marine protected areas of Madagascar are under represented and do not reflect the importance of coastal marine habitats around the island. It is necessary to create more marine protected areas and develop and implement individual management plans for existing MPA's within the framework of the 'Strategic Plan for the Network of Protected Areas in Madagascar' (ANGAP, 1999). Where there is a complex of marine protected areas, as in the case of Masoala, each requires an individual management plan that responds to its specific characteristics and needs.

Introduction

Situated in the Southwest Indian Ocean between latitudes 11^{o} 57' and 25^{o} 30' south and longitudes 43^{o} 14' and 50^{o} 27' east, Madagascar is the fourth largest island in the world with a surface area of 594,000 km^2. The geomorphology of Madagascar consists of a raised central plateau, which covers two thirds of the island and ranges in altitude from 800m. to 2,600m. Abrupt escarpments surround the central plateau and descend to a flat coastal plain. The east and north-east of Madagascar is characterised by a tropical humid climate whilst that of the west and south-west, receiving less precipitation is comparatively dry. Climatic conditions are generally highly variable between locations as a result of the wide range of altitude and latitude. Tropical cyclones that develop in the south-west Indian Ocean and Mozambique Channel occur between January and March (Ramiarison, 1998).

Madagascar has a population of 15.8 million with a growth rate of 2.7% per annum. Communities are predominantly rural and subsequently agriculture is the dominant economic activity, employing 70% of the active population. Whilst fisheries employ only 14% of the workforce, it is the dominant industry in terms of the revenues generated. Catches are typified by high value species such as prawns and shellfish destined for export markets. Given the diverse and unique natural environment of Madagascar, there is a tremendous potential for the development of the tourism industry, however, this sector is relatively small employing approximately 1% of the working population (Ramiarison, 1998).

The separation from continental Africa almost 165 million years ago, in combination with a diverse geomorphology and climate has resulted in a remarkably high rate of endemism and biological diversity. The coastal zone is characterised by a variety of habitats having diverse floral and faunal assemblages, these include species endemic to Madagascar as well as others common within the region (Ramiarison, 1998). The principal habitats and ecosystems of the coastal zone are:

- *Mangrove forests*. Mangrove forests cover an estimated 3,300 km^2 of the coastal zone, 98% of which is situated at 29 sites on the West Coast of Madagascar (Ranaivoson, 1998), see Figure 1.
- *Lagoons*. The principal lagoons cover a total surface area of 60,000 km^2, all of which are situated on the East Coast of Madagascar (Ranaivoson, 1998), see Figure 1.
- *Coral Reefs*. Coral reefs extend for a distance of 1,042 km around the coast of Madagascar. The distribution is discontinuous with the most extensive reefs located in the Northwest and Southwest. The fringing reefs on the East Coast of Madagascar are much less developed and not as extensive as those of the west coast (Ranaivoson, 1998), see Figure1.
- *Rocky outcrops*. A limited amount of the coastal zone consists of elevated rocky outcrops, these are principally located in the north-east and north-west of Madagascar (Ranaivoson, 1998), see Annex 1.
- *Sandy beaches*. Sandy beaches extend along the majority of the coastline on both the east and west coasts (Ranaivoson, 1998), see Annex 1.

A variety of crustaceans, molluscs, echinoderms, holothurians and fish are exploited from these habitats, providing an important source of revenue, employment and nutrition to the coastal communities. The coastal marine environment of Madagascar is relatively well preserved along uninhabited coastlines. However, a range of deleterious impacts associated with anthropogenic activities threatens biodiversity and the coastal living marine resources.

The impacts are most pronounced where coastal habitats are in close proximity to areas of high population density (Ranaivoson, 1998). Some of the principal threats to coastal habitats and resources allied to human activities include:

- Biological and chemical pollution from domestic and industrial waste.
- Overexploitation of mangroves and coral reef resources.
- Siltation derived from inadequate land management practices.
- Insufficiently regulated aquaculture development in mangrove areas.
- Localised eutrophication resulting from by-catch discards in the prawn fishery.
- Destructive fishing techniques such as the use of dynamite.

In view of these threats, protected areas have been established in order to maintain biodiversity and conserve natural heritage. There are 47 protected areas in Madagascar which cover a total surface area of 1,698,638 ha (ANGAP, 1999), see Figure 2. The state assumes the responsibility for the management of the national network of protected areas, which is conferred to the National Association for the Management of Protected Areas (ANGAP). There are three categories of protected area, which have different degrees of protection in relation to the conservation of biodiversity:

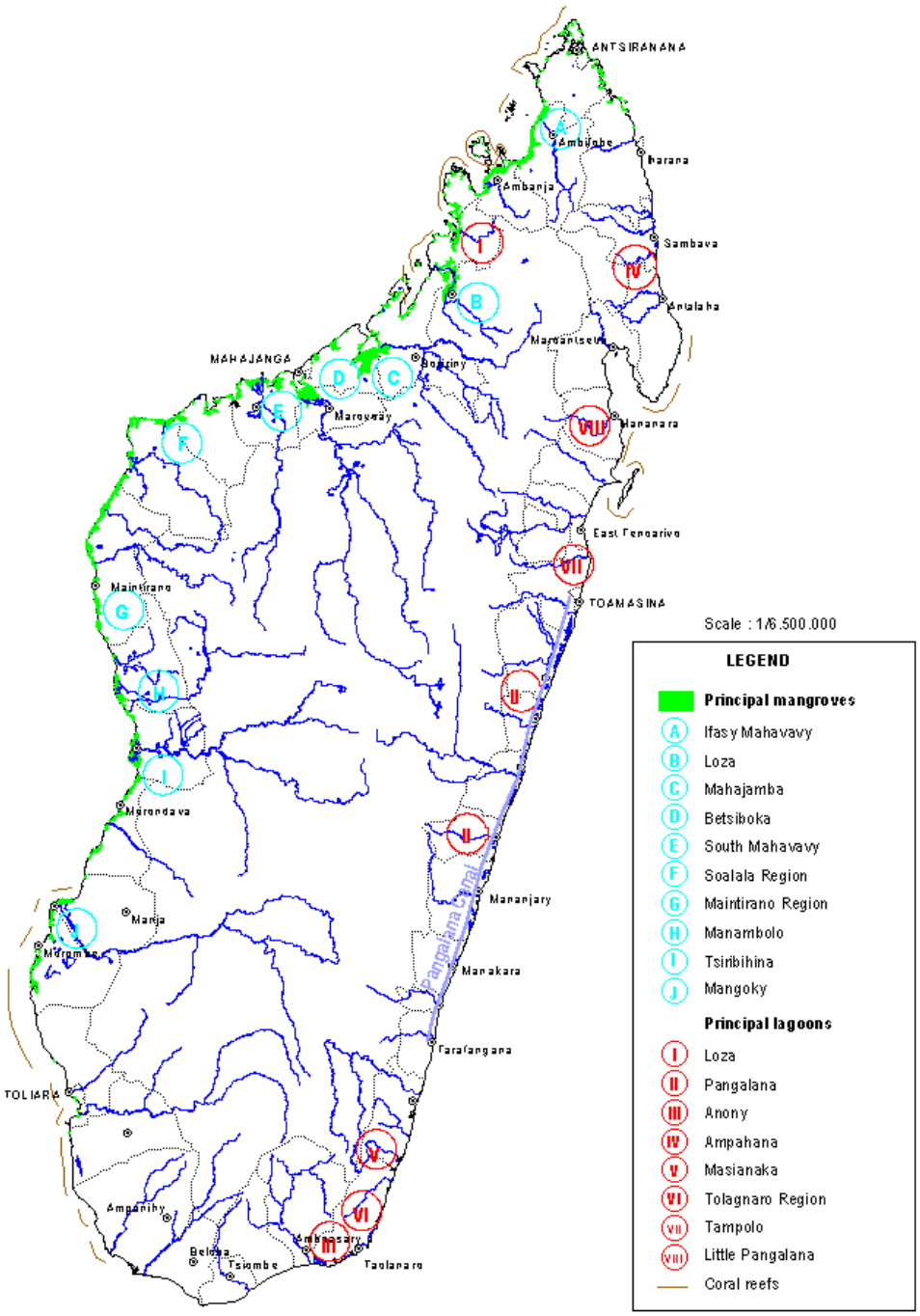
National Parks (NP). The goal of National Parks is to protect and conserve natural and cultural heritage whilst maintaining a recreational and educational function. There are a total of 16 national parks in Madagascar (Figure 2.) covering a surface area of 1,038,270 ha (ANGAP, 1999).

Integral Natural Reserves (INR). The network of Integral Natural Reserves was created in 1927. They were established with the goal of protecting the fauna and flora of the defined zones. Hunting, fishing, tree felling, mining, excavation, drilling, agriculture, land prospection and construction are forbidden. The introduction of species not naturally present into these areas is also prohibited and the collection of animals and vegetation is under national regulation. Furthermore, it is prohibited to enter and visit or camp within integral natural reserves without special permission from the national administration. Scientific research can only take place with the authorisation of the agency responsible for biodiversity management. There are a total of 8 integral natural reserves in Madagascar (Figure 2.) with a total surface area of 284,919 ha (ANGAP, 1999).

Special Reserves (SR). Special reserves were established in order to preserve natural ecosystems or sites with distinctive flora and fauna. They have the same degree of protection as integral natural reserves with the exception that there is a greater degree of flexibility with regards to their access. There are a total of 23 special reserves in Madagascar (Figure 2.), covering a total surface area of 375,449 ha (ANGAP, 1999).

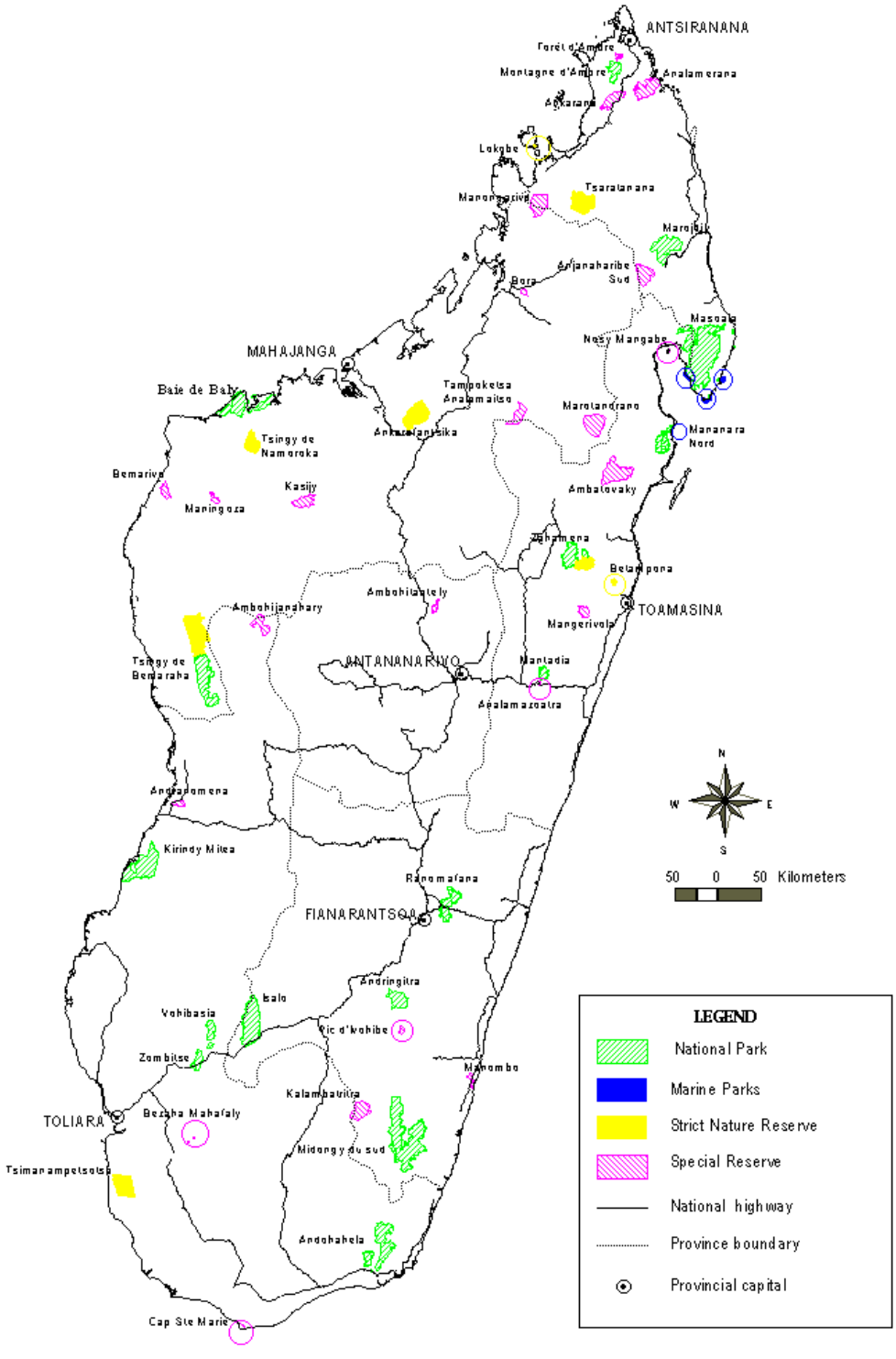
There are only 2 national marine parks in Madagascar, the Nosy Atafana Marine Park located in the Biosphere Reserve of Mananara-Nord and the Masoala Marine Park which consists of a complex of 3 separate marine protected areas. These are all classified as national parks and located in relatively close proximity to each other in the Toamasina and Antsirana regions on the north-east coast of Madagascar (Figure 2.). Covering only 11,000 ha (ANGAP, 1999), which represents 0.6% of the total surface area of protected areas in Madagascar, coastal marine habitats are under represented within the national network of protected areas (Rasolofo and Andrianarivo, 1998).

Figure 1. Principal Coastal & Marine Ecosystems of Madagascar



Data source : Direction des ressources halieutiques, 1996 - Realized and printed by ANGAP/BIS - May 2000

Figure 2. The National Network of Protected Areas in Madagascar



Data sources : ANBAP - Realized and printed by ANBAP/BIS - May 2000

2. Integrated Coastal Area Management in Madagascar: A Review

The first initiative in integrated coastal area management in Madagascar was the development of the management system for the UNESCO Biosphere Reserve of Mananara-Nord in 1989. However, it wasn't until 1997 that ICAM was formally adopted by the inscription of the 'Marine Environments and Coasts' in the 2nd phase of the National Environmental Action Plan. This was achieved in collaboration with the Environment Programme of the Indian Ocean Commission (PRE/COI) and the National Representative Working Groups under the direction of the National Bureau of the Environment (ONE). The strategy adopted encourages the integration of sectoral management practice across all levels within the pilot sites. The objective of this was to assure communication and synergy amongst the sectors and establish mechanisms to resolve conflicts. With the exception of the Biosphere Reserve of Mananara-Nord these activities are relatively new and have not yet been appraised in terms of their comparative performance. However, they are all characteristic of a 'bottom-up' participatory approach with a heavy emphasis on communication, co-ordination and education. A review of the associated ICAM activities implemented in the pilot sites within this framework is given here.

ICAM in the Tulear Region: The Tulear Region was selected as a pilot site by the Regional Marine and Coastal Environment (EMC) through a working group. A system of consultation was established in 14 communes by the formation of committees, which are responsible for monitoring the management of the pilot site through an informal convention between stakeholders. Projects were implemented such as the creation of a fishing provision centre, training in the ICAM process, regeneration of mangroves and algae culture. Following this, a regional planning committee was formed from a partnership between the private sector, public institutions and the communities of the region.

ICAM in Nosy Be: The Environment and Development Programme (PFED), which is a partnership between the private sector, the community and other stakeholders has the role of the regional working group (RWG) in Nosy Be. As in Tulear, ICAM training initiatives have been conducted and priority activities have been identified including reforestation, education, control of cholera and the establishment of local conservation organisations. Pollution monitoring programs are well established here as well as in Tulear.

ICAM in Menabe: The Regional Development Committee of Menabe, created in 1996 with the help of the local committee of development (CLD) of Morondava and other communes have formulated a 'Sustainable Development Plan of the Coastal Zone for Menabe'. This was achieved through the technical and financial assistance of the PRE/COI. The planning activities involved a diagnostic audit of the management of natural resources followed by the creation of an information system on the coastal zone. Subsequently, projects that responded to the immediate needs of the community were implemented.

ICAM in the Anosy Region: The Regional Development Committee established in the Anosy Region is in the process of forming the Regional Economic Development Strategy. This is a 5-year investment programme aimed at reducing poverty and improving the integrity of conservation in the region. The Commissariat General of the Development of the South, with the collaboration of the PRE/COI have developed a Management Plan of the Coastal Zone of the Southern Region. Activities currently in progress include the creation of monitoring units and projects relating to the reduction of deforestation and erosion.

ICAM in Foulpointe: The PRE/COI and the committee of support for the management of the coastal zone of Foulpointe has developed a project associated with the prevention and resolution of problems of degradation of the Foulpointe reef. This activity has the goal of encouraging an ICAM process to achieve these objectives. The following priority activities are planned: training in ICAM, educating the community on sustainable exploitation of the reef resources.

ICAM in Masoala: Integrated coastal area management in Masoala is conducted under the framework of a programme of environmental activities based on community participation in the management of naturally renewable resources (GELOSE). The process is formalised by a contract between the community and the administrative authorities. The Objectives are to encourage the sustainable use of marine resources and the conservation of biodiversity. The operation was effectuated in collaboration with a local community committee composed of representative stakeholder groups. The development of the ICAM process started in 1997, however, the system has not been in place long enough to achieve it's goals and was delayed by a change in the management authority 2 years after initial activities started. There has been some success in terms of the maintenance of biodiversity, conservation of ecosystems and sustainable use of marine resources. However, the process has not developed sufficiently to be able to resolve conflicts.

ICAM in Mananara: The UNESCO Biosphere Reserve of Mananara-Nord, established in 1989, was the first attempt at integrated coastal area management in Madagascar. The project has 3 functional sections: (i) Conservation and Protection of Biodiversity (ii) Community Development Assistance and (iii) Regional Development. The goals of the reserve are to develop the region and improve the quality of life for it's communities whilst conserving natural resources and protecting biodiversity. The development of the management process has consistently focused on co-ordination, communication and training, resulting in an effective and dynamic system that has proved capable of resolving resource base conflicts and meeting all of it's goals. The rationale of the process is based on relieving pressure on over exploited resources and sensitive habitats by facilitating alternative activities that are sustainable.

A major contribution to the success of the management of the marine park in the reserve was the ability of the Mananara Biosphere Project to transfer property rights to the resource users via a contract (see Annex 2). This unique approach to date has resulted in an increase in yields from the resource base with a subsequent improvement in the quality of life of the coastal communities. There has been a regeneration of critical habitats since the creation of the reserve and an increase in the status of biodiversity. Furthermore, there is a high degree of compliance and resource users have developed their own initiatives in the husbandry and conservation of resources.

This work represents the first initiative in terms of assessing the relative performance of integrated coastal area management and it's application to marine protected areas in Madagascar. As such there is no index to compare the successes and failures of other pilot sites. However, a comparison of the 2 case studies examined here suggests that the goals of ICAM can be achieved in a time frame of 5 to 10 years after the process is established, depending on the level of activity. The case study of the long-term experience in the UNESCO Biosphere Reserve of Mananara-Nord is exemplary of an integrated, participatory process applied successfully to the management of activities and resources in the coastal zone of Madagascar.

3. Key Marine Protected Areas: Case Studies

3.1 The Nosy Atafana Marine Park

Location and Background

The Nosy Atafana Marine Park is situated in the province of Toamasina in the north-east of Madagascar. The park is circular in shape with a diameter of 4 km. and a surface area of 1,000 ha (Figure 3.) The centre of the park is situated at 49^{o} 50' east and 16^{o} 16' south. The marine park was created with the national terrestrial park following the decree no. 216-89 of the 25th July 1989, and is now a component of the UNESCO Biosphere Reserve of Mananara-Nord. The Biosphere Reserve of Mananara-Nord is situated on the East Coast of Madagascar between latitudes 16^{o} 14' and 16^{o} 32' south and longitudes 49^{o} 38' and 49^{o} 50' east (Figure 3.). The Reserve has a surface area of 140,000 ha, of which 22,649 ha is populated with 47,000 inhabitants (Environment Program, UNESCO/MAB).

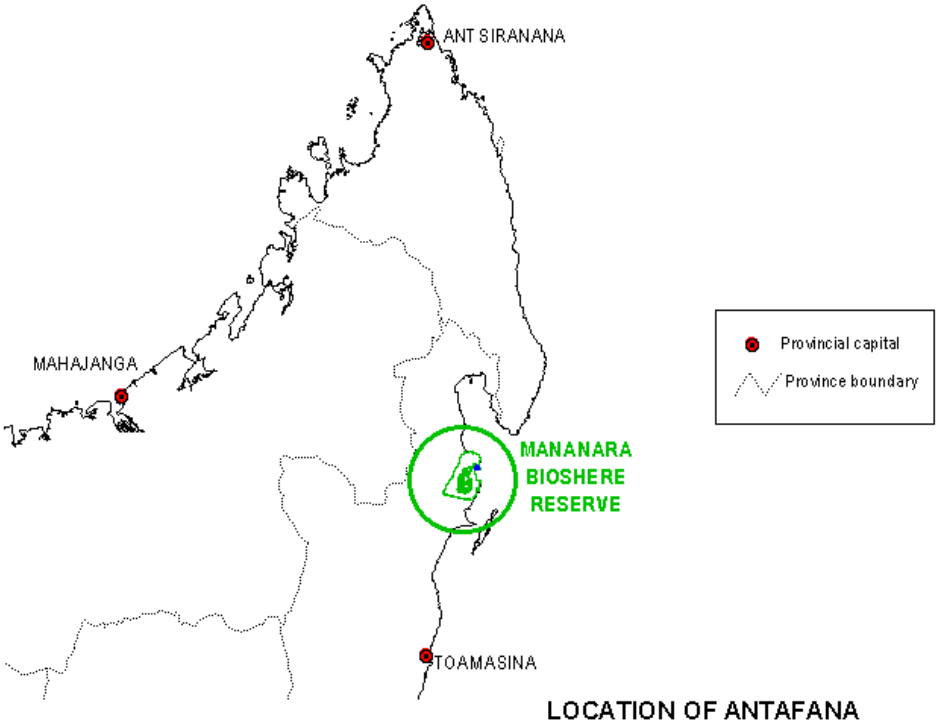
Management of the Nosy Atafana Marine Park.

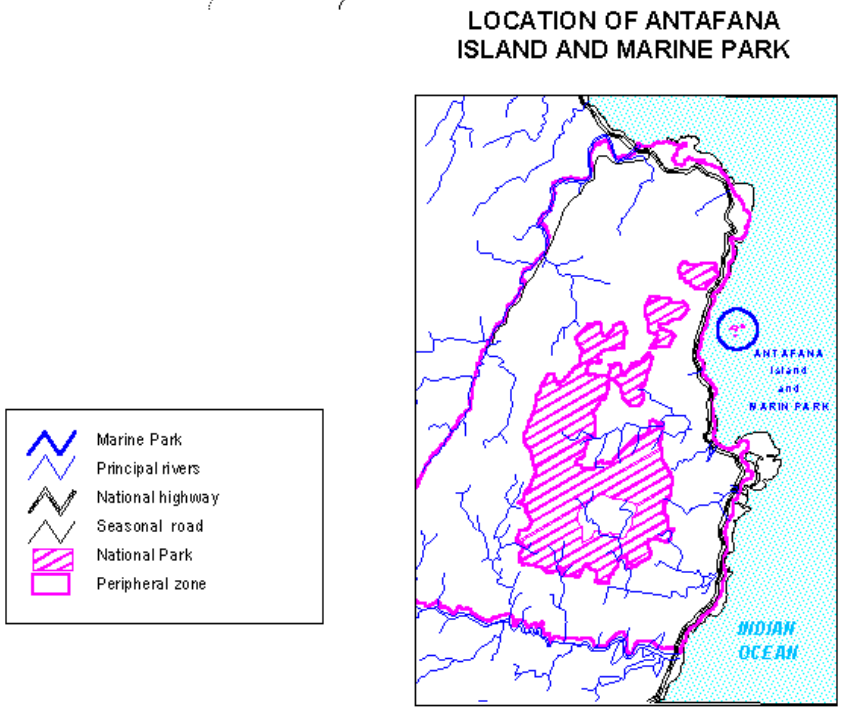
Since it's establishment, the UNESCO Mananara Biosphere Project (MAB) was given the responsibility of the parks management with the objectives of (i) maintaining the quality and quantity of biodiversity (ii) the conservation and rational management of marine resources and (iii) protection of the ecosystem of Nosy Atafana. The overall management goal for the biosphere was to develop the region and improve the quality of life of the coastal communities whilst achieving these objectives.

UNESCO conducts the operational management of the reserve under the supervision of ANGAP, which is responsible for the evaluation of programs and activities. In 1991, a usage contract between the Mananara Biosphere Project and the local community was signed (see Annex 2.). The short-term goal of this addressed the conservation and rational management of marine resources and in the medium-term, the protection of the ecosystem of Nosy Atafana whilst allowing a certain degree of access to resource users. The contract stipulates that the marine park would be open on Tuesday, Thursday and Sunday, and fishing is only authorised for fishermen from 4 villages: Sahasoa, Ivontaka, Menatany and Hoalampano. Nosy Atafana Marine Park is zoned into a central core, where no activities are allowed and a buffer zone where fishing is regulated.

The most striking aspect of the approach to the management of the Nosy Atafana Marine Park is the level of community and stakeholder participation. The management authority has a dedicated focus on a participatory decision making process. As a result, the programs and activities of the management authority are driven by the needs of the coastal community and stakeholders. The decision making process is achieved through stakeholder sub-committees. The Biosphere Reserve of Mananara-Nord is divided into 6 geographical sectors for logistical purposes. As an index of the level of community participation that has been achieved, there are 40 stakeholder group representatives per region. Each regional sub-committee meets 2-3 times each year to evaluate the programs, activities and management of the reserve (including the Nosy Atafana Marine Park). Every sector of the coastal community is represented including fisheries and agriculture associations, governmental technical service representatives, village Mayors, health services and schools. Since the creation of the park, the Mananara Biosphere Project has developed a completely integrated management mechanism based on communication, co-operation, and education.

Figure 3. Location of the Mananara Biosphere Reserve & Nosy Atafana Marine Park





Data sources : ANBAP, FTM - Realized and printed by ANBAP/BIS - May 2000

The marine park is managed with very limited resources and infrastructure. The responsibility of the management of the park rests with the director of the Mananara Biosphere Project (co-author here). The role of the manager is to act as an interface between the stakeholders and the project activities whilst facilitating a high degree of education, communication and co-ordination. There are 2 park rangers permanently based on the largest of the 3 islands in the park and communication with the headquarters is achieved using a single VHF radio. Patrols are conducted using a powered canoe on the days when the park is accessible to fishermen. Inspections are carried out to ensure that fishing gear and catches obtained comply with the regulations of the usage contract. These include minimum mesh and hook size limits and a complete ban on destructive fishing methods. Catches made both inside and outside the park are recorded. Contravention of the usage contract is punished with a ban on fishing in the park for a period between 2 weeks to 3 months depending on the nature of the offence.

In addition to the 2 wardens permanently based at Nosy Atafana, the Mananara Biosphere Project has a fisheries section which monitors the catches landed at the fishing villages on the coast adjacent to the park. The only building in the park is the accommodation for the park rangers however, there are plans to build a visitor chalet and observation hut this year.

The Netherlands Government funds the management of the marine park and the operational budget for five years is US $ 58,212 ending in 2001. Some revenue is generated from entrance fees, 50% of which is returned to the coastal communities by the management authority in the form of social development projects once sufficient funds have accumulated (current plans are to sink wells in the coastal villages lacking potable water). The Nosy Atafana marine park does not have a management plan, the development of this within the framework of the 'Strategic Plan for the Network of Protected Areas of Madagascar' (ANGAP, 1999) is a priority activity.

Population and activities in the Nosy Atafana Marine Park.

Artisanal fishing is permitted within the park on the days specified in the usage contract. A total of 3.3 tonnes of reef fish was caught inside the park in 1999. Handlines are used and fishermen on foot remove octopus with harpoons. The collection of spiny lobsters (*Panulirus sp*.) is banned in the park, although it does represent an important activity in adjacent areas. The collection of bait (mostly worms) is permitted on the days that the park is closed to fishing. Given the needs of both transients and the local population, the natural resources (holothurians, crustaceans, fish, octopus and mangrove wood) were exploited without regulation prior to the establishment of the park. When fishermen are stranded due to bad weather, they are permitted to stay in the park ranger's accommodation.

Only 29% of fishermen belong to associations that are allowed to enter the marine park. Of these, 34 are solely associated with the extraction of octopus. Women and children collect shells on the reefs along the coast outside the marine park during low tides but do not exploit any of the resources of the park. Some basic data relating to the villages associated with the Nosy Atafana Marine Park, catch rates and the number of recorded offences are given in Annex 3.

Other than regulated fishing, the Nosy Atafana Marine Park is very occasionally utilised by charter boats bringing divers in from centres at Isle St. Marie further to the south. The level of tourism is negligible with only 19 visitor permits being issued in 1999.

Resource Use Impacts in the Nosy Atafana Marine Park

The activities of fishermen on foot results in physical damage to live coral on the reef flat as a result of trampling and the use of harpoons to remove the octopus. This activity was reduced following the establishment of the marine park and usage contract. Furthermore, as a response to the issue, the management authority has run trials with octopus traps with a view to introducing them to the fishing community as an alternative non-destructive method. It is noteworthy, that quantifying the extent of this impact is difficult as the same type of physical damage occurs from cyclones.

Biodiversity.

Despite its relatively small size, all of the habitats characteristic of the coastal zone of Madagascar are represented in the Nosy Atafana Marine Park:

- *Mangrove forests*. Small pockets of mangrove forest are situated on the shoreline and interior of Rangotsy Is.
- *Lagoons*. The three islands in the park are situated in a sandy lagoon. Characteristic benthos includes green algae, sea grass, sponges and sea urchins. Calcareous algae are also present.
- *Coral Reefs*. A fringing coral reef encircles the lagoon and is separated from it by a reef flat. The benthic community is characterised by scleractinian corals.
- *Rocky outcrops*. Hely Is. and the eastern side of Rangotsy Is. are characterised by granitic outcrops and escarpments descending to the sea. The substrate in the littoral zone is colonised by encrusting algae and corals, macro algae and beds of *Crassostrea sp*.
- *Sandy beaches*. Atafana Is. Is surrounded by a sandy beach, and small sandy beaches are present on Rangotsy Is.
- *Coastal forests*. Coastal forests grow on sandy soils on the islands within the marine park. The dominant species (*Terminalia cattapa*) was heavily degraded but is now regenerating. The forest on Atafana Is. is a breeding site for fruit bats.

A preliminary inventory of the biodiversity of Nosy Atafana Marine Park was made in 1997 by the National Centre for Oceanographic Research (Annex 4). In addition to the species list produced, the preliminary survey of the coral reef indicated conditions that were ‘ecological perfect’ (Maharavo, 1997).

Regional significance

The Nosy Atafana Marine Park has a particularly important regional significance in that, despite is relatively small size, all of the principal habitats that typify the coastal zone of Madagascar occur within its boundaries. Furthermore, the park is significant as a marine resource base for fishing communities in the adjacent villages. Although there is no quantitative empirical evidence, representatives of the fishing community have observed that since the park was created, there has been an augmentation in the recruitment of reef fish. In addition, a ‘spill-over’ effect has been observed in terms of adult fish moving to fishing grounds outside of the park with a subsequent increase in catch rates. The largest of the islands (Atafana) is a habitat and breeding site for flying foxes and marine turtles use the park as a feeding ground. Whilst the migration of Humpback whales (*Megaptera novaeangliae*) occurs just outside of the park, a strong potential exists for establishing an observation

lookout on the raised granitic outcrop at the eastern extremity of Rangotsy Is. Given the status of this species there is justification to protect this narrow migration corridor. There is evidence that the park is occasionally frequented by Dugongs and may be a part of their range, running along the coast up to the Masoala Marine Park complex. Rangotsy Is. has a regional cultural significance in that it has a sacred burial site.

Achievements in the Management of Nosy Atafana Marine Park

There are a diverse range of examples of how the participatory management approach of the Mananara Biosphere Project has been successful in terms of meeting the goals of the Nosy Atafana Marine Park.

- **Maintenance of Biodiversity & Protection of the Ecosystem**

Improvements in the integrity of the habitats in the marine park have occurred since its creation:

(i) Regeneration of the coastal vegetation at the camping ground as a result of the prohibition on camping.
(ii) An improvement in the integrity of the coastal forests through the removal of coconut and breadfruit trees planted by the coastal communities.
(iii) Conservation of the breeding colony of fruit bats through a ban on hunting.
(iv) Regeneration of the mangroves at Rangotsy Is. following a ban on the exploitation of wood to make fish drying racks.
(v) Less physical damage to coral on the reef flat through a reduction in octopus fishing.

- **Conservation and Rational Management of Marine Resources**

The regulation of fishing activity in the Nosy Atafana Marine Park has resulted in:

(i) An augmentation in the recruitment of reef fish within the park.
(ii) A ‘spill-over’ effect in terms of adult fish moving to grounds outside of the park.
(iii) A subsequent increase in catch rates both inside and adjacent to the park.
(iv) Diversification of the user groups economic activities.
(v) Successful establishment of fish aggregating devices in areas outside the park. Resulting in increased catch rates and a diversion of fishing away from the park.

- **Conflict Resolution**

Fishermen within the region frequently visited Nosy Atafana and a number of encampments were present before the park was established. Subsequently, a conflict of interests arose from the prohibition on camping when the park was created. The participatory management approach enabled the conflict to be resolved and fishermen are now allowed to stay in the park ranger’s accommodation when stranded by bad weather. Another conflict developed as a result of the loss in income of fishermen caused by restrictions imposed on their activities in the park. This was resolved through the introduction of a variety of agricultural activities that substituted fishing on the days that the marine park was closed. Furthermore, a credit system was implemented, providing the means for fishermen to purchase primary materials enabling them to fish at other locations outside the park using different techniques.

Current Management Issues

The most prominent threat to the integrity of the Nosy Atafana Marine Park is the potential impact of tourism. To date, tourism activities within the park have been negligible (19 visitors last year). However, with the planned construction of a chalet and an observation shelter on Atafana Is., tourism is expected to increase soon. There is very little infrastructure for tourism within the region and subsequently the park is not easily accessed. Furthermore, the Mananara Biosphere project is taking a precautionary approach to the development by setting a limit of 10 tourists in the park at any one time. Despite this, it is imperative that any developments within the park take place within the framework of a comprehensive management plan, which encompasses rigorous ecological monitoring. A paradox exists in that Nosy Atafana Marine Park has a tremendous potential for the development of eco-tourism which would generate revenues both for the coastal community and management of the park. However, the current budget is inadequate to cover anything more that the existing operational management.

The most pressing issue in the fact that the Nosy Atafana Marine Park does not have a management plan and there is an absence of a permanent monitoring programme to assess the impacts of existing activities and potential developments. The outstanding achievements of the Mananara Biosphere Project in the management of Nosy Atafana may be jeopardised by the potential adverse impact of tourism development.

The existing species inventory is not comprehensive and there is a strong need for an exhaustive inventory of the biodiversity of Nosy Atafana Marine Park. Stock assessments of the marine resources need to be conducted. The infrastructure and human resources available for the operational management of the park are very basic and require updating in view of the planned developments. The issue of physical damage to corals from octopus fishermen using harpoons is in the process of being resolved by the Mananara Biosphere Project. The results of trials with bamboo octopus traps will determine whether the existing method can be substituted with one that is non-destructive.

Activities of commercial shrimp trawlers from the industrial fishing societies based in the provincial capital pose a combination of threats to the park. Whilst there is no poaching in the park, their activities are prohibited inside a 2 mile exclusion limit of the coast. Trawling within this at night has resulted in one boat being stranded on the coast adjacent to the park. The potential threat relates to accidental damage to the reef of the park through grounding and an associated fuel oil pollution risk. Furthermore, difficulties in resolving this issue led the resource base user groups to question the effectiveness of the management authority.

The usage contract only applied to the members of the fishing associations in the 4 villages in the coastal area adjacent to the marine park. However, other transient fishing communities also used these marine resources. Their exclusion from accessing the park resulted in the shift of effort further to the north into the Masoala Marine Park, the resources of which were already heavily exploited. Furthermore, the ICAM process was not yet established in the adjacent region to be able to resolve the conflict (see case study 3.2). Whilst the transient fishing community is relatively small, the principal of the transfer of resource use into an adjacent region must be recognised as a failure of the management system that created the shift. This could have been resolved if the management system of Masoala Marine Park had evolved in synergy with that of the Nosy Atafana Marine Park.

Lessons Learned in Management Practices

The remarkable success of the participatory management approach of the Nosy Atafana Marine Park can be attributed a combination of the following factors:

- The process is fully integrated including all stakeholders in the coastal community.

- The decision making process is dynamic, being capable of identifying and responding quickly to critical management issues.

- Issues are resolved by directing the activities of resource user groups to sustainable, non-destructive substitutes. The solutions are simple, viable and directly applicable by the resource users themselves.

- The rationale of the management process is based on communication, co-ordination, co-operation and education.

- The resources of the marine park are accessible through a usage contract that was developed by the management authority in association with the user groups. By allocating property rights, the coastal communities are protective of the marine resources in the Nosy Atafana Marine Park and report violations by unauthorised users from areas outside the region.

- Increased revenues from the benefits of the management regulations (eg. from increased catch rates and substitution activities) are realised by the resource user groups. As a result there is a high degree of compliance and respect for the management authority.

- The close dialogue between resource users and the management authority enables conflicts to be resolved.

- The quality of life and standard of living of the local community adjacent to the park can be improved by investing the revenues generated from entrance fees into social development projects. This also helps to instil husbandry for the natural resource base and a respect for the participatory ICAM system.

- The selection of isolated sites that have natural barriers increase the probability of successful management.

- There is a strong need for synergy in the development of the integrated coastal area management process and close collaboration and communication between regions. This is imperative in the context of users that are mobile in order to avoid a shift in a management issue to an adjacent watershed.

Needs Assessment and Recommendations

The priority activity for the Nosy Atafana Marine Park, is the development and implementation of a management plan within the framework of the 'Strategic Plan for the Network of Protected Areas in Madagascar' (ANGAP, 1999). The management plan should address the following needs:

Financial needs.

The current operational budget is inadequate. The budget required to establish and implement a strategic management plan for the Nosy Atafana Marine Park for 5 years is US $ 750,000 (determined by the UNESCO Mananara Biosphere Project, 1999).

Human resource needs.

Specialised training for the director of the management authority in marine protected area management.
Additional park ranger is required for operational management.
Technical training for rangers in monitoring techniques.

Physical Resource Needs.

Larger boat for wardens to improve communication and facilitate monitoring.
Improved communication facilities at the base in the park (longer-range radio).
Demarcation buoys of the boundary of the park.
Mooring buoys for visiting dive boats.

Technical Information Needs.

Ecological monitoring of the coral reef system.
Stock assessments and biological studies of exploited resources.
Comprehensive inventory of the biodiversity of the Nosy Atafana Marine Park.
Carrying capacity study and sensitivity analysis for eco-tourism in the Nosy Atafana Marine Park.

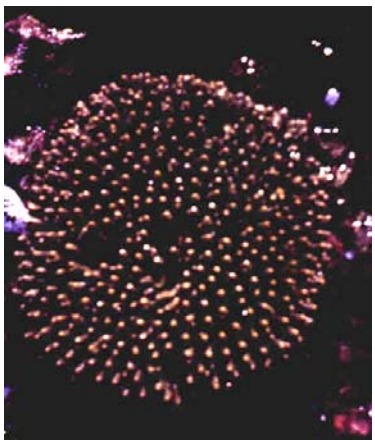
Legislative Needs

The resource user contract needs to be formally incorporated into the existing legislative framework. This could be achieved under the 'Dina' system, which is a customary social agreement.

Institutional Needs.

The structure of the management authority needs to incorporate a specialised section for the management of the marine parks.

Plate 1. Achievements in the Management of Nosy Atafana Marine Park



This healthy colony of *Acropora sp*. (above) is indicative of the absence of ecological perturbations in the Nosy Atafana marine Park.

Enforcement is successfully achieved using a dugout canoe powered by a 2 Hp motor (above). The allocation of property rights to marine resource users has resulted in a high degree of compliance with fisheries regulations.

Mangroves were cut to obtain wood for fish drying racks prior to the establishment of the marine park. These have now regenerated following a successful ban on their exploitation (above).

Access to fisheries resources is restricted to the coastal communities adjacent to the Nosy Atafana Marine Park. The resident park ranger records catches and inspections of the fishing gear are made to ensure they comply with regulations (above). Fishermen derive benefits from the fisheries regulations through increased catch rates both inside the marine park and in adjacent areas.

Coastal vegetation has regenerated following a prohibition on camping since the creation of the marine park (above). As an alternative, fishermen stranded by bad weather can stay in the park ranger's accommodation.

The conditions on the fringing are conducive to the recruitment and growth of reef building corals (above). Physical damage on the reef flat caused by trampling has been reduced and fishermen are provided with alternative non-destructive fishing methods.

3.2 The Masoala Marine Park

Location and Background

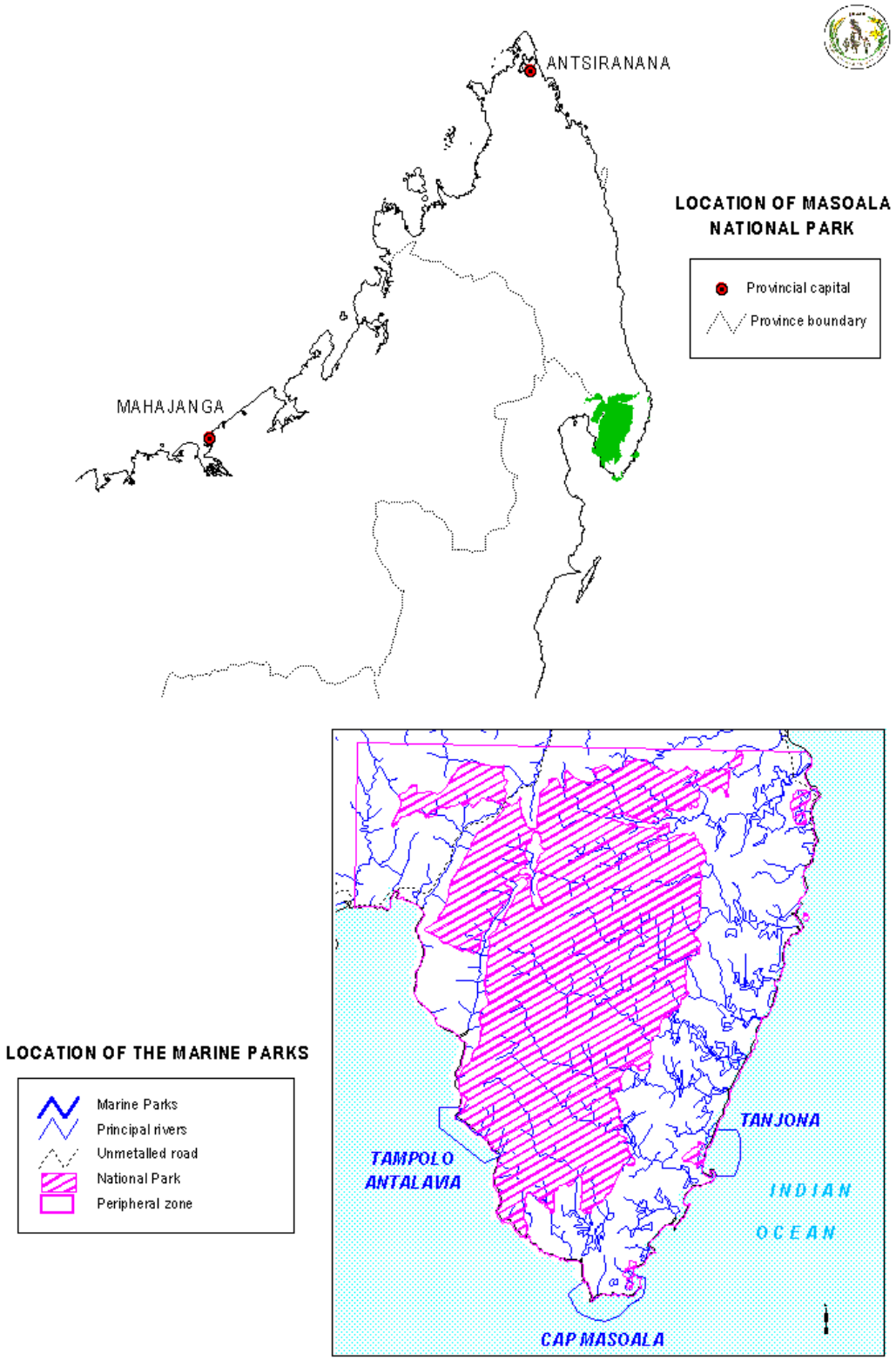
The Masoala National Park is situated on the Masoala Peninsular in the northeast of Madagascar. It has a surface area of 230,000 ha and was created following the decree 97-141 on the 7th March 1997. The park encompasses a complex of 3 marine protected areas (Tanjona, Cap Masoala and Tampolo Marine Parks) which have a total surface area of 81 km^2 (Figure 4). A list of the geographical co-ordinates and surface areas of the individual marine protected areas within this complex is given in Annex 5.

Management of the Masoala Marine Park.

Following its creation, the operational management of the Masoala Marine Park was conferred to an international NGO (Co-operative Assistance and Relief Everywhere - CARE) in partnership with an American research organisation (Wildlife Conservation Society – WCS). The overall jurisdiction and co-ordination rested in the National Association for the Management of Protected Areas (ANGAP) which falls under the Ministry of Environment. 2 years later the operational management was transferred to ANGAP. The objectives of the Marine Park were (i) to maintain the quality and quantity of biodiversity (ii) the conservation and rational management of marine resources and (iii) the protection of the ecosystem of the Masoala Marine Park. The overall management goal for the Masoala National Park was to develop the region and improve the quality of life of the coastal communities whilst achieving these objectives. In 1993, an agreement between several institutions enabled the establishment of the 'Integrated Conservation and Development Project' (PCDI). This established the framework of the integrated coastal area management process on which the management approach is based. The management authority has a dedicated focus on an integrated participatory decision making process, which is characterised by a high level of co-ordination, communication and education. As a result, the programs and activities of the management authority are driven by the needs of the coastal community and stakeholders. The Masoala National Park is divided into 5 geographical sectors (one of which is split in two) for logistical purposes. The decision making process is achieved through stakeholder sub-committees meetings held in each sector 2-3 times each year.

The marine park is managed with very limited resources and infrastructure. The responsibility of the management of the park rests with the director of the Masoala National Park (3rd Author here). The role of the manager is to act as an interface between the stakeholders and the project activities whilst facilitating a high degree of education, communication and co-ordination. There are 6 park rangers in total (called agents of conservation and education) with 2 park rangers working in each of the 3 marine parks. There is a 7m. boat with skipper and crew. The park rangers do not have the power of arrest and the approach to ensure compliance with regulations is conducted through sensitising resource users. The 3 parks are composed of a central core surrounded by a buffer zone. The Cap Masoala Marine Park has 2 central cores. Fishing is regulated in the buffer zones by mesh size restrictions and hook size limits. In cases where there is a disregard in terms of the requests to resource users made by the park rangers, the incident is reported to the management authority. Contravention of fisheries legislation is subsequently dealt with by the regional fisheries authority, which co-operates with the marine park management. Penalties involve the confiscation of gear.

Figure 4. Location of the Masoala Marine Parks



To date there has been no budget allocation for the Masoala Marine Park, operational management has so far been conducted within the budget of the terrestrial park. The application for funding for a 3-year period to cover the existing activities is US $ 69,000. The Masoala Marine Park does not have a management plan, the development of this within the framework of the 'Strategic Plan for the Network of Protected Areas of Madagascar' (ANGAP, 1999) is a priority activity.

Population and activities in the Masoala Marine Park.

There are a total of 1,361 inhabitants resident in villages adjoining the Cap Masoala Marine Park. Artisanal fishing using handlines and nets is conducted in the buffer zones by the communities living on the adjacent coastline. Fishermen on foot remove octopus using harpoons on the reef flats at Cap Masoala and Tanjona. The income of the coastal communities is supplemented by subsistence agricultural activities. Fishermen from areas outside the immediate vicinity of the park conduct poaching, the number of these migrant fishermen is almost double that of the fishermen in residence adjacent to the park. There is a small degree of tourism activity, with a planned campsite to be set up by the local communities in collaboration with an American travel company. There is good potential for the development of eco-tourism in Masoala Marine Park and a feasibility study has been conducted, however, the constraint of the lack of infrastructure inhibits the development of this industry. Some recreational diving for tourists is conducted by operators based at Isle St. Marie to the south of the park. Industrial trawlers fish for prawns on grounds outside the buffer zone. Women from coastal villages around the park collect shellfish at low tide on the reef platform (in areas outside the marine park) and are actively engaged in fishing practices using nets. Preservation and added value of fisheries products is achieved by smoking. Annex 4. presents data on the communities and villages adjacent to each of the marine parks in Cap Masoala.

Resource Use Impacts in the Masoala Marine Park

The results of the first year of ecological monitoring (Randriamanantsoa & Lope, 1999) have determined the status of the coral reefs of the Masoala Marine Parks in relation to anthropogenic activities. This is the only monitoring activity that has been conducted on the assessment of the status of the coral reefs of Madagascar. The results are presented in more detail in Chapter 4. (Assessment of Coral Reef Health) a summary of which is included here.

Tampolo Marine Park: The observations of the Tampolo-Antalavia Marine Park suggest that the reef system is in good health and the activities associated with the area are not detrimental to resources and the integrity of biodiversity (Randriamanantsoa & Lope, 1999).

Cap Masoala Marine Park: The study site at Ambodilaitry in the Cap Masoala Marine Park determined signs of perturbations derived from anthropogenic activities. The damage present was attributed to trampling and/or destructive fishing practices (removal of coral blocks to weigh down fish traps). Other coral mortality was attributed to an extended exposure period or desalination resulting from heavy rainfall. The presence of healthy colonies of branching acroporids, (*Acropora digitirfera*) suggest the possibility of regeneration if the preservation of the site is effective (Randriamanantsoa & Lope, 1999).

Tanjona Marine Park: The results of the transect studies to determine the status of the coral reefs of the Tanjona Marine Park show that the reefs are in good health. The study site, Ankaranilaotra, is characterised by a predominance of Acropora (28%) and other live non-Acropora families (25%). Representatives of the family Acroporidae are found in a variety of growth forms namely: tabular, digitate, sub-massive and branching. The site is ecologically stable and there are no major anthropogenic perturbations. The dead coral observed at the site (17%) was attributed to bleaching (Randriamanantsoa & Lope, 1999).

The needs of migrant fishing communities have resulted in the heavy exploitation of fisheries resources in the Cap Masoala and Tanjona Marine Parks. The exploitation of shrimps using nets with mesh sizes under the minimum limit has threatened the resource base, however, the situation is improving through the education of fishing communities by the conservation agents. Sites in close proximity to the marine parks (Paradis and Aquarium) are impacted by hypersedimentation associated with the deforestation of littoral forests (Randriamanantsoa & Lope, 1999).

Biodiversity.

The Masoala Marine Park has a range of habitats consisting of coral reefs, lagoons and estuaries, mangroves, rocky shores and sandy beaches. Since it's creation in 1997 there have been no habitat classification studies, however, species inventories have been made by Randriamanantsoa & Lope (1999) and Care (1999). A summary list is given in Annex 6. and the biota of each of the marine protected areas is described here:

***Tampolo Marine Park*:** The benthic ecology of the Tampolo Marine Park is characterised by the presence newly recruited corals attached to rocky substrates, suggesting a recent colonisation. The ichthyofauna is diverse, dominant species being *Chromis viridis*, *Chaetodon trifasciatus* and *Plectroglyphidon dickii*. Large carnivorous fish were also abundant in the park. (Randriamanantsoa & Lope, 1999).

***Cap Masoala Marine Park*:** 25% of the marine park is covered by coral reef with 107 species having been recorded. The majority of live corals have grown over dead corals and colonies of the families: Acroporidae, Poritidae and Favidae have shown rapid growth of new recruits (Randriamanantsoa & Lope, 1999). In terms of invertebrates, there are 49 species of mollusc, 6 crustacean and 18 species of echinoderms recorded. There are 97 species of fish from 25 families present at the Cap Masoala marine park. There are 6 species of mangrove recorded: *Avicenia marina*, *Bruguiera gymnorhyza*, *Ceriops canilleana*, *Rhyzophora mucronata*, *Carapa obovata* and *Sonnertia alba*. A total of 49 species of marine algae have been recorded, the most abundant genus being *Caulerpa* (in the sea grass beds), *Turbinaria* and *Padina* (attached to dead coral and boulders). Marine phanerograms are represented by 9 species with the most common being: *Syringodium isoetifolium*, *Thalassia impechrii*, *Thalassodendron ciliatum*, *Cymodecea serrulata* and *C. rondodata* (CARE, 1999).

***Tanjona Marine Park*:** Coral reefs cover 40% of the marine park. Of the 114 species recorded, the most common families are the Fungia and Poritidae. Branching, sub-massive, digitate, tabulate corals and small formations of micro-atolls are also present (Randriamanantsoa & Lope, 1999). There are 6 species of mangrove recorded from the Tanjona Marine Park: *Avicenia marina*, *Bruguiera gymnorhyza*, *Ceriops canilleana*, *Rhyzophora mucronata*, *Carapa obovata* and *Sonnertia alba*. The 31 species of marine algae are dominated by *Turbinaria ornata*, *T. deucurrens* and *Lithothaminum sp*. 9 species of

marine phanerograms have been recorded, the most representative of these being: *Syringodium isoetifolium* and *Thalassia hemprechii*. The inventory of marine species also includes 80 species of mollusc, 5 crustaceans, and 29 echinoderms. The most common species in the sea grass and micro-atolls are *Diadema setosa*, *Octopus* sp. and *Anadara* sp. The reefs of the Tanjona Marine Park are characteristically diverse in fish life, with 303 species being recorded (Randriamanantsoa & Lope, 1999).

Humpback whales (*Megaptera novaengliae*) migrate to the Baie d'Antongil from the south during the austral winter and have been observed nursing newly born calves between early August and September. The bay was also the location of the first sighting of a Southern Right whale (*Eubalaena australis*) in Madagascar (Rosebaum *et al*, 1997). Other marine mammals present include the common bottlenose dolphin (*Tursiops truncatus*) and *Stenella longirostris*. Dugongs have been reported in the Masoala Marine Park, although to date there is no formal species identification.

Regional significance

The Masoala Marine Park has an important regional significance in that all of the principal habitats that typify the coastal zone of Madagascar occur within its boundaries. It is also significant as a marine resource base for fishing communities in the adjacent villages. The termination of the migration of Humpback Whales (*Megaptera novaeangliae*) occurs just outside of the park boundaries in the Baie D'Antongil (Rosenbaum, H. *et al*., 1997). This area represents an important location for reproduction of the species, giving strong justification to protect the migration corridor and calving ground. Furthermore, the park may occasionally be frequented by Dugongs and is possibly part of the range for these species, extending along the coast down to the Nosy Atafana Marine Park complex.

Forests on the islands in the Cap Masoala Marine Park are the habitat for the Red Owl, which was discovered on the Cap Masoala Peninsular. At the same time as being endemic to Madagascar, it is threatened with extinction. Furthermore, the Snake Eagle, also threatened with extinction is only found in one other location. There is a site of historical cultural value in the form of a sacred burial site on one of the islands of the Cap Masoala Marine Park.

Achievements in the Management of Masoala Marine Park

- **Maintenance of Biodiversity & Protection of the ecosystem**

The prohibition on camping in the central core has resulted in the regeneration of coastal vegetation in the area adjacent to the Tampolo Marine Park. The reduction in the use of destructive fishing practices in Tampolo, through the education of fishermen has improved the integrity of the biodiversity and ecosystem of this marine park.

- **Conservation & Rational Management of Marine Resources**

The implementation of fisheries regulations by the education of fishermen using the Tampolo Marine Park has resulted in an increase in the abundance of marine resources. The co-operation of the management authorities with the regional fisheries authority has had examples of successful enforcement of the fisheries regulations in the other parks. In the past, fishermen in contravention of the fisheries regulations have been prosecuted and penalised by confiscation of their gear. The effective enforcement of the minimum size limit for

holothurians has resulted in an augmentation of the resource since the creation of the park. There has been a reduction in the exploitation of shrimps using nets with mesh sizes under the minimum limit, following the education of fishermen by the rangers.

Current Management Issues

There is conflicting use of resources created by the migrant fishermen from the Mananara-Nord region. This has resulted in the over-exploitation of fisheries resources, destruction of adjacent habitats and resource competition in the Cap Masoala and Tanjona Marine Parks. The fishermen from outside the region have better equipment and are more effective gear than the local communities who use less intensive methods. The effect of migrant fishermen's activities was to displace some of the community previously resident in Cap Masoala to Tanjona where marine resources were more abundant. As a result the children in the fishing community have lost the opportunity of an education.

Existing management is conducted within the general framework of that of the terrestrial park, a management plan for which is in development. However, given the special individual needs of the complex of marine parks, the synergistic development of management plans for these within the framework of the 'Strategic Plan for the Protected Areas of Madagascar' (ANGAP, 1999) is a critical management issue. Activities within the plan should be orientated at improving the capacity of human and physical resources, securing the establishment of the permanent monitoring programme, demarcation of boundaries, reinforcing the education of the resource users, providing alternative activities and realising the potential revenues of sustainable eco-tourism.

The existing demographic structure of coastal communities (50% of the population under the age of 25 years), indicates that the pressure on the resources of the Masoala Marine Parks will increase rapidly in the future. An acceleration of the existing ICAM process through increased activities and the development of a capacity to resolve conflicting resource use are imperative management issues in this context.

Lessons Learned in Management Practices

- A management strategy based on co-operation, education and communication with users is a powerful tool for resource conservation and maintenance of biodiversity. Objectives and goals may be realised in the short term through the successful application of this approach.

- The management authority must have the appropriate competence for ICAM to be a successful process for the management of marine protected areas. This in particular relates to the ability to install the appropriate structure and mechanisms that result in a participatory decision making process that has the ability to resolve conflicts.

- Transferring the operational management within an ICAM framework delays the development of the participatory management process and erodes the confidence of the community in the system.

- It is highly improbable that management goals and objectives will be achieved if the decision making process lacks the ability to resolve conflicting resource use. (Illustrated by the case of Cap Masoala and Tanjona Marine Parks).

- The management of a complex of individual marine parks must avoid displacement of resident communities as a result of a resource base conflict. The establishment of the structural components of the management system must occur simultaneously in order to be equitable. (Tampolo does not have a Fishing Association). Management planning must take into account the different characteristics and needs of the individual parks within a complex.

- There is a strong need for synergy in the development of the integrated coastal area management process and close collaboration and communication between regions. This is imperative in the context of users that are mobile in order to avoid a shift in a management issue to an adjacent watershed.

- The operational budget must be independently allocated to the marine park in cases where it is managed in conjunction with a terrestrial park.

Needs Assessment and Recommendations

The priority activity for the Masoala Marine Park, is the development and implementation of management plans within the framework of the 'Strategic Plan for the Network of Protected Areas in Madagascar' (ANGAP, 1999). The management plans should address individual needs in terms of the resources and activities of the 3 parks within the complex:

Financial needs. The financial requirement to successfully achieve goals and objectives of the Masoala Marine Park is US $ 1 million over a 5-year period.

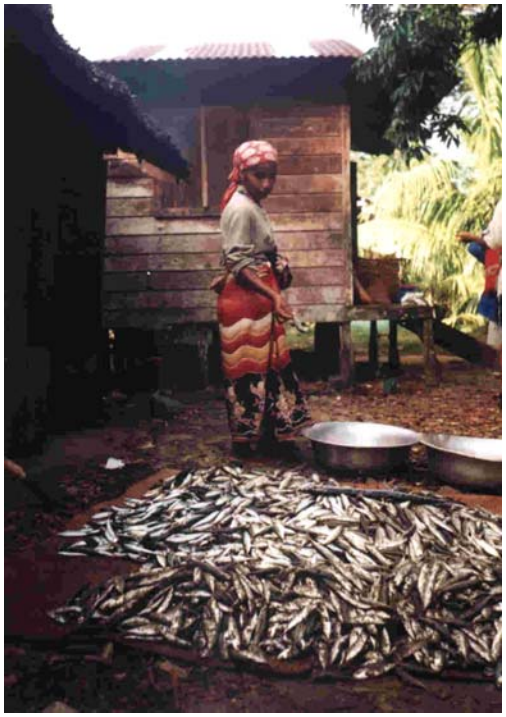
Human resource needs. Park rangers have limited technical skills, of the 6 staff present at the site, none have marine monitoring backgrounds. Training is required in education skills and resource/ecological monitoring. There is a need for further education programs and increased sensitisation of coastal communities. Senior management staff and technical staff require specialised training in the management of protected marine areas.

Physical Resource Needs. Enforcement would be improved if the conservation agents were resident in the parks or adjacent coast in the case of those without islands. Each of the Masoala Marine Parks needs a base where the conservation agents can stay. VHF and CB radios are needed for communication between rangers and the base. The central core of Tampolo marine park needs to be demarcated. The Masoala Marine Park only has 1 boat that is not particularly suitable.

Technical Information Needs. Ecological monitoring is currently under contract, this needs to be consolidated over a longer period. More detailed resource monitoring and assessment is needed as well as details of the demography of coastal communities and dynamics of migrant fishing communities.

Institutional Needs. The structure of the management authority needs to incorporate a specialised section for the management of the marine parks. The benefits of a resource usage contract may be realised in the form of a traditional social agreement or 'dina'. This may help in the resolution of the resource base conflicts associated with the activities of migrant fishermen.

Plate 2. Success and Failure in the Management of the Masoala Marine Parks



Women play and active role in the exploitation of marine resources in areas adjacent to the Masoala Marine Parks. Fisheries products are preserved and value added by smoking (left).

The population of migrant fishermen (below) is double that of fishing communities resident in villages adjacent to the marine parks, subsequently there is conflicting use of the resource base.

The depletion of fisheries resources in the Cap Masoala and Tanjona Marine Parks has caused the displacement of communities previously resident in adjacent coastal areas. As a result the children have lost the opportunity of an education (left). The participatory management process has not developed sufficiently to be able to resolve conflicts. Furthermore, the demographic structure of the population using the resources of the marine parks suggests that exploitation levels will increase in the future.

The management of the Tampolo Marine Park has been successful in prohibiting encampments of migrant fishermen. As a result, the coastal vegetation of the central core has regenerated since the park was established (above right). There has also been an increase in the abundance of fisheries resources following the successful approach of educating fishermen and discouraging destructive fishing practices.

4. Assessment of Coral Reef Health

There are three categories of coral reef in Madagascar namely:

- Barrier reefs, situated adjacent to the continental slope.
- Fringing reefs, located close to the coastline.
- Coral cays.

The distribution of the coral reefs of Madagascar is influenced by regional fluctuations in the marine environment (Battistini, 1960). The coral reefs of the east coast consist of fringing reefs located at Cap Masoala, Mananara-Nord and around Isle St. Marie (Figure 1). A fragmented barrier reef emerges in the Toamasina region along with rudimentary fringing reefs (Ranaivoson, 1998). The reefs of the West Coast are considerably more developed, extending for a total distance of 1,000 km and having a width between .5 to 3.5 km (Guilcher, 1956). Whilst there are several studies that classify the coral reefs of Madagascar (Battistini, 1960, Clausade *et al*., 1971 and IUCN/UNEP, 1988), it is only very recently that a monitoring programme has been established.

The permanent monitoring of the coral reefs of Masoala Marine Park was initiated by the signing of a protocol in October 1998, within the framework of the 'Programme de Conservation et Dévelopment Intégré' (PCDI). The protocol stipulated that a coral reef monitoring programme should be established to monitor the status of the coral reefs in the three marine protected areas of Masoala Marine Park and a nearby tourism site. The monitoring programme has since been conducted before and after each cyclone season, which occurs from January to March. The methodology used to determine the status of the coral reefs was established by the 'Regional Environment Programme of the Commission de L'Océan Indien' (PRE/COI), transects and quadrates are used to monitor the benthic community, whilst the reef fish community is monitored using underwater visual census. The monitoring sites have so far been sampled 3 times over a period of 1 year. The trends observed in the status of the coral reefs of the Masoala Marine Park are presented in Randriamanantsoa & Lope (1999). Their key findings are reproduced here.

Status of the coral reefs of the Tanjona Marine Park. A progressive improvement in the status of the health of the coral reef at Ankaranilaotra was observed between 1998 and 1999. There was a consistent increase in the cover of live coral and a reduction in the cover of soft coral and algae over the sampling period. The improvement is considered to be a result of stable ecological conditions favourable for the settlement and growth of hard corals. Furthermore, a moderation in the level of fishing activity within the park has resulted in a reduction in the damage caused by trampling. An increase in the abundance of reef fish was also observed over the same period.

The site at Ankarambiavy was characterised by a constant cover of Scleractinian corals, accompanied by an increase in the abundance of soft coral and algae. This increase does not signify a healthy status as it corresponds to the rate of reduction in the cover of dead coral, suggesting a proliferation of soft coral and algae. Despite a reduction in the status of the benthic community, there was an augmentation in reef fish populations over the sampling period.

Status of the coral reefs of the Cap Masoala Marine Park. The site at Ambodilaitra was characterised by environmental conditions favourable to the proliferation of soft corals, an

increase in the cover of dead coral, a high proportion of coral debris and a small proportion of acroporid corals in relation to non-acroporids. Thus, signifying a degeneration in the status of the coral reef system. The high proportion of coral debris at this site is considered to be a result of destructive fishing practices. Despite this, an increase in the abundance of reef fish was observed over the same period. Nonetheless, there is an urgent need to strictly preserve the coral reefs of Ambodilaitra.

The site at Ankaoalambanona had an almost constant cover of live coral over the sampling period, the majority of corals were new recruits dominated by; *Acropora formosa, A. aspera, A. humilis, A. digitata, A. cythera, Stylopora, Porities, Galaxea and Pocillopora*. Evidence of degeneration was associated with a proliferation of soft corals and algae and bleaching caused by extended exposure periods. Despite the fact reef that the site is fished, the abundance of reef fish increased in abundance over the year.

Status of the coral reefs of the Tampolo Marine Park. The results of the survey of the Tampolo Marine Park show an abundance of indicator species of coral and fish that suggest a stable unperturbed reef environment. There was a proliferation of acroporids over the study period notably *A. formosa*, *A. cythera*, *A. platifera*, and *A. chlathrata*. Furthermore, sub-massive corals including representatives of the genus *Galaxea*, *Goneastrea* and *Favia* are well established. There was no change in the cover of dead and soft corals over the study period and the cover of live coral increased from 25% to 60% over the year.

Table 1. Summary of the Status of the Coral Reefs of Masoala Marine Park.

Site	Transect	Quadrat	Fish Counts	Status
Ankaranilaotra	+	+	+++	ameliorating
Ankarambiavy	-	0	++	deteriorating
Ambodilaitra	-	-	+	deteriorating
Ankoalambanona	-	0	++	deteriorating
Tampolo	n/a	+	+++	ameliorating

Source: Randriamanantsoa & Lope (1999)
Key: + positive development, - negative development, 0 stationary

The overall analysis shown in Table 1. indicates that the status of 3 of the sites sampled in the Masoala Marine Park (Ankarambiavy, Ambodilaitra and Ankoalambanona) is deteriorating, whilst overall improvements were observed at 2 sites (Ankaranilaotra and Tampolo). The sites sampled in the tourism area (Paradis and Aquarium) were found to be degenerating as a result of hypersedimentation, the proliferation of soft corals and physical damage resulting from destructive fishing practices.

The degradation of the coral reefs of Masoala Marine Park occurs as a consequence of unfavourable ecological conditions, augmented by the deleterious effects of anthropogenic activities. Where there is a degradation of the integrity of the reef system, hard corals are slowly replaced by competing organisms that have higher tolerances such as macro-algae and soft corals. The physical damage from trampling, use of destructive fishing techniques and hypersedimentation from erosion following deforestation, represent the key anthropogenic threats to the coral reefs of Masoala Marine Park (Randriamanantsoa & Lope, 1999), see Table 2.

Table 2. Summary of the Factors affecting the Health of the Coral Reefs of Masoala.

Site	Development Trend	Factor	Mechanism
Ankaranilaotra	Progressive	Favourable ecological conditions. (With the exception of extended exposure periods).	Normal metabolic functioning of corals, enabling growth, reproduction and settlement.
		Reduction in anthropogenic activities	Reduction in physical damage
Ankarambiavy	Regressive	Proliferation of soft corals	Competition for space with hard corals
		Proliferation of algae	Crowding and asphyxiation of coral colonies
Ambodilaitra	Regressive	Proliferation of soft corals	Competition for space
		Proliferation of algae	Crowding and asphyxiation of coral colonies
		Proliferation of urchins (*Diadema setosum*)	Ecological disequilibrium caused by overfishing carnivorous and planktivorous fish
		Bleaching	Loss of zooxanthellae due to extended exposure periods
		Physical damage	Fishermen walking on reefs
Ankoalambanona	Regressive	Proliferation of soft corals	Competition for space with hard corals
		Proliferation of algae	Crowding and asphyxiation of coral colonies
		Bleaching	Loss of zooxanthellae due to extended exposure periods
Tampolo	Progressive	Favourable ecological conditions	Normal metabolic functioning of corals, enabling growth, reproduction.
		Presence of suitable settlement substrate	Increased settlement and recruitment
		Reduction in anthropogenic activities	Less physical damage

Source: Randriamanantsoa & Lope (1999)

Given the impacts of fishing on the coral reefs of Masoala Marine Park, in combination with the socio-economic importance of the associated resources, a range of management recommendations have been made in relation to these activities (Randriamanantsoa & Lope, 1999), these include:

- Reinstating fisheries regulations.
- Application of existing laws, ensuring there is adequate surveillance.
- Monitoring commercial exploitation of living marine resources.
- Improvement of the control of access of fishermen to the reefs and lagoons.
- Sensitising fishermen to the effects of destructive fishing practices.

The management recommendations relating to the status of the coral reefs of the Masoala Marine Park were directly related to the exploitation of marine resources. However, the fact that hypersedimentation is occurring as a result of deforestation, clearly emphasises the presence of a conflict and the need to enforce the capacity of the existing integrated approach to the management of the Masoala Marine Park.

5. Policies, Legal Instruments and Institutions

Legislation relating to marine parks

Marine protected areas are not the subject of specific body of legislation, as for terrestrial protected areas, they are established by regulatory legislation derived from and associated with international conventions on the protection and conservation of nature. The international law relating to terrestrial protected areas forms the basis of that for marine protected areas and consists of:

- The International Convention for the Protection of Fauna and Flora in Africa adopted at the London conference in 1933.
- The African Convention for the Conservation of Nature and Natural Resources adopted in Algiers in 1968.

Under the terms of the African Convention, both terrestrial and marine parks are considered as part of the national forestry domain. However, whether marine parks in Madagascar can strictly speaking be part of the forestry domain is unconfirmed.

There are at present just two national marine protected areas, the Biosphere Reserve of Mananara-Nord (which includes a marine component), and the three satellite marine parks of Masoala National Park (Tampolo, Cap Masoala and Tanjona):

- According to decree no 89-216 creating the Biosphere Reserve of Mananara-Nord, biosphere reserves are '*ecologically representative areas associated with research and conservation, monitoring, education, training and traditional land use*'.

- Decree no. 97-141 of 2 March 1997 (Official Journal of 21 July 1997) provided for the creation of the Masoala National Park, based on both the Algiers and the African conventions. In keeping with the strict approach of the Africa convention, article 3 states: '*all forms of hunting, fishing, exploitation, mining and works that modify the integrity of or results in perturbations to the fauna and flora are strictly prohibited*'.

Since 1992, new protected areas have been established in accordance with procedural guidelines issued by ANGAP and the Directorate of Forests in June, 1992.

A new draft Protected Areas Code (COAP) has recently been prepared and is currently before the National Assembly. This piece of consolidating legislation relates to all protected areas including aquatic ecosystems (*Nb – it still does not specify marine areas although it is assumed that aquatic includes marine)* and is based on the following principles:

- Conservation of the natural and cultural heritage for which research and education are essential tools, and for economic development.
- The establishment of a participatory approach and suitable means to achieve the objectives.

International Conventions

Madagascar has signed (and in some cases ratified) a range of regional and international conventions that apply to the management of the coastal zone and marine biodiversity:

- The Convention on the Law of the Sea (UNCLOS, 1982).
- The Convention on the Protection and Management of the Marine Environment and Coastal Zones of East Africa (Nairobi, 1985).
- The Convention on Biological Diversity (Rio, 1992) (ratified following law no. 95-013)
- The Prevention of Pollution of the Sea by Hydrocarbons (OIL POL, 1954).
- The Convention on the Control of the Movements of Dangerous Wastes and their Disposal (Basel, 1989).
- The International Convention on the Trade in Endangered Species (CITES, 1973).

Of the above, UNCLOS, Nairobi and Rio (through the Jakarta Mandate of 1995) specifically require the establishment of marine protected areas.

Institutions

Following the establishment of the Environment Charter (law 033 of 1990), environmental projects were conducted under the framework of the National Environmental Action Plan (PNAE). This also involved the establishment of the institutions required to enforce the existing institutional structure such as the National Environment Office (ONE) and the National Association for the Management of Protected Areas (ANGAP). Other public institutions (research and training) and non-governmental organisations participate in the environmental programs. A policy of integrated coastal area management will be developed by the 'Composante Environment Marin et Côtier' (EMC) under the Environment Programme this year. This should apply to protected areas in that a link exists between the EMC, protected areas and eco-tourism.

In accordance with decree n^{o} 97-012 of June 1997, the administration and management of the national network of protected areas of Madagascar are conferred to the National Association for the Management of Protected Areas (ANGAP) which falls under the Ministry of Environment. It is a private institution with a public interest. ANGAP was created in 1992 following the privatisation of the management of protected areas in accordance with the National Environmental Action Plan. ANGAP has the authority to delegate the operational management of protected areas to another institution, which could either be a non-governmental organisation, international agency or national public institution. ANGAP ensures the co-ordination of activities associated with protected areas and is responsible for their evaluation.

Currently, the marine parks are managed with the respective terrestrial park, that of Nosy Atafana is conferred to UNESCO, which is responsible for operational management, ANGAP is responsible for co-ordination, monitoring and project evaluation. The Masoala marine parks are under the direct supervision of ANGAP with the collaboration of the Wildlife Conservation Society (WCS) which is an American research organisation responsible for the conservation section.

Mechanisms for creation of marine protected areas outside the national system

The above discussion has related to the national network of protected areas. However, it has been recognised that protected areas outside the national system have an important role to play in ICAM. Several potential mechanisms exist to achieve this:

GELOSE (law 96-025) – The law on "Gestion Locale Sécurisée" (Secure Local Management) provides a mechanism for formal transfer of authority to manage natural renewable resources to local communities. At Masoala, a marine programme was introduced with the objective of promoting sustainable utilisation of marine resources and exploitation techniques that are compatible with conservation. The operation is implemented in collaboration with local community committees. The goal of the integrated approach to coastal area management adopted is to develop the region whilst promoting sustainable utilisation of marine resources, the conservation of endangered species, protection of ecosystems and maintenance of biodiversity. The following activities have been implemented to achieve conservation objectives:

- Protection of endangered species.
- Sensitising and educating resource users.
- Establishment and enforcing the partnerships between stakeholders.

In order to apply the process of ICAM, the following decisions were mutually agreed between stakeholders:

- Achieve rational exploitation of marine resources.
- Prohibition of fishing activities in nursery grounds.
- Improvement in fishing techniques and the introduction of new methods and technologies (eg. fish aggregating devices).
- The promotion of alternative activities.
- Augmentation in the revenues derived from fisheries products (eg. value added).

Other mechanisms – While GELOSE provides a specific mechanism for transfer of authority and is thus highly significant in socio-political terms, in practice protected areas can be established by simpler, less centralised means. The essential element is that a consensus be achieved between resource users to conserve a given area. Typically, this will be achieved through the establishment of community sub-committees and stakeholder groups such as the reflection committees. The success of the 'usage contract' established between the management authority and resources user groups for the Nosy Atafana Marine Park suggests that such an approach should be put forward as a model to be formally incorporated into legislation so that it can be adapted and transferred to other regions.

This may be best achieved by the 'dina' system which is a customary social agreement. It is a more general formula, which is being successfully applied for the conservation of Nosy Ve island, near Toliara. The terms of a dina can readily be applied to the context. Their principal weakness is that a dina operates as a social contract between the members of the communities participating; it does not legally bind outsiders and does not operate, like the GELOSE law, as a transfer of authority which is binding on the state. However, in many cases it may be adequate for the establishment of local protected areas, and is generaly respected.

6. Needs Assessment

Marine protected areas in Madagascar are under represented. There is a need to increase the number of marine protected areas (see Annex 7) and develop management plans within the framework of the 'Strategic Plan for the Network of Protected Areas in Madagascar' (ANGAP, 1999). The management plans should address individual needs in terms of the resources and activities of the marine parks and encompass the following aspects:

Financial needs. The current operational budget for the Nosy Atafana Marine Park is inadequate. The budget required to establish and implement a strategic management plan for 5 years is US $ 750,000 (determined by the UNESCO Mananara Biosphere Project, 1999). The financial requirement to successfully achieve goals and objectives of the Masoala Marine Park is US $ 1 million over a 5-year period.

Human resource needs. Senior and technical staff require specialized training in the management of protected marine areas. Training is required in education skills and resource/ecological monitoring for park rangers. There is a need for further education programs and increased sensitisation of coastal communities. Additional park rangers are required for effective operational management.

Physical Resource Needs. Larger boats for park rangers are needed to improve communication and facilitate monitoring programs. Improved communication facilities are required (long-range radios). Demarcation buoys at the boundary of the parks need to be installed and mooring buoys for visiting dive boats. Enforcement would be improved if the conservation agents in Masoala were resident in the parks or adjacent coast in the case of those without islands. Each of the Masoala Marine Parks needs a base where the conservation agents can stay. Tourism infrastructure needs to be developed in order to realise the potential revenues from eco-tourism.

Technical Information Needs. Ecological monitoring needs to be consolidated over a longer period and expanded to the Nosy Atafana Marine Park. More detailed resource monitoring and assessment is needed as well as information on the demography of coastal communities and dynamics of migrant fishing communities. Stock assessments and biological studies of exploited resources are required to improve current estimates. The Nosy Atafana Marine Park needs a comprehensive inventory of the biodiversity and a carrying capacity study and sensitivity analysis relating to the impact of eco-tourism.

Institutional/Legislative Needs. The legal status of the 'usage contract' is not defined. In order that it can be transferred as a management tool, it should be conducted under the 'dina' system, which is a customary social agreement. The structure of the management authorities needs to incorporate a specialised section for the management of their respective marine parks.

Programme Activity Needs. The management authority needs to increase the programs and activities associated with the coastal communities adjacent to the Masoala Marine Parks. These should be orientated at developing alternative practices and reversing the deleterious impacts associated with the habitats and resources. This should be accompanied by an increase in the current education and sensitizing efforts in order to provide a catalyst to the ICAM process.

7. Conclusion

The 2 marine protected areas of Madagascar have an important regional significance. All of the principal habitats that typify the coastal zone of Madagascar occur within their boundaries and they are important as a marine resource base for fishing communities in adjacent villages. Furthermore, the marine parks are characterised by high biological diversity and representative habitats of endangered and endemic species. The cultural value of these areas is indicated by the presence of sacred burial sites.

The management approach for both marine parks has consistently focused on an integrated community based participatory process with a high level of co-ordination, communication and education. As a result, the programs and activities of the management authority are driven by the needs of the coastal community and stakeholders. The rationale of the process is based on relieving pressure on over exploited resources and sensitive habitats by facilitating alternative activities that are sustainable. Very little resources are required for successful surveillance and enforcement as these responsibilities are shared between the management authority and resource users. A major contribution to the success of the management of the Nosy Atafana Marine Park, was the ability of the management authority to transfer property rights to the resource users via a 'usage contract'. This unique approach to date has resulted in an increase in yields from the resource base and a 'spill-over' effect into adjacent areas. Furthermore, there is a high degree of compliance and resource users have developed their own initiatives in the husbandry, protection and conservation of resources.

The management approach has resulted in an effective and dynamic process that has proved capable of resolving resource base conflicts and meeting all of its goals. The successful management of the Nosy Atafana Marine Park has enabled an improvement in the quality of life for coastal communities whilst conserving resources and improving the integrity of biodiversity and ecosystems. Improvements in the status of the habitats in the marine park have occurred since its creation including an enhancement of the coastal forests through the removal of coconut and breadfruit trees planted by the coastal communities. There has been less physical damage to coral on the reef flat through a reduction in octopus fishing and a regeneration of the mangroves at Rangotsy Is. following a ban on the exploitation of wood to make fish drying racks. The objective of resource conservation has been met by the regulation of fishing activity, resulting in an increase in catch rates within and outside the park and an augmentation in recruitment. The management process also has a demonstrated ability to resolve resource base conflicts, such as the over exploitation of marine resources and loss of income due to access restrictions.

However, a threat exists in the fact that the marine park does not have a management plan and there is an absence of a permanent monitoring programme to assess the impacts of existing activities and potential developments. The outstanding achievements of the Mananara Biosphere Project in the management of Nosy Atafana Marine Park may be jeopardised by the potential adverse impact of tourism development.

The participatory management process for the Masoala Marine Parks has not been in place long enough to achieve its goals and was delayed by a change in the management authority 2 years after initial activities started. There has been some success in terms of the maintenance of biodiversity, conservation of ecosystems and sustainable use of marine resources illustrated by the successful management of Tampolo Marine Park. However, the process has

not developed sufficiently to be able to resolve resource base user conflicts. As a result, the marine resources of the Tanjona and Cap Masoala marine parks are over exploited and there is conflicting use between communities resident on the coast adjacent to the parks and migrant fishermen. Furthermore, the integrity of biodiversity and ecosystems is jeopardised through the detrimental impacts of human activities. Habitat destruction is illustrated by the trampling of corals by octopus fishermen and other destructive fishing practices. The existing demographic structure of coastal communities (50% of the population under the age of 25 years), indicates that the pressure on the resources of the Masoala Marine Parks will increase rapidly in the future. An acceleration of the existing management process through increased activities and the development of a capacity to resolve conflicting resource use are imperative in this context.

This critical analysis has enabled a comparison of the performance of a replicated participatory management system for marine protected areas in the long term (Nosy Atafana at 11 years), and short term (Masoala at 3 years). A general lesson from the respective management experiences is that goals and objectives may be achieved as early as 3 years following the implementation of the process. The benefits may be realised in advance if catalysts are applied in the form of programs and activities such as public awareness campaigns or training programs for substitute activities. Inactivity as a result of a lack of capacity of the management authority is detrimental to the management process.

An important lesson learned is that to be successful, there must be synergy in the development of participatory integrated coastal area management systems applied to marine protected areas. The effect of limiting access to the Nosy Atafana Marine Park successfully excluded migrant fishermen from outside the region. Whilst this was instrumental in resolving a major resource use conflict, it exacerbated the same conflict in the adjacent region where the management process was not yet in place.

A management strategy based on co-operation, education and communication with users is a powerful tool for community development, resource conservation, ecosystem protection and the maintenance of biodiversity. The management of the Nosy Atafana Marine Park in the UNESCO Biosphere Reserve of Mananara-Nord is exemplary of an integrated, participatory process applied successfully to the management of activities and resources associated with marine protected areas. The high degree of success achieved suggests that the approach would be appropriate for adaptation to other coastal areas sharing similar characteristic, both within Madagascar and the region.

Improvements can be made through incorporating the usage contract as a traditional social agreement (dina) so that it is legally recognised and the authorities should create sections that are specifically responsible for the management of the marine parks. The major constraint to successful management determined from this analysis is the lack of capacity in implementing activities within the ICAM process (demonstrated by Masoala Marine Parks).

Furthermore, there is a need to develop and implement individual management plans for existing MPA’s within the framework of the ‘Strategic Plan for the Network of Protected Areas in Madagascar’ (ANGAP, 1999). The potential impact of current tourism developments without a comprehensive ecological monitoring programme and management plan is a major threat to the integrity of the marine protected areas of Madagascar.

8. Recommendations and Guidelines for MPA management

Recommendations

The marine protected areas of Madagascar are under represented and do not reflect the importance of coastal marine habitats around the island. It is necessary to create more marine protected areas (see Annex 7) and develop and implement individual management plans for existing MPA's within the framework of the 'Strategic Plan for the Network of Protected Areas in Madagascar' (ANGAP, 1999). Where there is a complex of marine protected areas, as in the case of Masoala, each area should have an individual management plan that responds to its specific requirements.

For the existing marine parks, the development of management plans is a priority activity. These should address individual needs in terms of the resources and associated activities and encompass the following aspects:

Financial: The budget required to establish and implement strategic management plans for the existing marine parks is US $ 1,750,000 for the next 5 years (determined by the UNESCO Mananara Biosphere Project and ANGAP, 1999).

Human Resources: Senior management and technical staff require specialized training in the management of protected marine areas and park rangers need to be trained in resource/ecological monitoring and education skills. Additional park rangers are required for effective operational management.

Physical Resources: Infrastructure requirements include; larger boats for improved communication and facilitating monitoring programs and a base at each of the Masoala marine parks.

Technical information gaps: More detailed resource monitoring and assessment is needed as well as information on the demography of coastal communities and dynamics of migrant fishing communities. Stock assessments and biological studies of exploited resources are required to improve current estimates. Carrying capacity studies and sensitivity analysis relating to eco-tourism are a priority activity.

Institutions and legislation: The structure of the management authorities needs to incorporate a specialised section for the management of their respective marine parks. The customary social agreement or 'dina' system needs to be considered as an alternative form of 'usage' contract for application in the Masoala Marine Park and other coastal areas in need of conservation.

Programme activities: The management authority needs to increase the programs and activities associated with the coastal communities adjacent to the Masoala Marine Parks. These should be orientated at developing alternative practices and reversing the deleterious impacts associated with the habitats and resources. This should be accompanied by an increase in the current education and sensitizing efforts in order to provide a catalyst to the existing participatory integrated coastal area management process.

A regional network of marine protected areas should be established in order to facilitate exchanges, expertise sharing and human resource development.

Guidelines for MPA management

The analysis of the success and failures associated with the 2 marine protected areas of Madagascar have enabled the elaboration of general management guidelines. These are also applicable in a regional context:

- An integrated management process based on co-operation, education and communication with users and stakeholders, is a powerful tool for conserving resources, maintaining biodiversity and protecting ecosystems. The resulting decision making process can be dynamic, being capable of identifying and quickly resolving critical management issues.

- Where the solutions are simple, viable and directly applicable by the resources users themselves, management issues can be resolved by directing the activities of resource user groups to sustainable, non-destructive substitutes.

- By allocating property rights to resources users, surveillance and enforcement can be improved. This can also instil a high degree of compliance with management regulations and husbandry for the resources.

- The quality of life and standard of living of the local community adjacent to the marine protected area can be improved by investing the revenues generated from entrance fees into social development projects. This assists in gaining support for the ICAM process and protecting habitats and ecosystems within the park.

- The selection of isolated sites that have natural barriers increases the probability of successful management.

- Transferring the operational management of a marine protected area within an ICAM framework, delays the development of the participatory management process and erodes the confidence of the community in the system.

- It is highly improbable that management goals and objectives will be achieved if the decision making process lacks the ability to resolve conflicting resource use. (Illustrated by the case of Cap Masoala and Tanjona Marine Parks). A close dialogue between resource users, stakeholders and the management authority is imperative if conflicts are to be resolved.

- The management of a complex of individual marine parks must avoid displacement of resident communities as a result of a resource base conflict. The establishment of the structural components of the management system must occur simultaneously in order to be equitable and management planning must take into account the different characteristics and needs of the individual parks within a complex.

- There is a strong need for synergy in the development of a participatory integrated coastal area management process and close collaboration and communication between regions. This is imperative in the context of users that are mobile in order to avoid a shift in a management issue to an adjacent watershed.

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List of Figures

List of Tables

List of Plates

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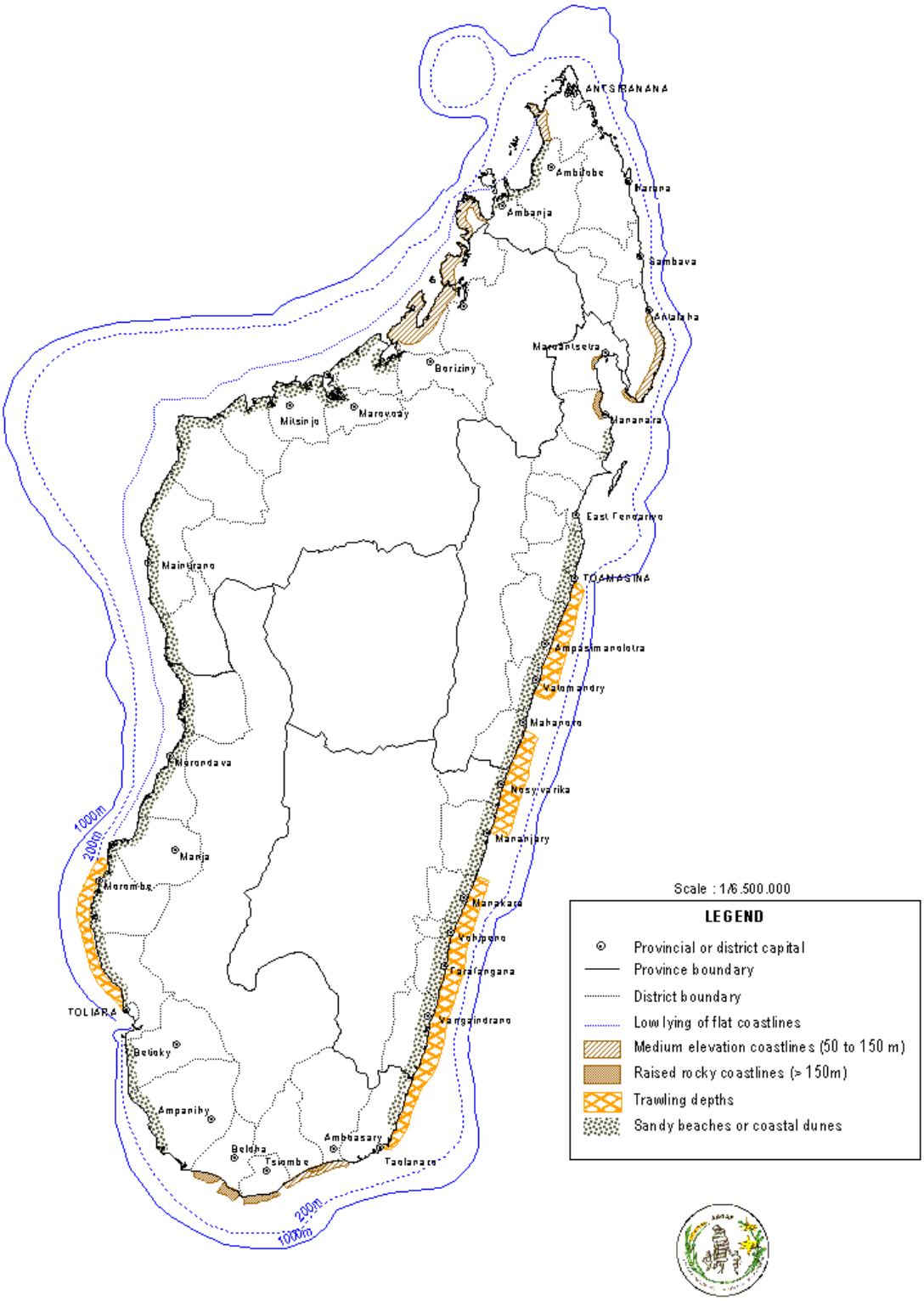
Annex 1. The Distribution of Rocky Shores, Sandy Beaches and Coastal Dunes in Madagascar.



Data source : Direction des ressources halieutiques, 1996 - Realized and printed by ANBAP/BIS - May 2000

Annex 2. Principal Components of the Resource Usage Contract for the Nosy Atafana Marine Park.

Article 1. Access Restrictions

- Fishermen of the villages Sahasoa, Ivontaka, Menatany and Hoalampano are authorised to fish in the Nosy Atafana Marine Park between the 1st September and the en of April.
- During this period, the days on which fishing is authorised are Tuesday, Thursday and Sunday.
- On theses days fishing is permitted between 5am and 5pm.

Article 2. Fishing Gear Restrictions

- Fishing gears authorised in the Nosy Atafana Marine Park are limited to
  (i) Nets with a mesh size greater than 5 cm.
  (ii) Hooks and lines.
  (iii) Harpoons

Article 3. Species Restrictions

Only fish, octopus and squid may be exploited from the Nosy Atafana Marine Park

Article 4. The Responsibilities of Fishermen

- The responsibility for adhering to the contract rests with the fishermen of the 4 villages specified.
- The park ranger and fishermen are responsible for the surveillance of poachers in the Nosy Atafana Marine Park.
- A lack of compliance may result in the total closure of the park.
- The contract can be modified under certain circumstances associated with the following:

- a reduction in the number of juveniles in the park
- an increase in the destruction of the coral reef
- the ability of fishermen from the 4 villages to fish successfully outside the park.

Article 5. Prohibited Activities in the Nosy Atafana Marine Park

- Visiting the marine park for exploitation between the months of May to August.
- Being in the Nosy Atafana Marine Park between 5 pm and 5 am.
- Camping on the islands in the park.
- Hunting
- Removal of shells, spiny lobsters, holothurians, collection of corals and shells.

Annex 3. Data Relating to the Nosy Atafana Marine Park

Data relating to the villages associated with the Nosy Atafana marine park.

Village	Population	No. Fishermen	No. Associations
Hoalampano	327	29	17
Ivontaka	330	34	6
Menatany	468	51	11
Sahasoa	985	65	18
Total	**2,110**	**179**	**52**

Catch Rates in the Nosy Atafana marine park (1996 to 1999).

	1996	1997	1998	1999
Catch/Fisherman/Trip (kg)	7.0	5.4	5.1	9.0

Offences in the Nosy Atafana marine park.

Offence	1998	1999	2000 (to April)
Illegal Fishing	5	3	1
Use of illegal gear	14	8	2
Total	**19**	**11**	**3**

Annex 4. Summary of the Inventory of Species in the Nosy Atafana Marine Park.

Classification	Family	No. Species
Scleractinian Corals	Acroporidae	8
	Fungidae	5
	Faviidae	8
	Poritidae	5
	Agarieidae	3
	Mussidae	1
Zoanthids	Zoanthidae	2
Soft Corals	Alcyonnaires	3
Actinarians	Actinaria	2
Hydroids		2
Hydrocorals		2
Molluscs	Gastropods	16
	Bivalves	10
	Cephalopods	2
	Nudibranchs	3
Crustaceans		8
Echinoderms	Asteroidea	4
	Echinidea	4
	Holothuria	6
	Ophiuridae	1
Fish		24
Mammals		3
Flora	Mangroves	4
	Phanogrammes	6
	Green Algae	7
	Red Algae	7
	Brown Algae	3

Source: Adapted from: Maharavo, (1997).

Annex 5. Information Relating to the Marine Parks of Masoala.

Marine Park/Surface Area	Co-ordinates of Central Core	No. of Inhabitants in Adjacent Villages	Number of Fishermen
Tampolo (35 km^2)	15° 46' 024" S 50 ° 20' 647" E	150	15
Cap Masoala (21 km^2)	15 ° 59' 328" S 50 ° 13' 012" E	1069	111
Tanjona (25 km^2)	15 ° 43' 893" S 49 ° 57' 437" E	142	30

Annex 6. Summary of the Inventory of Species in the Masoala Marine Park.

Classification	No. Species
Marine Algae	
Division Chlorophyta (Green Algae)	15
Division Phaeophyta (Brown Algae)	15
Division Rhodophyta (Red Algae)	21
Marine Phanerogrames	9
Mangroves	6
Hard Corals	
Family: Acroporidae	14
Family: Agariciidae	17
Family: Siderastreidae	3
Family: Caryophylliidae	2
Family: Dendrophyllidae	7
Family: Favidae	5
Family: Meruliniidae	2
Family: Mussidae	10
Family: Oculinidae	4
Family: Pectiniidae	5
Family: Pocilloporidae	7
Family: Poritidae	6
Family: Fungidae	24
Hydrozoans	3
Hydroids	1
Octocorals	1
Soft Corals	2
Sponges	4
Molluscs	98
Cephalopods	4
Arthropods	8
Echinoderms	30
Fish	
Family: Myliobatidae	1
Family: Acanthuridae	20
Family: Apogonidae	9
Family: Aulostomidae	2
Family: Balistidae	3
Family: Belonidae	1
Family: Bleniidae	1
Family: Chaetodontidae	39
Family: Chirocentridae	1
Family: Ephippidae	4
Family: Gerridae	2
Family: Gobiidae	1

Annex 6. Cont…

Classification	No. Species
Family: Haemulidae	3
Family: Hemirhamphidae	1
Family: Holocentridae	4
Family: Kyphosidae	1
Family: Labridae	10
Family: Lethrinidae	5
Family: Lutjanidae	6
Family: Monacanthidae	4
Family: Mullidae	7
Family: Muranidae	1
Family: Nemipteridae	2
Family: Ostraciidae	2
Family: Oplegnathidae	1
Family: Pempheridae	3
Family: Pomacanthidae	21
Family: Pomacentridae	102
Family: Scaridae	18
Family: Scombridae	1
Family: Scomberesocidae	1
Family: Scorpaenidae	2
Family: Serranidae	9
Family: Siganidae	3
Family: Soleidae	2
Family: Sphyraenidae	1
Family: Sygnathidae	1
Family: Theraponidae	1
Family: Tetraodontidae	2
Family: Zanclidae	1

Source: Adapted from; Randriamanantsoa, & Lope (1999).

Annex 7. Proposed Protected Areas in Madagascar