Proceedings of the Workshop on a Regional Perspective on MPAs in the Western Indian Ocean

Rodrigues Island, Mauritius

9-14 May 2007

Edited by
Alasdair Edwards
and
Tara Hooper

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Foreword

On 9 April 2007, four marine reserves were finally gazetted at Rodrigues Island. This good news came shortly before the regional workshop on 9-14 May entitled "*A Regional Perspective on MPAs in the Western Indian Ocean"*, the first such international scientific gathering held in Rodrigues. The workshop was opened by Rodrigues' Chief Commissioner, Mr Johnson Roussety, and brought together 75 delegates from 12 countries at the Escale Vacances Hotel in Port Mathurin to discuss the issues of unsustainable marine resource use and how MPAs can be used as effective management tools.

Originally planned as a modest meeting with 25 delegates, the scope of the meeting was widened in discussion WWF, the Indian Ocean Commission, and the Western Indian Ocean Marine Science Association (WIOMSA) to include a two-day session to initiate the Western Indian Ocean Marine Ecoregion (WIOMER) MPA Managers' Forum, in addition to the three-day formal meeting. The workshop was funded by the Darwin Initiative of the UK Department for Environment, Food and Rural Affairs (DEFRA), WWF, Fonds Français pour l'Environnement Mondial, WIOMSA, the European Union's Regional Programme for Coastal Zone Management of the West Indian Ocean Countries (ReCoMaP), and the French Ministry for Foreign Affairs.

The workshop was a great opportunity for Rodrigues delegates to learn lessons from MPA managers throughout the region and further afield (e.g. Sénégal, India, St Lucia), and for regional delegates to share information, experience and ideas. Highlights of the workshop included a visit to the newly gazetted Rivière Banane marine reserve and a stakeholder meeting by Creole speaking delegates (Seychelles, Mauritius, Madagascar, Comoros) with local Rodriguais fishermen affected by the new reserves.

The WIOMER MPA Managers' Forum, part of a project managed by the Indian Ocean Commission and WWF to bring regional coherence to MPA development, was successfully established and now networks MPA managers from Mauritius, Rodrigues, Seychelles, Comoros, Madagascar and La Réunion.

These Proceedings provide a summary of the presentations made, the full texts of 10 selected papers from the workshop and the abstracts of a further 16 papers. The papers give valuable insights into the establishment, effectiveness and lessons learned from management of MPAs in Rodrigues, Madagascar, Mauritius, Tanzania, Kenya, Seychelles and Sénégal. In addition, MPA Information Tables are provided for 13 marine protected areas in 6 countries in the WIO region (available separately online at www.ncl.ac.uk/tcmweb/tmr/mpa_information_tables.pdf) and finally a list of participants' contacts is provided. Summaries of the presentations in both French (www.ncl.ac.uk/tcmweb/tmr/presentations_sommaires_mpa_workshop.pdf) and English (www.ncl.ac.uk/tcmweb/tmr/presentation_notes_mpa_workshop.pdf) are also available on the web. We thank all those who contributed their time and expertise to the workshop and particularly those whose papers are published here. We are grateful to the Darwin Initiative for funding the publication of the Proceedings.

Alasdair Edwards and Tara Hooper (Editors)

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- The development of marine reserves in Rodrigues (Eric Blais & Liliana Ally)
- La démarche participative pour la mise en place du parc marin de Mohéli (Anfani Msoili & Mohamed Mindhiri)
- "To live with the sea" – the Velondriake network of marine and coastal protected areas, southwest Madagascar (Al Harris & Francisco Ramananjatovo)
- Supporting environmental stewardship: conservation, livelihoods and environmental education in Lakshadweep (Vineeta Hoon)

Summary by Session Chairman
Several things emerged from this session: (1) it is extremely important to first determine who the main stakeholders are who should be involved in the project; (2) in each of the presentations there were specific management activities in which communities were involved e.g. resource assessments, monitoring surveillance or simply consultation. The most successful cases were when the community actually took decisions in collaboration with the decision-makers; (3) activities that created a sense of ownership were successful; (4) the development of alternative livelihoods is very important; (5) branding is a very useful way to drive participation as the community is able to identify with the "product".

Thursday 10 May

Monitoring and Managing MPAs - Community Issues
Chairman: Eric Blais (Shoals Rodrigues)

- Integrating socio-economic monitoring of coastal management at a Western Indian Ocean site: experiences and challenges (Innocent Wanyonyi)
- Encouraging community involvement in MPAs – issues and approaches (Suzannah Walmsley)
- Environmental conflict management in Mombasa Marine National Park and Reserve, Kenya: a multicriteria spatial approach (Lynda Rodwell)
- Managing MPAs: a toolkit for the Western Indian Ocean (Dixon Waruinge & Julie Church)
- Integrated coastal management in West Africa: the evolution of integration in Cayar, Senegal (Paul Siegel)
- Territorial disagreements and agreements: a geographical method to display social acceptability of marine protected areas in the South-West Indian Ocean (Aurélie Thomassin)

Summary by Session Chairman
Several tools are available in the region to help to monitor and manage MPAs. It would be good to make these tools available to the maximum number of people and provide more training for people so that all managers are on the same wavelength. For example, the SocMon manual, ParFish and the MPA Toolkit. There is a need for training in using these tools in order for them to be effective. Paul Siegel also showed that very few MPA managers are trained in social sciences, but this is very important for MPA management.

Funding and Income Generation
Chairman: Denis Etienne (Indian Ocean Commission)

- Challenges of funding community-based fisheries-related projects (Pamela Bapoo-Dundoo)
- An MPA in La Réunion: Here it is, at last!! (Bruce Cauvin)
- The Madagascar Protected Areas and Biodiversity Foundation: lessons learned (2000 – 2007) for marine conservation (Jean Paul Paddack)
- Promotion of non-fishing income generating activities (Mary François)
- Turning MPA waste into an MPA solution (Julie Church)
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Summary by Session Chairman
This was a very important session: money is very important for the creation of MPAs and their effective management. The different presentations highlighted different methods of funding MPAs e.g. large organisations such as the EU or World Bank or private sponsorship. The development of a trust fund is a very interesting idea and something that is very feasible and could be put in place in other places and even on a regional basis; smaller grants from GEF-SGP are also very important for NGOs. The ReCoMaP project is a real opportunity for regional projects, which are lacking funding. Mary François however showed that depending on external funding isn't always enough and new methods of income generation need to be developed. Julie Church created an economic activity as well as developing an alternative livelihood and even with a very small amount of funding alternative livelihoods can be developed, for example in St Lucia. This is very relevant to Rodrigues as fishers will need to diversify in order to continue to earn a living.

Friday 11 May

Monitoring & Managing MPAs – Case Studies & Research Findings
Chairman: Jean Paul Paddack (WWF)

- Marine National Parks of the Seychelles (Allen Cedras)
- A network of National Parks in Madagascar (Jaomanana, Jean Baptiste Zavatra & Jocelyn Bezara)
- Involving the community of Mafia Island Marine Park (Haji Mahingika)
- The effect of a major coral bleaching event on the abundance and composition of carnivorous reef fish in Aldabra's Marine Protected Area (Pierre Pistorius)
- Using length-frequency data to identify management options: a case-study based on the large seine net fishery of Rodrigues Island, Indian Ocean (Alasdair Edwards)
- Successes and disappointments of MPAs in the Western Indian Ocean: the case of the Mombasa Marine Park and Reserve (Stephen Mangi)
- An overview of Reef Conservation Mauritius (Jennifer Ah-King)

Summary by Session Chairman
(1) A number of presentations discussed the lack of capacity and this is still a challenge – how can we jumpstart the process? (2) Sharing of information – it is very important that a webpage be created as part of the projects as it's important to keep up to date; (3) The involvement of communities is an integral part of success – how can we get them more involved in terms of monitoring and control? (4) There are still problems with involvement of the private sector; Julie's talk was inspiring, but there is still not a good collaboration between civil society, MPA management and the private sector. How can we make that more systematic and significant? (5) There is a need for good scientific data as shown by Pierre Pistorius and Alasdair Edwards, we also need to blend science and socio-economics; (6) We still need to find ways to be more effective lobbyists; (7) There is a funding problem, but it is less of a problem than we think – we need to provide a good sell for a product and be a bit more ambitious.

Impediments and Solutions in MPA Management
Chairman: Alasdair Edwards (Newcastle University)

- The management of the Blue Bay Marine Park (Sanjeev Leckraz)
- Shortcomings and strategies in communicating Govt-NGO-Public (Jacqueline Sauzier)
- Programme de gestion durable de la zone côtière des pays de l'Océan Indien: composante; «*Appel à Propositions*» (Tayffa Hassanali)
- Partnerships for MPAs in Mauritius and Rodrigues (Iain Watt)
- How is your MPA doing? Management effectiveness of MPAs in the WIO (Ian Valmont)
- Implications of biodiversity conservation in urban marine protected areas: the case of Mombasa Marine Park (Mohamed Omar)

Summary by Session Chairman
The different presentations showed how contrasting different MPA set-ups are, with different pressures, funding structures etc. On one hand there are fairly self-funded MPAs with lots of freedom and on the other, MPAs with more government funding and less freedom. Where there is more self-funding it is much easier to manage the MPA. There also different externalities e.g. in Mombasa urban externalities are very difficult to manage, in contrast Cousin Island has no real externalities, therefore some people have a much harder task. There are three points to raise: (1) MPAs are a means to an end and not the end themselves. They are a tool within an ICZM context and a way towards sustainable conservation; often the MPA becomes the goal; (2) it is surprising that there are so few social scientists here as coastal management has shifted much more towards socio-economics

these days. Natural science issues are fairly straight forward, but social issues are much more complex and conservation cannot be achieved without solving the social science issues; (3) It is encouraging to see some workable and realistic alternative livelihoods. Without these reducing fishing pressure, the creation of MPAs won't work.

Saturday 12 May

Visit to Rivière Banane and Island Tour
Delegates were taken to Rivière Banane to snorkel in the newly designated marine reserve and enjoy a picnic lunch, after which tour buses took them to Caverne Patate, stopping off at scenic view points and cultural sites, and offering the chance to stop and buy local produce and souvenirs.

Fisher Question & Answer Session
Francophone/Creole speaking delegates working directly in MPA management joined 22 fishers to discuss the implications and management issues related to four new MPAs that had recently been declared in Rodrigues' northern lagoon.

Sunday 13 May

WIOMER MPA Managers' Forum
Consolidating the Momentum Created in November 2003

- Review of resolutions made in 2003: the value of developing a Network (Rémi Ratsimbazafy)
- MPA managers' expectations of the Forum (Facilitators: Dr Paul Siegel/Thierry Razafindralambo)
- Examples of operational MPA networks: genesis, objectives, structure, activities (Catherine Gabrié)
- Discussions

Establishing Priorites

- Thematic issues (Facilitators: Dr Paul Siegel/Thierry Razafindralambo)
- Prioritisation and discussions (Facilitators: Dr Paul Siegel/Thierry Razafindralambo)
- Examples of positive developments following the establishment of the Network (Dr Catherine Gabrié)
- Questions & answers
- Defining the objectives of the Forum (Facilitators: Dr Paul Siegel/Thierry Razafindralambo)

Monday 14 May

Setting up the WIOMER MPA Managers' Forum

- Defining the structure, action plan (Working Group) (Facilitators: Dr Paul Siegel/Thierry Razafindralambo)
- Group Presentation
- Detailed discussion on the Forum structure and involvement of managers (Facilitators: Dr Paul Siegel/Thierry Razafindralambo)

Conclusions & Next Steps

- Summary of all stages
- Next steps
- Date and location of the next meeting and the themes to be discussed
- List of potential experts

2. SELECTED PAPERS

The development of marine reserves in Rodrigues

F. Eric I. BLAIS, Liliana ALLY and Emily R. HARDMAN*

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Abstract Artisanal fisheries are extremely important to the local population of Rodrigues, however the fisheries are in serious decline and the methods used by fishers are causing damage to the lagoon habitats. As a result, the Rodrigues Regional Assembly has now approved the creation of 4 marine reserves in the northern lagoon to allow fish stocks to recover and to protect the coral and lagoon habitats from further impacts. The reserve boundaries were identified in collaboration with the local fishing communities using a range of criteria including fish abundance, potential as spawning grounds, presence of degraded areas which need protection in order to recover, potential as good snorkelling sites for tourism, and likely impact on fisher livelihoods. The reserves were proclaimed in April 2007 and establishment of the first reserve at Rivière Banane is currently underway: a management committee has been established, a management plan has been developed and demarcation of the reserve boundary has taken place. Shoals Rodrigues is working to support the development of these reserves through a community-based approach, which combines research, training and education. Research activities consist of biological and socio-economic surveys; training activities work to build the capacity of Government and NGO staff and education activities are aimed at all members of the local community. Shoals Rodrigues also works to ensure that local stakeholders are included in the decision-making process through consultation sessions held in the fishing communities.

Background

Rodrigues is a semi-autonomous island forming part of the Republic of Mauritius, located 560 km north east of the main island in the western Indian Ocean. The island is surrounded by 90 km of fringing coral reef, which creates a shallow lagoon of 240 km^2. Fishing is one of the largest employment sectors on Rodrigues, as there is a lack of industrial development and tourism is in its infancy. There were 2,024 full-time, registered fishers in 2006 (13% of the total workforce) (Central Statistical Office, 2007) with an estimated additional 2,000 people fishing on a casual basis. Due to the prevailing strong SE Trade winds and lack of suitable boats, fishing is almost entirely restricted to within the sheltered lagoon.

As a result of this intensive fishing, the lagoon fisheries are now in serious decline. Total lagoon catches have declined by 50% between 1998 and 2006 and octopus catches fell from 775 tonnes in 1994 to 266 tonnes in 2006 (Fisheries Research & Training Unit, unpublished data). The catch per unit effort within the seine net fishery has declined significantly over the past 5 years and the catch is now dominated by small herbivorous fish, while carnivorous species are rare. Many of the important species, such as the rabbitfish and emperors, are also now severely overexploited and the majority of individuals are being caught before they reach maturity. The techniques used by the fishers create further problems: octopus and large net fishers work on foot and through trampling, cause substantial damage to the coral and algal habitats in which they fish. Furthermore, despite regulations to the contrary, seine net fishers often use illegally small mesh sizes, and so collect juvenile animals.

Management methods so far introduced have included the prohibition of spear fishing, reducing large net license numbers, enforcing a minimum mesh size of 9 cm and closing the large net fishing season between March and October, however despite these efforts fish stocks have continued to decline. As a result, the Rodrigues Regional Assembly, in collaboration with *Shoals Rodrigues*, has now approved the creation of four marine reserves in the northern lagoon at Rivière Banane, Anse aux Anglais, Grand Bassin and Passe Demi (Fig. 1). The location of the reserves was decided in collaboration with the major stakeholders through meetings at fisher communities held during 2002 and meetings of the Coordinating Committee for Fisheries and Marine Resources. The reserves have now been officially proclaimed and the first reserve at Rivière Banane is currently being established in collaboration with the local fishing community.

Aims and objectives

The lagoon fisheries are very important to Rodrigues but they are being seriously overexploited. The lagoon and reef habitats provide feeding and spawning grounds for commercial fish species, as well

as having high biological interest in their own right. The outer reefs have well developed healthy coral communities and a number of endemic species have been recorded. The lagoon habitats are however being degraded by human activities and new developments in Rodrigues have the potential to cause further damage to these habitats.

The aim of the development of a network of marine reserves in Rodrigues is therefore, to promote the sustainability of fisheries in the Rodrigues lagoon and to protect the coral reef and lagoon habitats from further human impacts.

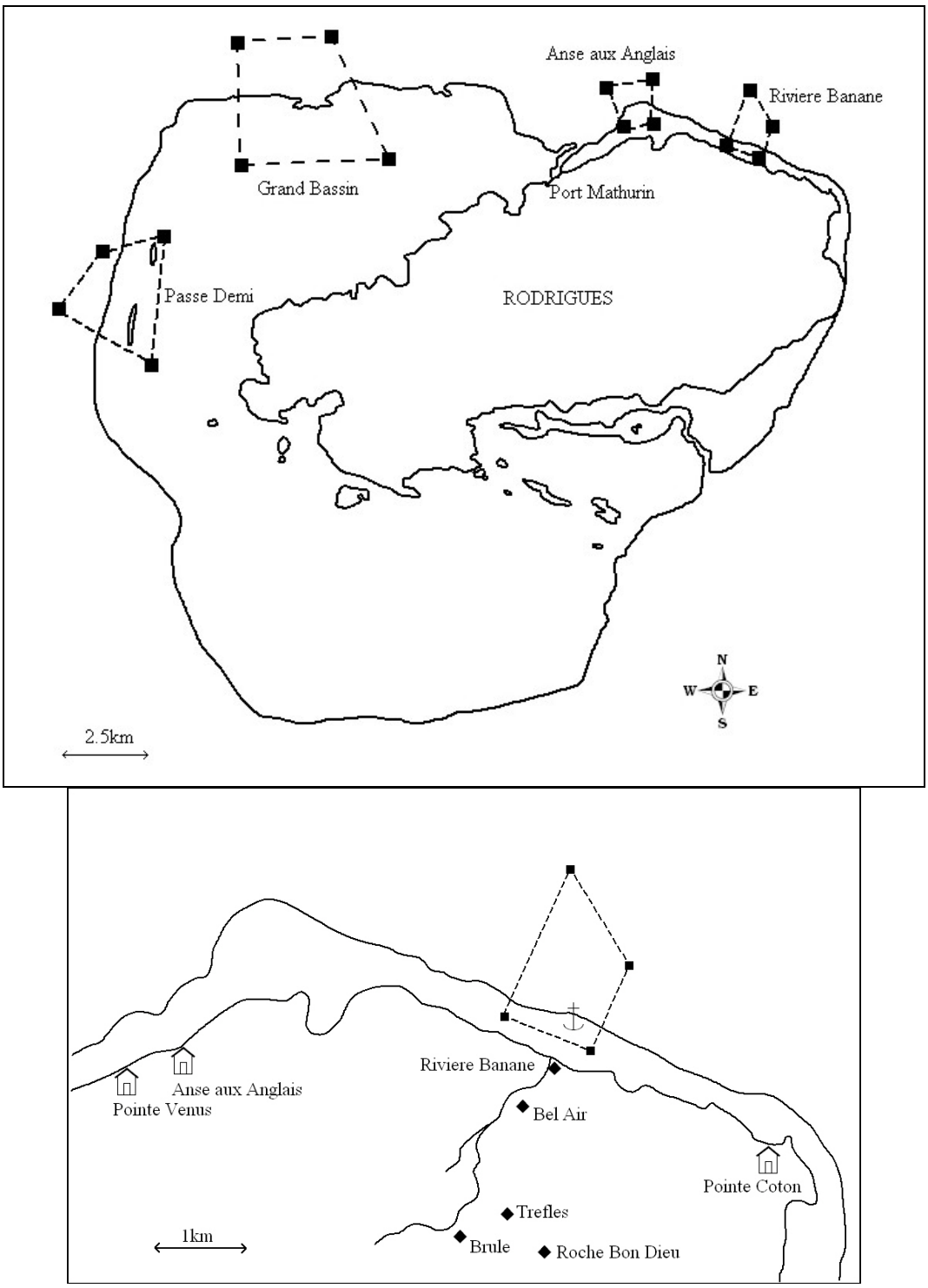

Fig. 1. The four marine reserves in the northern lagoon, with the reserve area at Rivière Banane shown in more detail, highlighting neighbouring villages and tourist sites (⚓= snorkelling site; 🏠 = hotel).

Methods

During October – December 2002, meetings were held at 18 fishing villages around Rodrigues discussing the need for marine reserves with over 400 fishers. There was a general consensus from these meetings that fisheries in the lagoon were in serious decline and 80% of fishers interviewed acknowledged that fish stocks had declined in recent years, with 86% in support of marine reserves (Gell *et al*. 2003). From these meetings, five potential reserve areas were chosen based on the fishers' suggestions, due to them being spawning grounds (Grand Bassin; Couzoupa), having large numbers of fish (Couzoupa, Grand Bassin, Passe Demi and Anse aux Anglais), being good diving/snorkelling sites (Passe Demi, Anse aux Anglais and Rivière Banane) and containing degraded areas that require protection in order to recover (Rivière Banane and Anse aux Anglais). A Geographical Information System of the Rodrigues lagoon (Chapman 2001) was also used to ensure that the reserves contained a range of different habitats and species.

Through funding from the UNDP-GEF Small Grants Programme and the Darwin Initiative, Shoals Rodrigues has been working to support the development of these reserves through a combination of research, training and education. Research activities have focused on setting up biological and socio-economic monitoring programmes to assess the success of the reserves. Coral reef monitoring is undertaken every six months at 13 sites around the island using the Global Coral Reef Monitoring Network methods to assess benthos, fish and invertebrates and lagoon habitat monitoring is carried out once a year at eight sites. Catches from the seine net fishery have been monitored for five years and monitoring of the basket trap, line and octopus fisheries commenced in 2006. Socio-economic monitoring also commenced in 2006, as part of the CORDIO SocMon programme, undertaking surveys at the village of Rivière Banane. Training has concentrated on capacity building, using international scientists to provide training to local NGO staff and Government officials in scientific survey techniques (including dive training) as well as data analysis. Education activities target all members of the community through primary school visits, a Saturday club for teenagers, workshops for teachers and fisher education sessions and a number of educational resources have been produced such as posters, games and a primary school pack. Shoals Rodrigues also works to ensure that stakeholders are included in the decision-making process through annual stakeholder meetings held at the different fishing villages. Fishers are updated on the progress of the reserves and consulted about issues such as enforcement and alternative livelihoods. The results of these meetings are then relayed to the Rodrigues Regional Assembly through the Coordinating Committee for Fisheries and Marine Resources and the production of annual reports. These activities will continue to be undertaken by Shoals Rodrigues once the marine reserves have been demarcated to ensure their long-term success.

Results

The Coordinating Committee for Fisheries and Marine Resources discussed the proposals submitted by Shoals Rodrigues and approved the creation of four of the areas: Grand Bassin, Passe Demi, Anse aux Anglais and Rivière Banane. The four reserves were gazetted in Mauritius on 10th March 2007 and came into force in Rodrigues on 9th April. The reserves cover a total area of 24.3 km^2 (Grand Bassin: 14.1 km^2; Passe Demi: 7.2 km^2; Anse aux Anglais: 1.5 km^2 and Rivière Banane: 1.5 km^2) and include shallow lagoon, reef flat and reef slope habitats extending out to a depth of 30 m. Detailed surveys of two of these areas (Grand Bassin and Anse aux Anglais) have confirmed that they are suitable areas for protection. Grand Bassin has high coral cover on the reef slope (66%), with the presence of endemic species and high numbers of juvenile fish species (Winton 2006). Anse aux Anglais also has high coral over on the reef slope (>50%) and although the lagoon is badly degraded there are areas of healthy coral in the eastern part of the reserve; there are also high numbers of juvenile fish species (Jacob 2005).

The reserve at Rivière Banane was the first reserve to be established with funding from Fonds Français pour l'Environnement Mondial through the Indian Ocean Commission's programme "Réseau des Aires Marines Protégées". Seven demarcation buoys were placed around the boundary of the reserve during April 2008 by *Shoals Rodrigues* and two permanent mooring buoys were also deployed: one in the popular snorkelling site "Aquarium" and one offshore in 12 m of water. The project also involves the construction of information boards on the beach at Rivière Banane, explaining the rules of the marine reserve and the construction of a watch tower on the hill overlooking Rivière Banane. A management committee was set-up consisting of the major stakeholders, such as villagers from Rivière Banane, dive/tour operators, the Fisheries Research and Training Unit, Fisheries Protection Service, *Shoals Rodrigues*, MPA project, National Coastguard and the Environment Unit and chaired by the Departmental Head for the Environment. A draft management plan for Rivière Banane was developed in November 2007 in collaboration with all stakeholders (Gell 2007) as part of a project funded by the Darwin Initiative.

Monitoring surveys highlight the decline in the seine net fishery and suggest that the development of this network of marine reserves will promote sustainable fishing and allow fish stocks to recover (Hardman *et al*. 2008a). Habitat monitoring indicates that the reef slopes (at 6-15m depth) are healthy with high coral cover (>45%), whereas reef flats are degraded (<30% live coral cover), due to a combination of natural impacts (coral bleaching) and

trampling damage from fishers (Hardman *et al*. 2008b). The fish communities at both reef and lagoon sites are however dominated by small damselfish and large predatory carnivores are rare and indication of overfishing (Hardman *et al*. 2008b, c). These studies all highlight the need for the development of the network of marine reserves in Rodrigues. Socio-economic studies, however indicate that fishing is very important to the Rivière Banane community, with over 60% of the community being dependent on fishing for their household income (Hardman *et al*. 2006a). This suggests that the development of a marine reserve in the region will therefore have an important financial impact on a number of households and highlights the importance of involving the local community in the development of the reserves. Training and education activities have been very successful with large numbers attending the weekly fisher education sessions and the Saturday club for teenagers and over 60 people receiving training in diving and survey techniques, thus raising awareness of the importance of marine reserves around the island.

Consultation sessions have continued to be held annually by *Shoals Rodrigues* at the fishing villages in the north of Rodrigues to ensure the on-going support of the fishers for the reserves. The majority of fishers support their development; however all are concerned about their loss of fishing grounds and loss of earnings, with many asking for compensation (Hardman *et al*. 2006b, 2007, 2008d). To address this issue, the fishers in Rivière Banane have created two new Associations. These Associations, Association Pêcheurs de Rivière Banane and Ocean Tribe have been successful in obtaining funding from the Global Environment Facility Small Grant Programme to develop alternative livelihoods. The Association Pêcheurs de Rivière Banane will develop a project to raise livestock (goats, chickens, sheep and dairy cows) in a sustainable and environmentally-friendly way and Ocean Tribe will buy a glass bottom boat and start a business taking tourists to visit the new marine reserve. These projects should eventually provide sufficient income to the fishers to prevent the need to fish illegally within the marine reserve. Training has also been provided to villagers from Rivière Banane allowing them to be employed as community rangers to support the Fisheries Protection Service and National Coastguard in enforcement of the reserve regulations.

Lessons learned

The process of developing a network of marine reserves in Rodrigues has been very slow, taking five years for proclamation of the reserve to take place and as yet none of the reserves are properly established. The different projects undertaken by Shoals Rodrigues over this time highlight the importance of combining scientific data collection (biological and socio-economic) with education and awareness-raising within the local community. In particular, it is essential to include the local fishing communities in all aspects of the development of the reserves, in order to provide them with a sense of ownership. Although the majority of fishers around Rodrigues do support the marine reserves, a number of fishers are still opposed to this idea as they feel that reserves are not necessary and will result in a loss of income (Hardman *et al*. 2007, 2008d). These fishers do not want to take-up alternative livelihoods and ask for monetary compensation. Further awareness-raising work is therefore required in these villages to ensure the success of the more controversial Grand Bassin and Passe Demi marine reserves. Close collaboration with the local government and other stakeholders such as the Fisheries Protection Service, transparency of actions and clear definition of roles are also essential to the successful management of the marine reserves.

Recommendations

There are a number of challenges still facing the development of a network of marine reserves in Rodrigues. Fishers highlight illegal fishing as one of the main problems in Rodrigues (Hardman *et al*. 2006b, 2007, 2008d) and this needs to be resolved if the reserves are to function successfully. One solution that has been suggested to the Management Committee is the creation of rangers who would work alongside the Fisheries Protection Service and National Coastguard enforcing the reserve regulations. A number of fishers have already expressed an interest in working as a ranger in the reserves and preliminary training has been provided. In addition to providing an alternative income, this would also ensure effective enforcement of the reserve regulations; involving local stakeholders promotes a sense of local ownership and a sharing of responsibility and has been shown to be very effective in many marine protected areas around the world. It is therefore recommended that this system be implemented in Rodrigues.

In addition, fishers are very concerned about loss of livelihood, and suggest that if they are not provided with an alternative income they will continue to fish in the reserve areas. The alternative livelihood projects developed at Rivière Banane are running successfully, however the development of further alternative income schemes for fishers is essential. Fishers indicate that they would be happy to do other jobs such as beach cleaning, planting trees, off-lagoon fishing or would like to start up their own business (Hardman *et al*. 2007, 2008d). It is therefore recommended that assessments are made of the current economic situation around Rodrigues, to highlight current sources of income, the number of people who will be affected and highlight vulnerable groups so that appropriate alternative livelihood schemes can be developed.

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"To Live with the Sea" – development of the Velondriake community-managed protected area network, south-west Madagascar

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The original article has been published in the journal *Madagascar Conservation & Development*: Harris, A (2007) 'To live with the Sea' – Development of the Velondriake Community-Managed Protected Area Network, South West Madagascar. Madagascar Conservation & Development 2, 1:43-49. It is freely available at: www.mwc-info.net/en/services/journal.htm.

Abstract Madagascar's south-west coast supports some of the largest coral reef systems in the western Indian Ocean. These reefs not only provide critical habitat to thousands of marine species but also are essential to the survival of the indigenous Vezo people who rely on healthy marine resources for food, transport, cultural identity and income. However coastal populations are growing rapidly and international fisheries companies have begun exploiting the region's waters through a sophisticated collection network to supply an expanding export market. In recent years local fishers have begun reporting declines in the size and number of their catches.

Building on the success of a pilot marine no take zone launched three years ago in the remote fishing village of Andavadoaka, Blue Ventures Conservation (BV), Madagascar's Institute of Marine Sciences (Institut Halieutique et des Sciences Marines – IHSM) and the Wildlife Conservation Society (WCS) are now working with 21 neighbouring villages, and fisheries collection and export companies to develop a network of community-run marine and coastal protected areas that will span more than 800-square kilometres, aiming to benefit more than 10,000 people and protect coral reefs, mangroves, seagrass beds and other threatened habitats along Madagascar's south-west coast. The villages, grouped into three constituent geographic regions, have established a management committee which serves as a liaison between conservation scientists and community members, providing input and insight into all phases of conservation planning, from research activities to implementation of management plans. The management committee also selected a unifying name for the network: *Velondriake*, which means "to live with the Sea."

Along with protecting biodiversity and livelihoods, the network is working to increase environmental awareness among communities, expand local and national capacity for biodiversity conservation and serve as a model for other community conservation, economic development, and governance initiatives across Madagascar and elsewhere. Velondriake aims to benefit villages within the network by empowering members of the local communities as managers of their own natural resources, enabling communities to contribute directly to the development of sustainable resource management systems to support local culture and livelihoods. Additional benefits are being brought to local partner organisations and institutions through the capacity building resulting from involvement of their staff in the project and the improved availability of data, lessons learned and best practice guidelines.

Background

South-west Madagascar exhibits one of the largest and most biologically diverse coral reef systems in the western Indian Ocean (Cooke 2000). These reefs not only provide critical biodiversity habitats but are also essential to the survival of the semi-nomadic Vezo communities, who are completely dependent on the region's marine environments for food, transport, income and cultural identity. Vezo communities in the region of Andavadoaka, a remote village of 1,200 people located on the south-west coast of Madagascar (Fig. 1), some 50 km south of Morombe, have subsisted from traditional and artisanal fishing activities for generations. Census data collected by Blue Ventures during household surveys in Andavadoaka in 2005 show that fishing is the primary income-generating activity for 71% of the population (Langley *et al.* 2006).

Despite their enormous biological, social and economic importance, the region's marine environments are facing severe threats from climate change and direct anthropogenic impacts. Over the last decade many shallow coral reefs in southern Madagascar have suffered widespread degradation

following the mass coral bleaching and mortality event attributed to the El Niño event of 1998 (Cooke *et al.* 2003). Bleaching events have continued in recent years as a result of periods of anomalous warming of sea surface temperature. Marine surveys have revealed that following bleaching-related mortality, many of the reefs in the region have undergone a general phase shift from coral to algal-dominated habitats (Harding *et al*. 2006).

Fig. 1. Location of the Andavadoaka region, south-west Madagascar. (Imagery ESRI).

These broad-scale climatic stresses have coincided with a dramatic increase in fishing activities in recent years. Coastal population growth, and the concomitant increasing need for marine resources, has been rapid, exacerbated by high levels of migration towards coastal zones. The agricultural productivity of inland farming areas in southwest Madagascar is severely restricted on account of the region's aridity, and the rich marine resources of coastal areas in the region have long attracted people from inland farming communities on account of the presence of supplementary dietary proteins and relatively lucrative income sources.

Census data reflect this trend. The population of the Toliara region grew by 324% between 1975 and 1993 (Cooke 2000). Limited employment opportunities, combined with low agricultural productivity, resulted in a five-fold increase in the fishing population in a period of 17 years leading up to the early 1990s, causing an overexploitation of marine resources, especially near urban centres such as Toliara (Gabrié 2000). Laroche *et al.* (1997) provide evidence that over-fishing in the Toliara region has led fishers to target lower value fish in an effort to sustain yields in the face of reduced stocks of large piscivorous species. At the beginning of the new century, over 50% of the artisanal fishing in Madagascar was estimated to occur along the reef systems of the south-west (Cooke 2000). The village of Andavadoaka, at the geographical centre of this proposal's project area, has seen a doubling of population input rate (births and immigration arrivals per year) in the 10 years leading up to 2003, with over 50% of the population being aged 14 or under. Fishing is the primary economic activity for 71% of villagers (Langley *et al.* 2006).

Alongside population growth, fishing pressure has also been considerably exacerbated by commercial-isation of traditional fisheries. In recent years international seafood collection companies have developed a new and highly lucrative fisheries market for a wide range of seafood products throughout the region. Commercial collectors and exporters first arrived in villages in the project area in 2003, bringing a more easily accessible and higher paying market for fresh octopus and large reef and pelagic fish species (L'Haridon 2006).

Although fishing methods are still traditional, the recent introduction of market exports for fresh seafood products, as opposed to the traditional dried and salted fish market, has led to an increase in the value and exploitation of target species. This increase has been accompanied by a change in recent years from a largely barter and subsistence economy to a fisheries-dependent cash-based economy. The dramatic increase in fishing intensity seen in recent years has raised concerns amongst local communities and conservation groups of direct reef damage and overexploitation.

Working in partnership with the University of Toliara's Institut Halieutique et des Sciences Marines (IHSM), UK-based NGO Blue Ventures Conservation commenced monitoring the region's marine environment in 2003, with the establishment of a field research station in the village of Andavadoaka.

Progress towards community management

Vezo communities in Andavadoaka and surrounding villages understand that the livelihoods and economic security of community members are inextricably linked to the health of local marine ecosystems. Local fishers have reported observing marked declines in catches over the last decade, and since 2003 discussions have taken place between the Andavadoaka community and Blue Ventures regarding the development of a marine protected area in the region. When engaging the community in discussions of this nature it has been critically

important to avoid the proliferation of misconceptions amongst local fishers of the function and benefits of protected areas. Furthermore, it has been important during all discussions regarding marine conservation issues to avoid the alienation of fisheries collection and export companies, which represent the largest economic force in the region.

Considering the economic needs of the village, it was considered of paramount importance that management approaches began with a pilot protected area scheme that had the potential to offer relatively immediate economic rewards in order to provide potential incentives for establishing further protected area trials. A management scheme for the octopus fishery, aiming to provide both economic and ecological benefits, was therefore selected as the most appropriate starting point for conservation planning, since octopus is currently the most important marine resource for the economy of many fishing communities in the region, accounting for over 70% of marine produce purchased by commercial fisheries collectors in Andavadoaka (L'Haridon 2006).

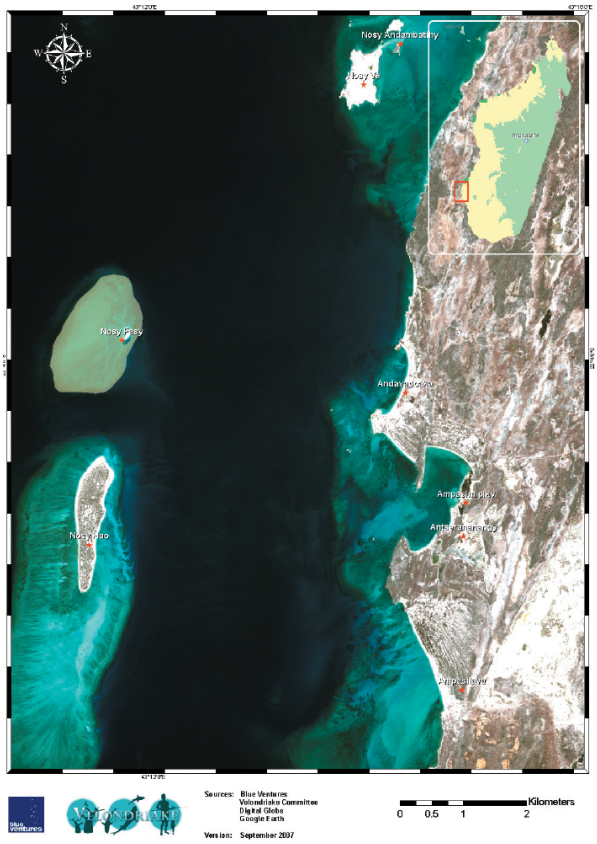

Fig. 2. Location of the trial octopus no-take zone at Nosy Fasy (Imagery Digital Globe).

Between October 2003 and October 2004 meetings were held with both female and male fishers in Andavadoaka to discuss fisheries data, community perceptions of the state of fisheries and marine resources, and options for management. In October 2004 a Dina, or local law, was decided upon by the village, agreeing to the closure of the reef flat around the sand cay of Nosy Fasy, a 200 hectare barrier island located 7 km offshore due west of the village, for a period of 7 months commencing November 1st, 2004 (Fig. 2). The fishing restriction applied only to all forms of octopus fishing; fishing for other species, such as reef fish, was allowed to continue. Although a popular fishing site for octopus before the closure, the loss of the Nosy Fasy site to octopus fishers during the closure period represented an estimated reduction of only approximately 15% of local fishing grounds. A guardian was employed by the village fisheries cooperative to prevent poaching. Fishers worked together with village elders and representatives of Blue Ventures, the Wildlife Conservation Society (WCS), fisheries collection company Copefrito, and the IHSM to produce the Dina.

The primary goal of the no take zone (NTZ) was to trial a conservation intervention that might serve to improve the sustainability of reef octopus *Octopus cyanea*, the village's most important commodity. Village elders and local fishers combined their traditional knowledge of fishing activities with fisheries data collected by Blue Ventures to implement a seasonal fishing ban aiming to allow octopus to grow in size and number, in order to produce greater yields for local fishers when the ban was lifted. Results from the first experimental closure, implemented between November 2004 and June 2005, showed that the number and average weight of octopus caught by villagers was significantly greater after the closure and when compared to control sites (Humber *et al.* 2006). In addition the Ministry of Fisheries consulted project results in creating new fisheries legislation for an annual six-week closed season for octopus fishing across the south-west of Madagascar country starting in December 2005.

Despite the positive fisheries effects of the trial NTZ, catch per unit effort did not increase as expected after this trial closure; an unanticipated outcome attributed to intense over-harvesting of octopus by visiting migrant fishers ("freeriders") on the days following the NTZ's reopening. Notwithstanding this issue, following presentation of the results of the programme to communities throughout the Andavadoaka region, Andavadoaka and neighbouring villages requested support in adopting this model for octopus fisheries management in order to pursue further NTZs as a means of restoring stocks and providing some protection for the shallow water reef habitats upon which much the region's economy depends. By early 2006 a series of three short-term octopus NTZs had been implemented, including a re-closure of the first trial NTZ at Nosy Fasy. This groundswell of community interest in developing marine conservation programmes led to an unprecedented opportunity for villagers to work together to develop a broader network of marine and coastal protected areas.

Between July and October 2006, representatives of 23 coastal villages, from Bevato in the north to the Baie de Fanemotra in the south, along with facilitators from Blue Ventures and WCS, came together in Andavadoaka to propose develop a series of maps of suggested protected areas and other conservation reserves aimed at protecting local marine and coastal ecosystems and promoting sustainable resource use (Fig. 3). In total, communities proposed eight marine zones encompassing lagoon patch and fringing reefs for permanent closure as marine protected areas (MPAs); 16 reef flat zones for temporary closure as octopus NTZs; three mangrove protected areas; one intertidal lagoon zone with restrictions on seine fishing for protection of seagrass habitat; one special management area for aquaculture trials near Andavadoaka; one special management area for ecotourism in Andavadoaka; and three terrestrial areas for protection of baobab trees *Adansonia grandidieri* within selected areas of dry forest habitat. It was agreed that an approximately rectangular envelope, encompassing all of these special zones, would comprise the management boundary, within which additional regulations governing resource use and access would apply. The network was named 'Velondriake', which means 'to live with the Sea'.

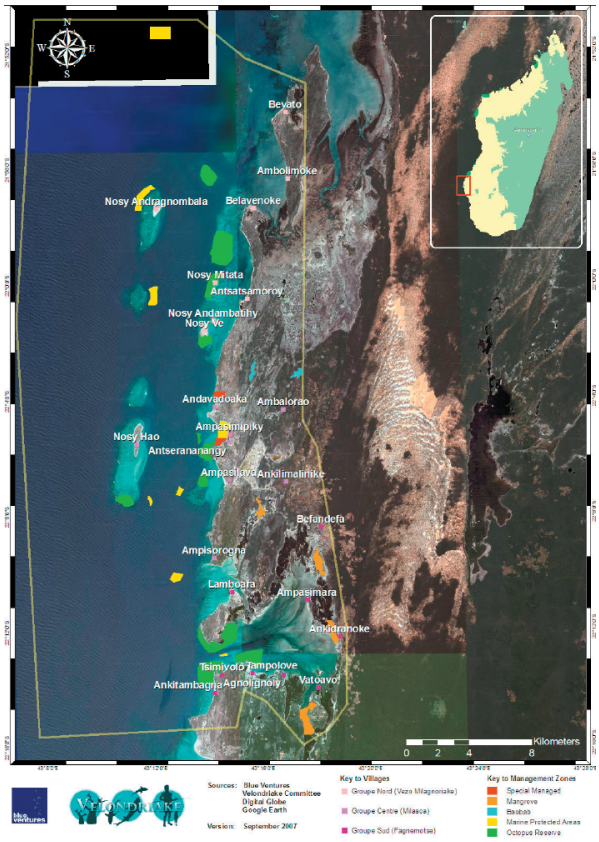

Fig. 3. Location of protected areas and special management zones within the Velondriake network, September 2007 (Imagery Digital Globe and Google Earth).

The proposed Velondriake management envelope containing all individual proposed protected and managed habitats equals 823 km^2 in size, covering over 40 kilometres of coast (see figure 1). Within this area, 20.06 km^2 (2.44% of the total management area) comprise specific protected or special management areas. Of this, 12.56 km^2 (approximately 15.61% of the total 80.47 km^2 of reef flat located within the management envelope) constitute proposed seasonal NTZs for octopus fishing; 3.75 km^2 constitute proposed permanent coral reef marine protected areas; 2.67 km^2 constitute proposed permanent mangrove protected areas; 0.55 km^2 constitute proposed permanent terrestrial forest protected areas; and 0.23 km^2 and 0.27 km^2 constitute proposed special management areas for marine aquaculture and ecotourism development respectively.

In August 2006 meetings took place in Andavadoaka to discuss the creation of a management committee to include representatives from surrounding regions to oversee the protected area planning process. The committee was to be supported and elected by members of three regional sub-committees (Vondrona), split geographically between the northern, central and southern regions of the protected area network. It was agreed that one or more representatives from all villages within the Velondriake network would be members of the Vondrona subcommittees, representatives being chosen by election in their respective villages. The northern group, Vezo Milagnoriake, comprises nine villages from two administrative regions, or Fokontany, from Andavadoaka to Bevato. The central group, Milasoa, comprises five villages from two Fokontany in the region surrounding Andavadoaka. The southern group, Fagnemotse, comprises nine villages from four Fokontany in the region between Andavadoaka and the Baie des Assassins.

The Velondriake and Vondrona committees' status was formalised at a series of meetings in Andavadoaka in October 2006 with the election of committee members, approval of the Velondriake Dina, and development of a preliminary action and management plan for the protected area network, identifying the overall goal and specific objectives of the initiative. The committee now serves as a liaison between communities, scientists and representatives of conservation NGOs, providing input into all phases of the conservation work, from research activities to the implementation of management plans.

Aims and objectives

The primary goal of the Velondriake network, as stated in the preliminary management plan, is to protect marine and coastal biodiversity while improving livelihood sustainability in the Velondriake region.

Within this goal a number of specific objectives have been identified associated with the development of the protected area network. These include:

developing the capacity of Velondriake's local and regional management committees for self-management; promoting communication, solidarity and coordinated environmental management planning between villages; and diversifying local economies through the promotion of ecotourism and the development of mariculture as an alternative income source in Velondriake villages.

Crucially, the management plan focuses on empowering local communities as managers of their own marine resources, able to contribute directly to resource management plans aiming to support local culture and livelihoods.

Monitoring and assessment

Community members are receiving training and support from partner conservation organisations to monitor the network to ensure that conservation strategies are being implemented, raise awareness amongst fellow community members about the potential economic and environmental benefits of biodiversity conservation, and gather data on species health and socioeconomic indicators to measure conservation success.

Fisheries monitoring

Monitoring of fisheries within the Velondriake region is critical to developing understanding of the impact of no take zones and fisheries management plans on local stocks. Monitoring of octopus and fin-fish fisheries in the region commenced in 2004, and in 2006 this was expanded to include landings by local shark and marine turtle fisheries. Local women and fisheries collectors are trained and employed by Blue Ventures to carry out surveys of landings and catches throughout the year, recording additional fisheries data including gear types and catch locations. The continuous monitoring of the fisheries over time will provide greater understanding of the impacts of the industry on the local marine resources, and ultimately allow for more specific and effective management techniques to be employed.

Ecological monitoring

Velondriake's partnership with established conservation groups is helping gather critical information on local marine species and habitat status. A long-term regional coral reef research programme, monitoring changes in the status and biodiversity of reef sites, has been developed in the region since 2003, incorporating reef habitats both within and outside protected area zones. Data gathered are shared with the IHSM and international marine research networks to assist in marine research and conservation efforts. Additional ecological monitoring is carried out at seagrass and mangrove habitats, as well as within the deciduous dry 'spiny' forest habitats. Since October 2006, project partners have been in the process of monitoring proposed sites to finalise the location and zoning plans for the protected areas within final management plan for Velondriake.

Socio-economic monitoring

Since 2005 socioeconomic research has been carried out in Andavadoaka and the two neighbouring villages of Ampasilava and Lamboara, in partnership with a regional Western Indian Ocean coastal socioeconomic monitoring programme coordinated by the CORDIO network (Coral Reef Degradation in the Indian Ocean). Following a training workshop in Andavadoaka in 2006 to involve local communities in the monitoring programme, this programme has been expanded to cover 10 of the total 21 villages within the Velondriake network. Communities within the Velondriake region vary widely in terms of size, ethnicity, and environmental locality; the latter category comprising villages situated on offshore islands, inshore coastal habitats, sheltered deltaic mangrove environments and inland dry forest habitats. Fishing practices, target species and market access all vary widely between villages. The main objectives set out by the Velondriake socioeconomic study are to establish an understanding of the current socioeconomic status as a reference for future change, and to understand community attitudes to management methods, and the perceived impacts that these measures have on communities. Knowledge gained from this monitoring programme will enable future marine resource management plans to be tailored to local situations, whilst aiding the development of effective environmental education programmes.

Results and lessons learned

The experimental NTZs piloted in Andavadoaka showed that short-term closures of reef flats to octopus fishing can lead to an increase in the number of octopuses fished once a closed area is reopened. The observed increase in mean weight brought about by the closures means that fishers, who are paid by the kilogram of wet weight of octopus, increased their earnings. Furthermore, increasing the average size of the octopus population is likely to also increase its reproductive output. Results have confirmed that decreasing fishing intensity on the opening days can increase the duration of fisheries benefits from the NTZs (Humber *et al.* 2006).

Perhaps more importantly than their direct impact on fisheries, the development of pilot NTZs in Andavadoaka, targeting a single species in one specific shallow marine habitat, has served as a highly effective learning experience for conservation practitioners and communities throughout the Velondriake region. Through the trial NTZs, local fishers have been able to see how conservation activities can improve octopus populations and lead to greater fishing yields. Consequently less than two years after it was first implemented the pilot NTZ project has precipitated broad-scale community support for the proliferation of NTZs for fisheries

management across a much wider region. Moreover, increased awareness of the potential benefits that can be derived from conservation tools such as the NTZs, brought about by efforts to communicate and share results from the first trial NTZs, has given rise to community support for the development of other broader-scope management interventions, including permanent protected areas covering a range of marine, coastal and terrestrial habitats.

In line with requests from all communities within the Velondriake network, partners must now focus on the development of a coordinated environmental education and awareness-raising programme, aimed at all ages of society, in order to provide local stakeholders with the tools, training and institutional capacity needed to monitor and manage natural resources.

Support for Velondriake across the wider region has been borne out of the development of long-term working relationships between conservation groups, communities and other stakeholders, based on perseverance, commitment and transparency between parties. The readiness of fisheries collection company Copefrito to be fully involved in conservation planning, in particular supporting the trialling of NTZs and sharing company fisheries data, has led to the evolution of a highly effective multi-stakeholder partnership through the course of the project. This, along with the permanent presence since 2003 of Blue Ventures' field research station in the region, has undoubtedly been instrumental in developing mutual understanding and trust between conservation groups, community leaders and fisheries companies, in turn strengthening the credibility of proposed conservation interventions. The successful continuation of these partnerships depends on maintaining regular communication and dialogue between all parties.

The bottom-up approach to marine and coastal conservation adopted by the Velondriake project to date has so far worked effectively in producing a community-endorsed blueprint for the first network of marine and coastal protected areas in southern Madagascar. Whilst the precise circumstances of this project may not be replicable directly beyond the semi-nomadic Vezo communities of the Andavadoaka region, the community-management and partnership processes employed in the project's development will provide Madagascar's first potentially replicable model for community-centred marine and coastal conservation planning. In doing so this initiative is expanding national capacity for biodiversity conservation, and improving the availability of data, lessons learned and best practice guidelines. Throughout the Velondriake project technical reports and policy briefs are made available to local and national government, research groups and NGOs, as well as relevant international networks, to raise awareness of the initiative wherever appropriate.

Fig. 4. Fishers landing catch of *Octopus cyanea* following reopening of Nosy Fasy no-take zone.

It remains to be seen what the long-term ecological and fisheries effects of the octopus NTZs will be, since both the short- and long-term effects of the permanent protected areas and other managed zones within the expanded Velondriake network remain unknown. Although encouraging, the rapid growth in the number, area and nature of the reserves incorporated within the network has meant that the detailed, rigorous monitoring, community liaison and feedback that were prioritised throughout the first experimental NTZs cannot be continued at the same focused level across the broader Velondriake region, due to fundamental limitations of human and financial resources available for the project. Although members of the management committees and partner organisations contribute considerable time freely to the initiative, unavoidable core management, communication, monitoring and travel costs, as well as salaries of collectors involved in monitoring catch landings, constitute significant financial overheads to the project in its current form.

If Velondriake's objective of promoting long-term sustainable management of marine and coastal resources is to be realised in the medium to long-term, communities must be empowered with skills and resources to manage and monitor resources without direct NGO leadership and donor financial support. There is currently no financial model in place to enable Velondriake communities to independently meet the costs of capacity building, monitoring and management of the Velondriake network. Consequently the project depends on external support from partners. This dependency poses a fundamental limitation to the financial sustainability of the network. Without the development of a management fund, supported and maintained by communities, local cooperatives and/or fisheries collectors, and fairly administered by the Velondriake management committees, Velondriake's continued success will remain at risk to the withdrawal of partner aid.

During the Velondriake zoning meetings held in Andavadoaka, communities recognised the importance of incorporating marine, coastal and terrestrial areas that have the potential to attract tourists to the region. Ecotourism does not have the potential to offer as reliable or potentially as great a source of income to local villagers as fisheries products. However, it represents a potentially more sustainable non-extractive use of reef resources that could deliver sufficient income to promote the management of protected areas. Vezo communities in the Velondriake region have few resources other than the sea that they can utilise to generate income, and at this point in time have only extractive options for resource utilisation. With a growing market of tourists arriving in Andavadoaka the potential exists to incorporate local villagers into this expanding service industry and for local communities to obtain substantial economic gain in doing so. By demonstrating to local villages that coral reef and other marine and terrestrial resources can be used to generate income from non-extractive activities, whilst also simultaneously achieving conservation and fishery benefits, protected areas have the potential to provide a greater appreciation for, and understanding of, natural resources within the region. The need to develop Velondriake's capacity to receive, host and guide ecotourists has led to the development of a community eco-guide training programme, and plans for construction of a community-run eco-lodge, which will be fully owned and managed by the village of Andavadoaka, and occupied in part by visitors brought to the region by Blue Ventures' existing ecotourism programmes, which currently account for over 7,000 tourist-nights to the village each year.

Notwithstanding the manifest benefits of community management within Velondriake, the project remains vulnerable to forces beyond local community control. Despite encouraging community support of, and adherence to, local management plans, villages have no assurance that the local laws established during the creation of Velondriake will be either known to, or respected by, outside or migrant resource users. Commercial fishing trawlers operate with increasing frequency within Velondriake's shallow waters, irrespective of fisheries restrictions that have been agreed by local resource users. Similarly, outside investors seeking to acquire and develop land within the Velondriake area are able to do so without consulting the Velondriake committees in their current form. Plans for major tourism developments within the Baie de Fanemotra are currently being proposed with negligible consultation of communities living within the bay. Such activities pose an insidious and potentially damaging threat to traditional livelihoods, as well as the health of local coral reefs and related marine ecosystems. As such there remains a critical need to communicate and strengthen local environmental governance structures and management plans at a regional and national level, in order that relevant governmental departments can play their role in supporting and safeguarding Velondriake, through reinforcement of the legislative status of this pioneering initiative.

For regular research reports and more information please visit:

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Three decades of NGO activism in marine conservation in Mauritius

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Abstract The Mauritius Marine Conservation Society (MMCS) has been active for almost 30 years in marine environmental activism. With a small core of active members, never exceeding 75, and including both scientists and non-scientists, the MMCS has contributed to the creation and management of MPAs in Mauritius. The successful 20-year struggle for the proclamation of MPAs was only a first step in conserving biodiversity and providing reserve areas for maintaining fisheries resources. In Mauritius an extremely limited area of inshore marine habitat is being preserved – the areas preserved serve mainly to sensitize the public and visitors to the value and beauty of the coral communities. The management of the marine parks in Mauritius has been inadequate and does not involve local communities despite efforts by civil society to contribute. This paper describes 30 years of activism regarding the creation and management of marine parks in Mauritius.

Introduction

Human societies generally manage the marine environment with ignorance, since Man is a terrestrial organism and does not live in water so has no innate understanding of how the marine environment functions. This is especially true in the island of Mauritius where the majority of the decision-makers do not know how to swim, never venture out to sea nor have any empathy with marine life. There are however, some people in Mauritius who live on the coast, own boats and fish or dive. But it is generally not these people who make the laws and they generally have little political voice or influence.

Those who often make the best advocates of good management practice are those who have witnessed the consequences of bad management practice at first-hand. Thus it was with the creation of the first non-governmental organisation (NGO) in Mauritius concerned with the protection of the marine environment – the Mauritius Marine Conservation Society (MMCS). The Mauritius Underwater Group (MUG) had been formed in 1964 some years after the first self contained underwater breathing apparatus (SCUBA) had been brought from Europe and for many years these pioneer divers explored the lagoons and reefs of Mauritius. It must be said that many of them hunted fish with spearguns and pillaged the historic wrecks, but it also allowed people to observe marine life in its natural habitat for the first time. And so it was that some of these divers started to realise that they were seeing fewer and fewer big fish on the reefs. The large, territorial reef species were quickly shot out by SCUBA spearfishermen. Then came dynamite-fishing in the 1970's and 1980's. The divers visited sites only to find parts of the reef destroyed and at night-time along parts of the coast one could regularly hear explosions and see the pirogues with lamps, collecting the dead fishes.

So, 30 years ago, a few courageous divers discussed what to do and finally decided that enough was enough! They thus created an NGO for the protection of the marine life. Their diving colleagues laughed at them and wouldn't stop using their spearguns until slowly they too realised that the effects of spearfishing and collecting live shellfish were adding to the destructive effects of dynamite and seine netting. In addition, when turtles and marine mammals ventured into the lagoons, they were regularly killed by fishermen. The latter also removed corals in large quantities and dried and dyed them to sell to tourists who had just started appearing at a few coastal hotels.

Achieving the aims and objectives of the MMCS

The MMCS was thus created by a core of divers who had first-hand experience of the effects of over-fishing and the deterioration of marine environment, not by biologists or conservationists. All of the members were and are volunteers who work on marine conservation issues. They formulated clear and simple objectives:

1. To promote an awareness and appreciation of marine life and an interest in the need for marine conservation in Mauritius.
2. To arouse an interest in the creation of marine parks to regenerate marine life and also to serve recreational and educational functions.
3. To encourage the public and visitors to respect laws relating to all aspects of the protection of

marine life, the marine environment and the preservation of underwater sites of archaeological interest and value to Mauritius.
4. To induce Government to enforce existing laws controlling spearfishing, dynamite fishing, shell and coral collection, net fishing, aquatic pollution and the general destruction of the reefs.

Three aspects are noteworthy:
1. the implication that Government was not enforcing laws,
2. the implication that the public was not aware of the laws, and
3. the early importance accorded to the creation of Marine Parks.

Thirty years later, these three aspects remain priorities for the MMCS – the education of all Mauritians, including the political decision-makers or perhaps especially the political leaders, and the need for marine protected areas. Recently the MMCS revised the Aims of the Society and surprisingly there were very few changes – where we talked about "creating" marine parks 30 years ago, we now talk about "creating and managing" protected areas, but our motto remains "Conservation through Education".

If we reflect on these aims, is it not remarkable that an NGO has been successfully operating for three decades with a mission to induce Government to enforce the laws? Why has it been necessary for the MMCS to mobilise resources to pressurize the government to do this? As a short answer, we recall a meeting in the early 1980's when the Ministry of Agriculture & Fisheries had accepted to meet the MMCS representatives about dynamite fishing although government officers denied that dynamite fishing was a widespread problem. The officials said that since it was illegal to possess dynamite, it was not an issue. At the meeting the MMCS presented the officials with a bag of dynamite which had been bought the week before, openly from fishermen. The shocked officials were shamed into action and dynamite fishing came to an end effectively by 1986. But the MMCS's first poster "*Proteze ou la mer*" printed in 1987 mentions dynamite fishing, showing that it was still an issue in the public perception, even then.

The same was true for spearfishing and shellfish extraction; the MMCS embarked on public sensitization programmes which were aimed mainly at educating the politicians, and this finally contributed to persuading the Government to pass laws to make these activities illegal, the former in 1984 and the latter in 1988. However, in both cases, the practice of shellfish removal and spearfishing, are still widespread. The MMCS regularly raises this with the authorities, but spearfishing especially is rampant, and the MMCS has evidence of the symbiotic relationship of the Coast Guards and such illegal activities.

This raises the whole issue of the role of NGOs in lobbying and campaigning on two levels, for:
1. the creation of laws, and
2. the enforcement of existing laws.

In the experience of the MMCS, it is often easier to convince the authorities to make a law than to enforce a law. This is, in our analysis, simply because a politician gains more stature in the public eye, and an image of being an active parliamentarian and a "do-er" among his colleagues, if he contributes a law rather than asking the Police or an enforcement agency to act. By enforcing a law, such an action will require time, money and effort on behalf of the agency, and it will invariably result in a negative action against someone. Such actions are generally unpopular, and politicians do not like being unpopular.

Marine parks – initial pressure

When we look at the creation of Marine Parks (or marine protected areas (MPAs), it is illustrative of the above principle. Although the creation of parks took a very long time to achieve, it was an easier step than encouraging the authorities to enforce the law and to manage the MPAs. The MMCS began in the mid-1970's to speak out for the creation of marine parks. At that time, in the Western Indian Ocean Region only some East African countries had MPAs. "Fishing Reserves" did occur in many countries including Mauritius, and were well controlled particularly in South Africa, Mozambique and Namibia on account of their powerful fishing industries.

In Mauritius what would have been the motivation for creating MPAs? It was clear that there was no particular political gain to be made out of declaring a MPA in Mauritius, which perhaps explains the absence of political will. However, there was a disastrous situation of over-fishing in the lagoons and there was a nascent tourist industry, both of which would benefit from properly managed MPAs. It had been shown that the lagoon fish resources were being exploited at far above their maximum sustainable yield (Ardill 1983) and lagoon yields had dropped from 2,120 tonnes in 1977 to 1,300 tonnes in 1985 (Government of Mauritius, 1991a).

Procter and Salm (1974) made the first formal proposal to create marine protected areas in Mauritius. They advocated that Balaclava Bay and Blue Bay be established as marine parks on the basis of their diverse coral communities. Some of the "Outer Islands" were also mentioned but although officers of the Ministry of Fisheries were in regular contact with international scientists of ORSTOM, IFREMER, FAO and IUCN among others, they did not put forward any local initiatives to create MPAs. However, the message was received by the politicians and civil servants and from then until the late 1990's, government officials would trot out that these two sites were on the list to be proclaimed as marine parks. No more precise study was conducted to determine the location and size of protected areas required. Since there was no appropriate legislation under which such

areas could be proclaimed and managed, the government stalled.

The UN Conference on the Environment in Rio de Janeiro in 1992 was an impetus to take stock and take environmental issues forward, and there was a stated intention by Government at this stage, to proclaim properly managed areas on land and in the sea, in which biodiversity could be protected. The Rio Conference led to a new law, the Environment Protection Act (Government of Mauritius, 1991b) promulgated in 1992 which was proactive in establishing the principle of environmental impact assessment, but did not include the means to create and enforce biodiversity reserves. The UNESCO Man and the Biosphere (MAB-UNESCO, The Man and the Biosphere Programme 1970, http://unesco.org/mab/mabProg.shtml) land reserve at Bel Ombre/Bassin Blanc, which had been "established" in 1974, remained totally unmanaged. Instead Government instituted a system of including a wide variety of organisations to participate in establishing a Reserve – the concept of MAB reserve areas – including all stakeholders. However, through lack of clear leadership, the idea did not take root. The Rio Conference did however, stimulate the passing of a new law, which enabled the proclamation of the first National Park in the republic - the Black River Gorges National Park - (Government of Mauritius, 1993a). The scene was set for the creation of the first Marine Park.

Marine parks – the pressure mounts

The MMCS kept the issue alive during the 1980's through slide shows in schools, community centres and public talks. The MMCS magazine "*Diodon*" from this period contained articles on MPAs and on several occasions the issue was raised in the island press, in discussions with politicians, and in the Legislative Assembly. When it was clear that there was no political will to declare MPAs, the MMCS changed strategy – two alternative strategies were considered:

1. to approach the end-users of lagoons and reefs i.e. the fishing communities themselves, and
2. to approach companies that operated adjacent to and in the lagoons,

with the aim of convincing them to act as protectors of the marine ecosystems. For practical reasons, it was decided to approach a private sector company which leased land at the pristine Blue Bay and which used the resources in the lagoon for tourism. The proposal was drawn up and presented to their Managing Director, to establish a "Marine Garden" area in the lagoon and an Education Centre on the land. Guided snorkelling trails would be laid out underwater and visitors would be briefed in the Education Centre. The MMCS would assist with setting up the entire scheme, delimiting zones and training the guides. Without needing any permissions from the authorities, the company would permit its clients to conduct only certain activities in the water, they would monitor the condition of the corals and other marine life in the protected zone, and the company would zone the bay and regulate access – for their clients only of course, not the general public – it was hoped that this would create a *de facto* MPA. An ambitious idea but after consideration the company decided not to proceed. The reason was clear – the company believed that the bay was for the Government to conserve and not them. They further believed that if they started such a system, it would work well and then attract the jealousy of the authorities who had not shown itself to be capable of creating MPAs. Anxious to minimise their interaction with Government, the proposal foundered.

The MMCS thus returned to mobilising public opinion about the creation of MPAs and targeting the local political leadership and international opinion. The methods employed were:

1. local press articles on MPAs and the need for them in Mauritius,
2. public talks on MPAs and their benefits and attractions,
3. meetings with political leaders to discuss MPAs,
4. participation on the National Environmental Committee.

During this period, the MMCS and the Society for the Preservation and Conservation of the Environment (SPACE) campaigned to stop drift-netting, a particularly destructive form of fishing. Our efforts were met with success and a law was passed (albeit not widely enforced) which made such fishing illegal (Government of Mauritius, 1993b). The MMCS took the opportunity again to stress the need for adequate protection of Mauritian inshore marine resources.

In addition, when in 1995 the World Bank sponsored an international study on MPAs, which was carried out by the IUCN and the Great Barrier Reef Marine Park Authority (Kelleher *et al*. 1995), the MMCS presented data for the Western Indian Ocean, and we strongly recommended that the Mauritian Government create MPAs around:

- the northern islets of Coin de Mire, Round, Flat, Gabriel and Serpent islets,
- the lagoon and fringing reef off the south-west of Mauritius, with the Black River National Park on land,
- the Cargados Carajos archipelago,
- the Chagos archipelago (which although forming part of the British Indian Ocean Territory (BIOT) was part of Mauritian territory and over which Mauritius enjoys fishing rights)

These areas contained high biodiversity, were relatively undeveloped territories and had the physical size and resilience to sustain biodiversity. For educational purposes the proclamation of Blue Bay and Balaclava Bay as MPAs was also supported. The MMCS called for the delimitation of MPAs according to ecological and biological reasons, not purely political or administrative ones.

In 1996 the call for MPAs in Mauritius was becoming a clamour. The popular press repeatedly carried articles calling for MPAs, and the tourism industry was subjected to pressure from European clients who were shocked at the neglect of the lagoon and reef environments. The situation had become farcical whereby the hotel owners at Balaclava Bay printed "Marine Park" on their brochures and even their invoices, as if the area was a MPA whereas it lacked any meaningful management or protection, with boats, skiers and fishermen in happy anarchy.

However, one Sunday afternoon MMCS representatives were invited to the home of the Minister in charge of the dossier on MPAs, in order to discuss the creation of marine parks – for a couple of hours we outlined the benefits of proclaiming and managing such areas. There was already a department of officers at the Ministry and there was a Management Plan for Blue Bay (drawn up, unfortunately, without any input from non-government stakeholders), there was a certain management infrastructure, and there were financial resources. Why not go ahead? A few weeks later it was announced that two marine parks in Mauritius were to be proclaimed – in October 1997, nearly 20 years after the MMCS had been set up, partly in order to campaign for the creation of such marine parks.

Marine parks – the end? Or the beginning?

The MMCS was pleased that the battle to create MPAs had been won, but that for proper management was only about to begin. It was not clear at the start how far the Government were prepared to involve non-government sectors and stakeholders in the management of the MPAs. So the MMCS had repeated contacts with the Fisheries Department concerned, which appeared amenable to including civil society participants in the monitoring, management and even the enforcement side of activities at the Marine Parks. However, no concrete action was ever taken.

Balaclava Bay Marine Park was a failure. MMCS made an underwater film there in 1998 which showed the state of the *Acropora* coral communities − completely ravaged by physical destruction as well as choking filamentous algal populations. Shellfish, particularly *Tridacna* sp. clams (*benitiers)* were heavily harvested by local fishermen and fishing with *casiers* (fish traps) and lines took place openly and intensively. When Procter and Salm (1974) had surveyed this bay in the mid-1970's, it was inaccessible to cars and was a spectacular and relatively pristine inshore ecosystem. Two decades later, there were four successful hotels on the coast there, disgorging tourists who practised watersports throughout the area. The MPA was on paper only; there was no management infrastructure and no attempt was made to implement any real zoning, local sensitization of fishing communities or boaters; no mooring buoys were deployed; there was no education of tourists.

Some months after the proclamation of the Marine Parks, the MMCS was once again campaigning. A private company had been given permission to extract 1.5 million m³ of sand from off the west coast of Mauritius. After militant action, the MMCS and sister-NGOs managed to persuade the Government to stop the extraction, which was menacing the stability of the west coast lagoons. Although the extraction of coral sand by hand and pirogue continued for a while after this before also being banned, this event had a large psychological impact on the public and the politicians. It was the first time in Mauritius that e-mail had been used to lobby international opinion for the protection of the environment, and with divers stressing the impact of sand extraction on tourism, the public was happy to see the extraction stop.

Following this, the MMCS organised a "National Marine Environment Press Award" event and spoke to the public and press about the management of marine parks. MMCS then embarked on a campaign to seek inclusion of non-governmental representatives in the management of MPAs, and a formal proposal was sent to the authorities about including civil society stakeholders in the management of the Marine Parks. MMCS was convinced that volunteers from the community could play an important role in the management of MPAs as "park rangers" assisting with policing, monitoring and guiding in the park. A "Marine Parks Authority" structure was suggested to manage the Marine Parks, directed by an Executive Board comprising eight members, four from Government departments, and three or four from civil society, with a Chair who had experience of management and marine areas:

- Chairman appointed by the Prime Minister,
- Permanent Secretary of the Prime Minister's Office,
- Director of the Environment,
- Director of the National Parks & Conservation Service,
- Principal Scientific Officer, Albion Fisheries Research Centre,
- Representative of environmental NGOs,
- Representative of fishing communities,
- Director of Ahrim (Association of Hoteliers & Restaurateurs of Mauritius)

A set of Management Principles and a structure for operational and strategic management were proposed. The main thrust was to distance the Ministry of Agriculture from day-to-day operations but to leave the ministries with strategic direction, and to include civil society and private sector in the operations. Confusion of mandate and competition between the Environment and Agriculture Ministries was also a major issue, which was resolved by removing both from operations but combining them in strategic issues (Fig. 1).

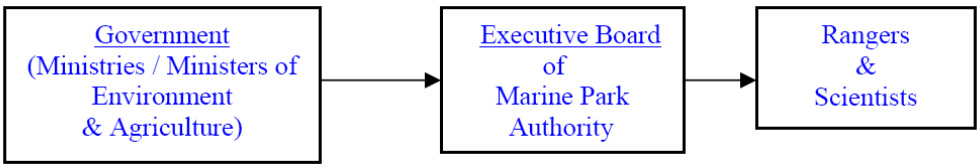

Fig. 1. Management structure for Mauritius Marine Parks proposed by MMCS.

Finally, a "Round Table" on MPA management was organized to which a wide range of stakeholders were invited – the managers of the Marine Parks from the ministry, NGOs and representatives of the tourist and fishing communities – as well as journalists. The park managers brought to the discussion the management plans and the group of about 50 interested and dynamic people brainstormed, dissected and discussed why the Marine Parks were not working. This seemed to break down many barriers and was widely reported in the press. Since people from all sectors were present, all stereotypes could be attacked, viz:

- The politicians will only act if there is money in it for them,
- The *fonctionnaires* (civil servants) will never act because the government service is not dynamic,
- The academics do not apply the results of their research or bring their knowledge into the real world,
- The NGOs are interested only in halting all development,
- The economic operators – fishermen, hotels etc. – are selfish and driven only by profit, and
- The public are apathetic and couldn't care less!

Although the discussion was vivid yet afterwards, it was apparent that since the Government owned and controlled the MPAs they remained in the driving seat.

From here on – the future …

Despite this initiative, no effective management seemed to be happening on the ground. Then there was an event which changed much – the proposed building of "Follies Hotel" on an islet in the middle of the Blue Bay Marine Park. As Sénèque (2002) stated some time afterwards: "*Le cas de BlueBay est un exemple désolant - et typique - de laisser-aller de la part de nos gouvernants, de négligence de la part du public en général et surtout de l'insatiabilité des développeurs pour les profits rapides envers un patrimoine naturel qui n'a pas cessé d'émerveiller jusqu'à ce jour spécialistes du monde sous-marin et profanes.*

Tous les éléments étaient réunis à Blue Bay pour en faire un site de rêve – une baie protégée par un récif de corail qui la met à l'abri des assauts de l'océan et comporte une étroite passe donnant accès à la haute mer. A l'intérieur du lagon, touchant presque le récif, un îlot boisé d'environ 4 hectares, oasis de verdure posé sur la mer turquoise. Et au centre de la baie, entre l'îlot et le littoral, une agglomération de massifs coralliens hors du commun, le fond marin étant recouvert d'une couche de coraux vivants dont la densité les rend uniques et permet de classer ce site parmi les meilleurs à l'échelle mondiale."

Once again, NGOs took up the battle to stop a project which was judged to pose significant risks to the marine environment and biota of the Marine Park – EcoSud in collaboration with MMCS, which carried out a scientific appraisal of the situation, managed to stop the project. Once again, the press played a major role in sensitising the public and through them the political decision-makers.

The Marine Parks in Mauritius continue, in the opinion of the MMCS, to be managed in a sub-optimal manner, despite the Regulations which were gazetted in 2002 (Government of Mauritius, 2001). Where are the education facilities, where are the guides? What monitoring occurs and how is the ecology of the MPAs changing? Why is civil society and the productive sector not involved in the management of the MPAs?

The challenges

Where are the MPAs that will ensure some kind of sustainable maintenance of biodiversity and fisheries resource exploitation? The area of Mauritius's marine environment that is protected remains negligible. The development pressure on the coast in Mauritius is staggering. When EIA permits are granted for development projects which hold risks for the marine environment, what conditions are attached to the granting of the development permit? Who monitors compliance to these conditions?

At present in Mauritius, there is an extraordinary situation regarding sea-cucumbers (*bambaras*). Cabinet agreed to a virtually uncontrolled exploitation of these animals (Echinodermata: Holothuroidea), and there is currently no restriction placed on their harvest. With current exploitation it is inevitable that soon, *bambaras* will be a scarce resource and species are likely to disappear or become extremely rare. But what is the role of these creatures in the ecosystem and how will it react to their disappearance? We are likely to witness consequential changes to the sandy shore ecosystems on account of this lack of control by the authorities. We saw it with drift-netting, oceanic long-line fishing, sand removal for building, coral removal for lime manufacture. The list is long just as is the list of ecological effects – beach erosion, fish scarcity, reef degradation, turbidity and discoloration of lagoons.

MPAs remain, in the opinion of the MMCS, an excellent way to manage the marine environment for our children's generation, and thereafter. When will Government put aside a substantial area of lagoon and reef, to be preserved as it is, without exploitation? Why should tourism always be invoked as the only reason for conserving our marine biological resources?

If there is an overall conclusion to be drawn from the 30 years of experience of the MMCS activism, it is that the political leadership is sensitive to public opinion. The press has been sympathetic to the environmental cause over the years, but the MMCS has always put forward scientific arguments for the preservation of nature and marine resources. This has assured an objectivity of view and a benchmark from which to state the case. This has been invaluable in working towards a healthy and sustainable marine environment in Mauritius.

Acknowledgements

We are grateful to those few divers with foresight who, frustrated with the inaction of the authorities and the uncontrolled hunting activities of the diving fraternity, created the MMCS – Yves Robert and Bob Latimer and a few others – as well as our colleagues Yann and Nathalie von Arnim, Owen Griffiths, Olivier Tyack and all the active conservationists of the MMCS, the MSDA and MUG.

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The management of the Blue Bay Marine Park, Mauritius

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Abstract The Blue Bay Marine Park, located in the south-east of Mauritius, was proclaimed a National Park in October 1997 and declared a Marine Protected Area and designated as a Marine Park in 2000. The main objectives of the Blue Bay Marine Park are the conservation of marine biological and genetic diversity, tourism and recreational activities, education and research, and public awareness. It extends over an area of 3.5 km^2 along the seashore from Pointe Corps de Garde in the north to Pointe Vacoas in the south. The Blue Bay Marine Park is recognised for its exceptional seascape and unique coral gardens and harbours a marine ecosystem of rare beauty in terms of its diverse and rich communities of marine flora and fauna especially the corals. To date 38 species of coral and 72 fish species have been recorded in the park. As one of two marine parks in Mauritius, Blue Bay has an important role in the conservation of resources for future generations. The Fisheries and Marine Resources (Marine Protected Areas) Regulations 2001 provide for the control, surveillance and sustainable management of the various permissible activities within the park through (i) a zoning plan, (ii) enforcement of the law, (iii) a permit system, (iv) education, sensitisation/awareness campaigns and (v) research and monitoring of physical, chemical parameters and substrate cover, flora and fauna. Though the management plan is explicit and seems quite simple to implement, yet many difficulties are encountered in its effective implementation in the day to day management of the park.

Background

The Blue Bay Marine Park, located in the south-east of Mauritius was proclaimed as a National Park under the Wildlife and National Parks Act 1993 in October 1997. It was declared a Marine Protected Area and designated a Marine Park in June 2000 under the Fisheries and Marine Resources Act 1998. It extends over an area of 353 hectares (3.5 km^2) seaward, from Pointe Corps de Garde as its northernmost point to Pointe Vacoas in the south. Blue Bay has been declared a marine park because it harbours a marine ecosystem of rare beauty in terms of diverse and rich communities of marine flora and fauna especially the coral reefs which remain in good condition.

Two types of reefs occur in the park: fringing reef and patch reef. The fringing reef extends from Pointe Corps de Garde to Pointe Vacoas and is opened midway by a pass. The overall length of the reef is about 3 km. The reef flat is about 10 m wide and composed of dead corals and coral rubble. The fore reef slope is characterised by several grooves consisting of basaltic rocks and boulders. The patch reef of the park has luxuriant coral growth. Dense growths of table corals, cactus corals, stag-horn corals, brain corals and fire corals alternate and compete for space. The patch reef is the only location in Mauritius where *Montipora aequituberculata* has been recorded. At least 38 coral species are recorded, representing 28 genera and 15 families. Surveys carried out so far, have revealed the presence of 72 fish species representing 41 genera and 31 families. Commercial species and many reef fish, including those that have a schooling behaviour, are present in the park. Other marine fauna recorded in the park include numerous invertebrate species and one species of turtle. Marine flora include four species of sea grass namely *Halodule uninervis, Halophila ovalis, H. stipulacea* and *Syringodium isoetifolium*. Thirty-one species of algae representing 26 genera and three families have also been recorded. Among these, there is a predominance *Halimeda sp., Ulva sp., Gracilaria sp.* and *Avrainvillea sp*. Two species of mangroves, namely *Rhizophora mucronata* and *Brugieira gymnorhiza* are found scattered along the inter-tidal region of the south-western part of the park.

Blue Bay, being a popular tourist spot and the favourite beach in the southern part of Mauritius, is extensively used for recreational purposes. It is estimated that more than 100,000 visitors, including both Mauritian and foreign nationals, visit the park every year. The various recreational activities that are carried out in the park are: (i) scuba diving and snorkelling, (ii) non-motorised surface water sports such as wind surfing, sailing, water skiing, paddle boatsing, and kayaking, (iii) swimming, (iv) boating (e.g. glass bottom boats, boats transporting divers and snorkellers, boat transporting visitors into and outside the boundaries of the park), (v) recreational fishing with pole and line along part of the coast, and (vi)

fishing using pole and line and basket trap beyond the fringing reef.

Goals and objectives of the Blue Bay Marine Park

There are four broad management goals that have been distinguished for the Blue Bay Marine Park. These are:

1. Conservation of biological and physical resources.
2. Provision of recreational opportunities that are environmentally sustainable and compatible with the overall conservation goal.
3. Information, education and interpretation to promote understanding and appreciation of the natural values.
4. Research and monitoring to promote a better understanding of the natural environment and the impacts of use and management activities.

Each of the goals has its own set of objectives that are more or less inter-related. The conservation objectives are to:

- conserve the main ecosystems, i.e. the forereef, patch reef, seagrass beds, algal communities and mangrove stands,
- protect the habitats and nurseries of species of commercial importance,
- increase the stocks of over-exploited species,
- restore areas that have been degraded,
- minimise negative impacts from visitor activities,
- minimise negative impacts from activities on adjacent lands.

The recreational objectives are to:

- promote and facilitate recreational activities that are low-impact and non-disruptive,
- integrate recreation with interpretation and education programs,
- ensure that recreational activities do not exceed the environmental carrying capacity of the area,
- ensure that recreational activities are safe and adhere to set standards of quality and safety.

The information, education and interpretation objectives are to:

- provide interpretation of the natural features of the park to the public,
- develop an information/education program for park visitors and the public at large,
- encourage behaviour that is caring and promotes conservation.

The research and monitoring objectives are to:

- collect data on the ecosystems of the park for management purposes,
- assess the effectiveness of management actions,
- determine negative impacts of user activities,
- interpret the results of research and monitoring and translate into management action, where needed.

Tools for managing the Blue Bay Marine Park

The Blue Bay Marine Park is managed by the Ministry of Agro-Industry & Fisheries (Fisheries Division). Management of the Blue Bay Marine Park is carried out through application of the Fisheries and the Marine Resources (Marine Protected Areas) Regulations which came into force in 2001. The regulations provide the different tools for the management of the park, namely: a) a zoning system, b) a permit system, and c) law enforcement and patrol. Coupled with the above tools, awareness and sensitization campaigns, and research and monitoring are also conducted for the management of the park.

Zoning

The Blue Bay Marine Park has been demarcated into zones with specific coloured buoys in order to 1) provide protection to critical habitats, ecosystems and ecological processes, 2) conserve biological diversity, 3) cater for various permissible activities, and 4) separate conflicting human activities. The different zones in the park are:

(i) Strict Conservation Zones (A & B) – for the conservation of sensitive and special ecosystems in which a limited number of recreational activities is permitted, such as glass bottom boating, snorkelling and diving. Fishing is not allowed in the Strict Conservation Zone A, while line fishing is allowed from the shore in the Strict Conservation Zone B. These zones are demarcated with green buoys.

(ii) Conservation Zone – this places emphasis on the conservation of biological resources. Most recreational activities are permitted, but fishing is not, except line fishing from the shore in a designated area.

(iii) Multiple Use Zone – this allows for recreational activities, line fishing and basket trap fishing.

(iv) Swimming Zone – this is designated for swimming only and demarcated with yellow buoys and floats. Boating and fishing are not allowed in the swimming zone.

(v) A traffic lane provides for entry into or passage through the park by motorised boat with a speed not exceeding 3 knots. Buoys with red and white vertical stripes demarcate the traffic lane. Use of non-motorised boats, fishing, snorkelling, swimming and diving are not allowed in the traffic lane.

(vi) A ski lane is designated for water skiing and no other activity is permissible. It is demarcated by orange buoys.

(vii) Mooring zones for the mooring of boats are demarcated by white buoys.

Permit system

The permit system was introduced in order to control the different types of permissible activities that are carried out in the park. Provision was made in the

Fisheries and Marine Resources (Marine Protected Areas) Regulations 2001 for the creation of a Marine Protected Area Fund where revenue generated could be credited and used for the maintenance and operation of the park. The different types of permits and their charges are illustrated in Table 1.

Table 1. Type of permits issued in Blue Bay Marine Park and their corresponding charges.

SN	Types of permits	Charge
1	Line fishing	No charge for registered fishermen Rs. 200 for amateur fishermen yearly
2	Line/basket trap fishing	No charge for registered fishermen Rs. 200 for amateur fishermen yearly
3	Boat/vessel	No charge for registered fishermen and pleasure craft Rs. 5 000 for private pleasure craft, big game fishing boat, catamaran, pleasure boats yearly
4	Permissible activities	Rs. 200 yearly
5	Plant/animal introduction	Rs. 1 000 yearly
6	Display	Rs. 10 000 yearly
7	Interference	Not less than Rs. 50 000 depending on merits of application
8	Commercial activity	Rs. 5 000 yearly
9	Photography	Rs. 5 000 yearly
10	Access	Rs. 1 000 per day
11	Marine Park symbol	Not less than Rs. 20 000 depending on merits of application
12	Recreational	Rs. 1 000 yearly
13	Access permit to conservation or strict conservation zones	Rs. 100 per day
14	Ski	Rs. 200 per hour

Law enforcement and patrol

Law enforcement is a very important part of the management of the Marine Park. It is ensured by officers of the Fisheries Protection Service of the Ministry on a 24-hour basis. Law enforcement is done through patrolling in the park. Boat patrols and coast patrols are carried out daily at varying times, during which permits of all those present in the park are checked. Contraventions are established against those who do not have the required permit in their custody or those who do not have a permit at all. Those who are involved in illegal activities such as fishing in non-permitted areas are also booked and their equipment seized.

Awareness and sensitization campaigns

A sensitization and awareness campaign is important as it promotes understanding and appreciation of the natural values among the general public. This strategy was aggressively used prior to declaring Blue Bay, a Marine Park, so as convince the local fishermen, hoteliers and other stakeholders of the consequences and benefits of a marine park. A combination of various mechanisms is used to disseminate information and to increase conservation awareness among the park users and the public, targeting young people in particular. Such mechanisms include lectures, slide and video presentations, brochures, pamphlets, posters, signboards, display boards, billboards and guided tours. During the sensitization campaigns, information on the main values of the park with regard to the coral reef ecosystem, algal and seagrass communities, and the mangrove ecosystem are provided. The functions of these ecosystems, their interrelationships and their importance, the aims and objectives of the park and their management strategies are explained. Do's and don'ts in the Blue Bay Marine Park are also explained.

Research and monitoring

Research and monitoring is another tool that assists management of the park. Monitoring of the coral reef, algae, sea grass ecosystems, visual fish census and other marine invertebrates is carried out annually. Five permanent stations have been established, the first one is located in the back reef, the second and the third in the Strict Conservation Zone A, the fourth in the seagrass beds of the Strict Conservation Zone B and the last in the algal communities of the Conservation Zone. A combination of Line Intercept Transect and quadrat methods are used in monitoring. Monitoring of water quality is also carried out on a bi-annual basis. Water samples are taken at several stations and parameters

such as nitrate, phosphate, biological oxygen demand, chemical oxygen demand, dissolved oxygen, total and faecal coliforms and pH are determined.

Management outcomes

The Marine Protected Areas concept is relatively new in Mauritius. Although Blue Bay was declared a Marine Park in 1997, effective management of the park did not start until mid 2004. Before then, the permit system had not yet been established, only part of the zoning had been done, patrol and surveillance was only carried out during daytime, and there was inadequate equipment. However, sensitization campaigns and monitoring of the park were on-going. In mid-2003 that the different zones were demarcated with buoys and by mid-2004 the park was under 24 hour surveillance.

Although management of the park has only recently been fully operational, tangible and positive results have been obtained with regards to the number of permits processed and issued, contraventions established and prosecutions made, water quality parameters, and percentage live coral cover and fish abundance. To date, more than 500 permits to carry out different activities in the marine park have been issued (Table 2).

The number of contraventions established and number of cases prosecuted in 2004, 2005 and 2006 were as follows:

2004: 18 cases prosecuted. These included 7 cases of basket-trap fishing, 6 cases of pole-and-line fishing, 2 cases of fishing with nets, 2 cases of possession of fishing gear, 1 case of use of spear gun.

2005: 29 cases recorded. These included 7 cases of fishing with nets, 5 cases of possession of fishing gears, one case of use of spear gun. Three persons were prosecuted, 8 basket traps were removed from the park, 92 metres of nets and 21 fish were seized.

2006: 25 cases recorded. These comprised basket traps (9), spear-gun and underwater fishing equipment (4), nets with undersized mesh (4), pole-and-line fishing (7), and fishing line. Six illegal fishing contraventions were also established.

Table 2. Number of permits of various types issued in the Blue Bay Marine Park.

Type of permit	Number issued
Boat/vessel	201
Line fishing	200
Commercial activity	13
Recreational	103
Basket-trap fishing	33
Interference	6

Long-term monitoring carried out at the five permanent stations reveals moderately high live coral cover at Stations 2 and 3. Macroalgae, seagrass and sand were mainly present at the other stations. Results on the percentage of substrate cover and fish count are shown in Tables 3 and 4. The fish species comprised mainly Acanthuridae, Labridae, Scaridae, Pomacentridae and Plotosidae (Table 4). Acanthurids are particularly prevalent in the park. Sea turtles have also been observed in the park.

One of the most important decisions taken, so far, has been the banning of undersea walking in the park as this activity entailed the destruction of the corals. Recently, a steering committee has been established having as members, representatives of the ministries of Housing & Lands, Environment, Tourism, Beach Authority and two non-governmental organisations, namely the Mauritius Marine Conservation Society and Eco-Sud. The aim of setting up the steering committee is to get all the stakeholders involved in the management of the marine park.

Table 3. Percentage of substrate cover at the monitoring stations (2005)

Life form categories	Station 1	Station 2	Station 3	Station 4	Station 5
Acropora branching	-	10.4	26.5	-	-
Acropora digitate	-	6.7	12.2	-	-
Acropora tabular	-	42.3	40.8	-	-
Coral foliose	-	13.6	2.1	-	-
Coral submassive	-	17.7	0.7	-	-
Mushroom coral	-	-	1.1	-	-
Total live coral cover	**-**	**90.7**	**83.4**	**-**	**-**
Sand	8.3	2.1	-	80	30
Rock	5.2	-	-	-	45
Dead coral	64.1	7.3	16.6	-	-
Macroalgae	15.8	-	-	3	25
Seagrass	-	-	-	17	-
Zoanthids	0.3	-	-	-	-

Table 4. Number of fish/100 m^2 (2005)

Family	Station 1	Station 2	Station 3	Station 4	Station 5
Acanthuridae	8	22	school	0	0
Aulostomidae	0	4	6	0	0
Balistidae	5	2	0	0	4
Blenniidae	0	0	0	3	1
Chaetodontidae	3	7	6	0	0
Gobiidae	0	0	0	3	1
Labridae	12	15	9	8	0
Lethrinidae	2	5	3	0	0
Monacanthidae	1	2	0	0	0
Mugilidae	3	0	0	6	2
Mullidae	8	7	4	0	6
Scaridae	16	4	9	0	3
Serranidae	1	2	2	0	1
Sparidae	0	4	2	0	0
Zanclidae	1	3	2	0	0
Plotosidae	0	0	0	156	0
Pomacentridae	27	56	48	0	0

Problems encountered and lessons learned

Since the marine park concept is relatively new in Mauritius, and the Blue Bay Marine Park is the first one that is under effective management, we are still learning from our day-to-day problems. Many unexpected problems have cropped up during the management of the park mainly with the application of the Fisheries and Marine Resources (Marine Protected Areas) Regulations 2001 (Government of Mauritius 2001). This is because during the preparation of the regulations many activities were not considered as they were not commonly practised in Mauritius. However, with the passage of time and the expansion of the tourism industry, these activities have become common. Such activities include kite surfing, boat exhibitions and placing of temporary structures such as barges and pontoons. Amendments to the regulations have already been proposed and submitted to the Attorney General's Office for vetting.

Another problem that is faced in the management of the park concerns the permit system. Most of the permits that are issued are renewable. However, many permit holders, especially those who do not pay the permit fees such as registered fishermen and pleasure craft owners, do not renew their permits on time.

Mooring of boats is another problem. Three mooring zones with 45 mooring buoys have been provided for free mooring at different locations in the Blue Bay Marine Park. However, most of the boat owners, being residents of Blue Bay, want to moor their boats in the mooring zone that is located near their residences. This leads to the unavailability of mooring buoys at one location, the other two mooring zones being most of the time unoccupied. In turn, this leads to conflicts among boat owners and at the end of the day, we have to resolve such conflicts though the mooring service is being provided free.

With the demarcation of the marine park with different coloured buoys to delimitate the different zones, maintenance becomes an important issue. As Mauritius is a tropical island, it is often struck by tropical storms and cyclones that cause detachment of buoys and damage to their associated structures. Maintenance work is done by officers of the marine park who have now acquired the necessary skills to carry out the work. All the officers have been trained in scuba diving and now the maintenance of the park is ensured by the marine park officers.

Recommendations

The management plan of the Blue Bay Marine Park incorporates the tools needed to attain the aims and objectives of the park. As such, there are no major flaws in the plan. However, for the proper and efficient implementation of the plan the following are recommended:

a) *Recruitment of additional staff.* The success of a MPA depends directly on the human resources that are involved in its management. The recruitment of additional enforcement officers would facilitate more efficient law enforcement, control and surveillance of the park.

b) *Training of staff.* Most of the officers directly involved in the management of the Blue Bay Marine Park have obtained the necessary skills and experience while working in the field. Considering the growing importance of MPAs with respect to conservation of marine biodiversity and protection of critical habitats, it is necessary to provide officers with professional training in different aspects of park management. Training of personnel will not only contribute to a more efficient and productive management of the park, but could eventually lead to more detailed monitoring and improve services offered to both stakeholders and the public. A training programme should be designed for park staff at all levels. Secondly, exchange programmes between different countries

with professional expertise and knowledge in the area concerned could be helpful.

c) *Participatory approach for management.* The success of a MPA depends to a large extent on the active involvement of stakeholders in all aspects of management, from planning to implementation, monitoring and evaluation. In the case of the Blue Bay Marine Park, though a steering committee has been set up, having as members representatives of different ministries, authorities and non-governmental organisations, many stakeholders are still not actively involved. The steering committee needs to be broadened to include representatives from among others, the hoteliers, boat owners and educational institutions. Furthermore, there should be more active rather than passive participation with a more community-based management approach.

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Community involvement in marine conservation: Trends from Mafia Island Marine Park

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Abstract The establishment of Mafia Island Marine Park (MIMP) in 1995 introduced a new community-based collaborative approach to the conservation of Tanzania's coastal environment. The marine park has involved the community in its management through Village Liaison Committees (VLC) and Village Enforcement Units (VEU), as well as through village-based resource monitors. Under the marine park's enforcement strategy, the VLC and VEU work at ground level ensuring that the park's resource users comply with the park's rules and regulations. Also, the park's communities are involved in research and monitoring through the village-based data collectors. Community involvement is structured towards MIMP's goal of integrating conservation for the protection of resources with local sustainable development. By looking into long-term trends in the effectiveness of community involvement we concluded that using village-based data collectors may be profitable and effective in monitoring the resource use in a MPA. The data obtained through the method showed constant octopus extraction over the past five years and a decrease in fishermen's catch since the institution of effective management started in 2002. It was found that efficient conservation can only be achieved if there is sufficient financial backing. Secondly, trends in enforcement showed that by using VEU the number of infringement incidents can be reduced resulting in more sustainable fishing habits, as well as creating understanding of the park's management within local communities. Nonetheless, when the park's management is in conflict with communities, such as the Jibondo Island community, unsustainable fishing remains widespread. This can be an attribute to the high dependence of such communities on the marine environment and absence of alternative livelihoods. In addition, the problem of fishing pressure by non-resident fishermen still remains. It is recommended that stronger commitment is encouraged from both the village-based resource monitors, the VEU and the VLC. More funding towards our park, to support these bodies, would be of great benefit. In addition alternative livelihoods in problem areas, such as Jibondo, would promote sustainability. Environmental education is also deemed to be very important to ensure future community involvement, commitment and compliance.

Background

In 1995 Mafia Island Marine Park (MIMP) was the first marine protected area to be established in Tanzania under the Marine Parks and Reserves Act No. 29. The Park lies between 07°45'07"S and 08°09'40"S and between 39°30'00"E and 39°54'01"E (Fig. 1) and is approximately 120 km south of Dar es Salaam and 20 km offshore from the Rufiji Delta (Board of Trustees 1994). Its area totals 822 km^2, of which more than 75% is below the high water mark. The park is unique in that it includes 14 villages, which now have a total population of over 20,000. Four villages lie entirely within the boundary of the marine park; the three island villages of Chole, Juani, and Jibondo, plus Kungwi village near Mlola Forest. Another island in the west of the park, Bwejuu, is wholly within the boundary, but is a sub-village of Kilindoni (Fig.1). Communities on Mafia are entirely rural and poor, even by national standards, with an annual per capita income of US$100-150 (Rubens and Kazimoto 2003). Fish and related marine resources are the most important economic generator with extreme communities, such as Jibondo, deriving 70-80 % of the livelihood from the marine environment (Board of Trustees, 1994).

Mafia Island Marine Park is one of the few remaining reef complexes within Tanzania's coastal waters in relatively pristine condition and the area has been recognized internationally as a critical site for biodiversity (Board of Trustees 2000). The site is characterised by influxes of high energy Indian Ocean waters on the east, sheltered waters enriched with sedimentary discharge from the Rufiji Delta on the west and a high bathymetric complexity of the sub-tidal seascape surrounding the various islands, islets and reefs (Rubens and Kazimoto 2003). This has resulted in an outstanding mosaic of tropical marine habitat diversity and associated high species richness. Mangrove habitat covers about 17.4 km² with eight mangrove species represented; coral reefs fringe much of the coastline and include 48 genera of corals; extensive seagrass beds include 12 species of seagrass,

which formerly provided grounds for dugongs; 134 species of marine algae have also been recorded in the park. With over 400 species of fish being supported by the diverse marine habitats, the MIMP supports productive fisheries, with more individuals, higher biomass and larger fish being recorded in the park than at other sites around Mafia Island (Kamukuru *et al.* 2004; Machano 2005). In combination with the Rufiji Delta and the Songosongo Island to the south, the area is being considered for both Ramsar and World Heritage Status (Rubens and Kazimoto 2003).

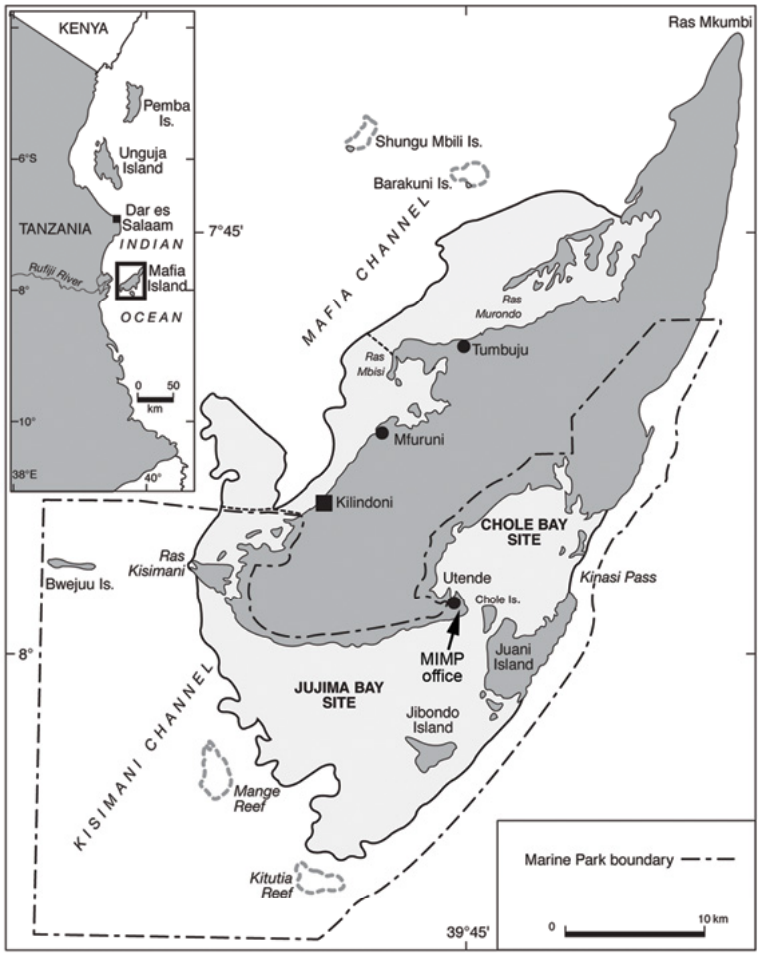

Fig. 1. Map of Mafia Island, Tanzania, indicating the Mafia Island Marine Park (MIMP) boundary and head office.

MIMP is charged with the responsibility of integrating conservation and the protection of resources, with local social and economic development, leading to sustainable resource use. In its endeavours to scale down conflicts between resource conservation and resource use, the park's management has been adopting two major principles, namely to integrate a multiple user approach through the application of a zoning scheme, and to encourage community participation in the running of the park (Board of Trustees 2000). The collaborative management approach utilises Village Liaison Committees (VLC) and Village Enforcement Units (VEU), who are concerned with the daily management of the villages. They are the "*eyes and ears of the villages*", and in collaboration with the village government (VG) they make up the community-based participation in the management of MIMP. These bodies, the VLC, VEC and VG, act to their capacity in curbing unsustainable and illegal incidents, but also liaise with the MIMP Enforcement Unit in cases of incidents beyond their capacity. In addition, the MIMP management incorporates the views of the park's communities through the Advisory Committee (AC), which functions as an advisory body to the Board of Trustees (Fig. 2). The park is unique in that it involves the community in monitoring the resource use in the park, while researching the resource status, ecosystem health and biodiversity, is mainly done through professional scientists.

Aims and objectives

The overall goal of this study was to analyze the effectiveness of community involvement in the MIMP management strategy. The study assesses community participation in monitoring of the park resource use and in enforcing of park regulations. It examines long-term trends in using village-based monitors for the collection of data on local fishing effort and Village Enforcement Units (VEU) in improving management.

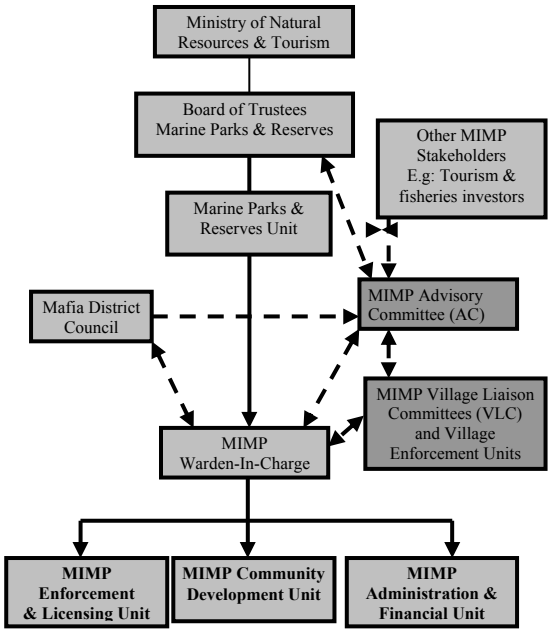

Fig. 2. The management structure of MIMP, indicating the community involvement.

Methods

Data were primarily obtained from reports of research in Mafia Marine Park. These included Hockings *et al.* (2000), Rubens and Kazimoto (2003), and Hogan (2003) and unpublished reports. In addition, information was obtained from regular meetings with stakeholders and also findings learned during the coordination of day-to-day implementation of research and monitoring activities in MIMP vis-à-vis community participation in implementing the Park's objectives.

Effectiveness of community involvement in monitoring and research in MIMP

In general, the monitoring of resource use in MIMP is practised at two levels. At the village level, where the data collectors monitor the village landing sites, and at the Tanpesca Ltd processing plant (Machano 2005). The village-based data collectors are supposed to monitor 15 days per month, recording fishermen's catches. The type of fish caught, their weight, the fishing method, vessel type used, duration of the fishing effort, and location of the fishing ground are recorded. The same data are collected for the octopus fishery and also the sex of the catch is noted. A Tanpesca processing plant on the west of the island that exports prawns and octopuses provides a second avenue to collect data on octopus catches. This paper will concentrate the octopus fishery where good catch records exist for 2002-2006. To assess the effectiveness of the community data collectors, octopus catches recorded by the village-based monitors are compared to the catch data collected by Tanpesca. Analysis of catch and effort from the data collectors is carried out at the end of each month. Trends have been compared to changes in MIMP management strategies to see if these have affected fisher behaviour.

Effectiveness of community involvement in enforcement

According to the management plan some resource extraction is allowed on the basis of a permit system. These include the collection of dead corals and mangroves for domestic use by MIMP residents. In addition, each resource user in the park must possess a resident user certificate that is obtained through a Village Licensing Officer (VLO) of the village councils, who in turn recommend them to the Warden in Charge. Resident user certificates are issued for the general and specified use zones of the park, whereas core zones disallow any resource extraction. Fishermen from outside MIMP may apply for non-resident user permits which are recommended by village councils in the areas they want to operate from. These are restricted to the general use zone only.

In addition to collaborating with MIMP sea and land patrols, the VEU regularly embark on patrols during which they monitor the legitimacy of the fishermen by checking their documentation. If fishermen in the park cannot produce user certificates to the MIMP and VEU enforcement patrols, they may be subject to fines, confiscation of their fishing gear and/or imprisonment. Unsustainable gears (nets with small sized mesh, beach/purse seines) may be confiscated depending on mesh size and the type of fishing operation. Legal action is taken against non-compliers and may result in fines or imprisonment. This enforcement has now been in operation since 2002. To assess the effectiveness of community involvement in enforcement, the number of incidents of infringement was recorded, as well as the management actions taken – arrests, gear confiscations, and/or imprisonment. This has led to problem identification and recommendations for future actions

Results and Discussion

Effectiveness in community involvement in monitoring and research (data collection)

Octopus catches over the last five years have been relatively constant at the MIMP village landing sites, ranging between 5 and 10 $kg.d^{-1}$. Data collected by the village monitors shows that fish catches in the park were high between the beginning of 2003 and mid-2004 at 20 $kg.d^{-1}$ (Fig. 3). In contrast the octopus catches monitored at the Tanpesca processing plant have shown great variation, from less than 5 $kg.d^{-1}$ in February 2003 to 40 $kg.d^{-1}$ in September 2003 (Fig. 3). Sales of octopuses from the park to Tanpesca vary considerably. This is because Tanpesca buys octopuses from a variety of sources around Mafia Island, not only from the Park, and will only purchase

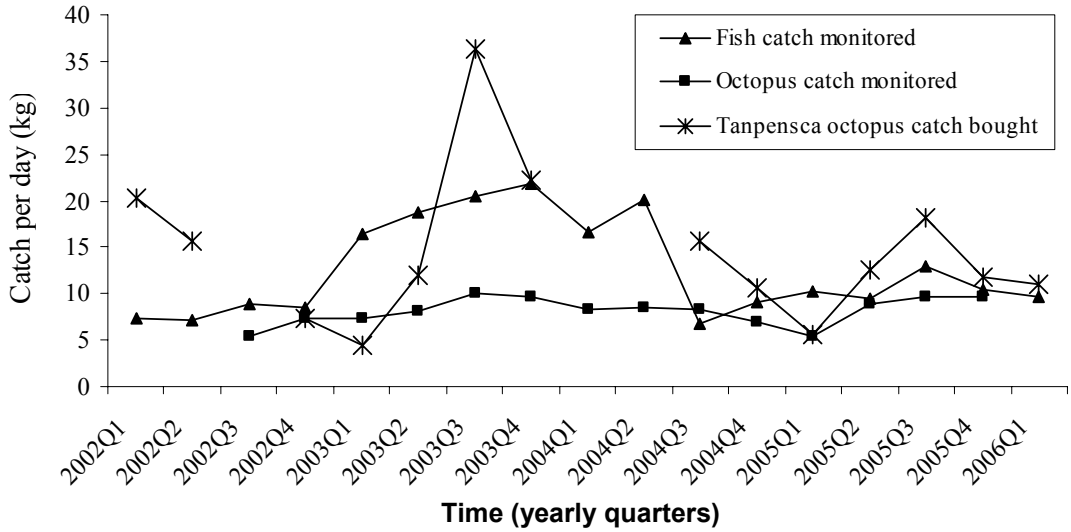

Fig. 3. Daily octopus catches monitored from purchases of the Tanpesca processing plant and through MIMP village data collectors from 2002-2006, and daily fish catches monitored by MIMP village data collectors.

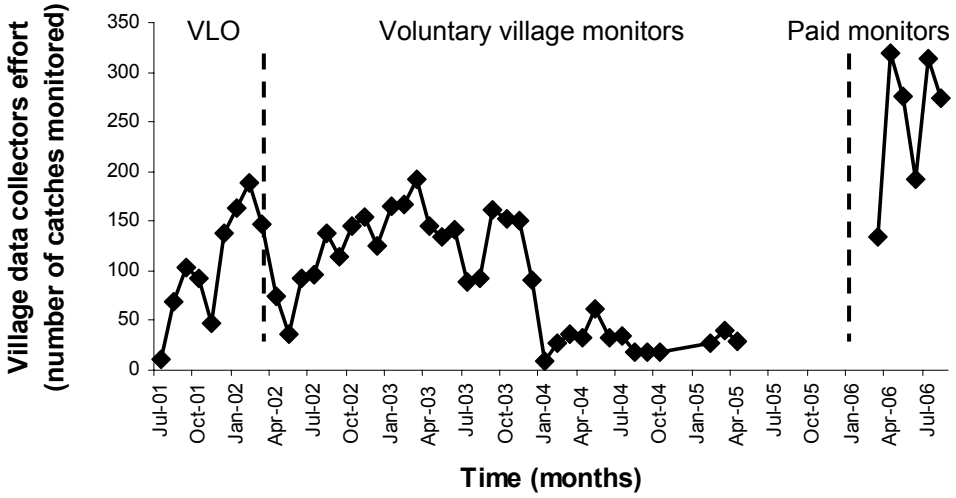

Fig. 4. Change in monitoring effort by village data collectors from 2001-2006

specific sizes and quality. Frequent changes in management at Tanpesca have proved to be a serious setback in maintaining data on monitoring of catches brought in.

The village data collectors' effort, measured as the number of fishermen's catches monitored each month varied considerably from 2002-2006 (Fig. 4). When the VLO were in charge of the data collection, prior to March 2002, between 50 and 200 fishermen's catches were monitored per month. In order to create a sense of ownership of park activities by villagers, a switch in data recording from VLO to voluntary village monitors was initiated in early 2002. Initially, between 2002 and 2003 monitoring went smoothly, but by January 2004, there had been a dramatic decline in the data collection effort. This was caused, probably by low motivation in which some monitors demanded to be paid some compensation for their time. A new strategy was implemented in January 2006, whereby monitors are paid US$3 (about 3000 Tanzanian shillings) per day for 15 days in a month. Consequently, data collection effort increased dramatically and has continued to remain high. Although the variation in collection effort does not seems to have hampered the data obtained on octopus and fish catches (Fig. 3), the reliability of recent data is likely to have improved with the larger sample size.

Effectiveness of community involvement in enforcement

Infringement incidents in the marine park were very high prior to 2001 and many people were arrested (Fig. 5). Prior to 2001 there were no VEU patrols, only MIMP patrols that were done mainly by sea. With increased patrolling effort in 2002, particularly by the VEUs, the number of incidents of infringement was greatly reduced, less fishing equipment was confiscated and fewer people were arrested. The rise in enforcement was due to VLCs taking a more active role in the park's management after 2001.

The number of non-residents applying to be in the marine park has remained relatively constant over the past few years, at about 70 permits per year. Over the years there have been a reducing number of residents applying for permits, probably due to environmental education and alternative resource use. The demand for new Resource User Certificates, which allow the holders limited exploitation of MIMP's resources, have also been decreasing over time (Kazimoto 2006), with 1200 certificates allocated in 2000/01 and only 68 in 2006/07 (Table 1). This is because only new recruits demand local resident user certificates. It seems therefore that the decline in certificate demand does not correlate with the fishing effort taking place in the park, which seems to be on the rise (Fig. 3).

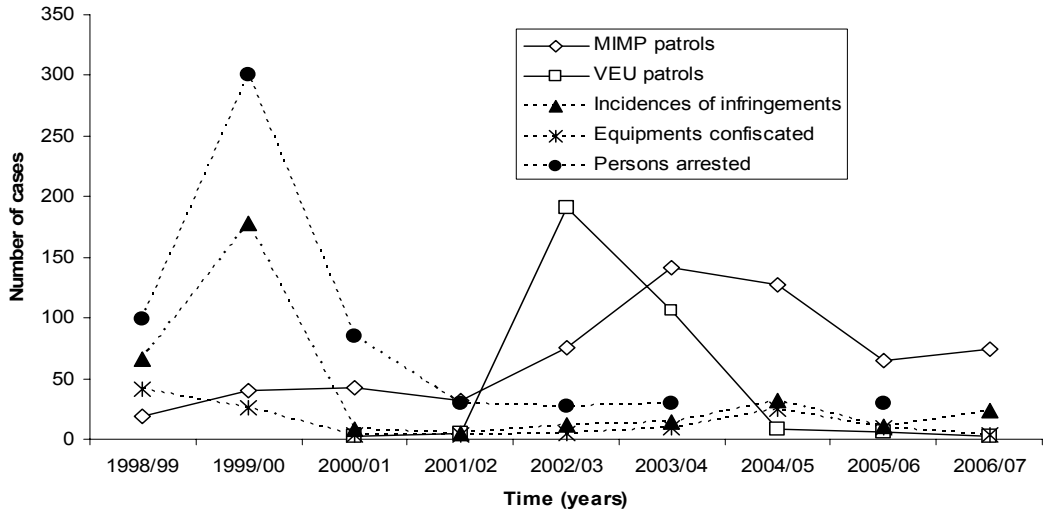

Fig. 5. Enforcement effort, in terms of patrols, by MIMP management and the village enforcement units (VEU) and resultant incidents monitored, equipment confiscated and people arrested 1998-2007.

Table 1. Number of additional residential and non-residential permits and new resource user certificates issued to villages in MIMP from 1999-2007.

Type of Permit	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Resident Permits	_	203	195	18	48	39	16	6	16
Non-Resident Permits	_	130	61	79	73	78	90	13	59
Local Resident Resource User Certificates	_	_	1200 to Jobondo, Chole, Bwejuu & Juani	1511 to Mlongo, Miburani, Chemchem & Kiegeani	130 to Marimbani	796 to Kungwi & Baleni	-	21 to Chemchem & Baleni	68 to Mlongo, Baleni, Chole & Marimbani

Lesson learned

Effectiveness of community involvement in monitoring and research (data collection)

Incorporating village monitors in collecting data for the research and monitoring department of MIMP's management body were useful in monitoring resource exploitation in the park (Fig. 3). As shown by octopus-monitoring, Tanpesca's data did not appear closely correlated with the amount of octopus caught in the park, mainly because it buys octopuses from all Mafia Island villages, not only MIMP villages, and it only buys the larger undamaged individuals. In addition, the Tanpesca plant has changed management often over the past years, and gaining their commitment to collect data has proved difficult. MIMP monitors also recorded the trend in fish catches per day. These appeared to decline in 2004 (Fig. 5) following increased enforcement (Mahingika 2006).

Using village-based data collectors, therefore, has proven useful in monitoring the resource use in the park.

By the end of 2005 it was realised that the effort of the voluntary village monitors had dramatically declined. In recognition of the time and effort the data collectors spend on the work, it was decided to pay them some allowances for the service they are rendering the park. The reason for the sharp decline in data reporting in January 2004 (Fig. 4) was thought to be due to the destruction of the scales used to weigh the catch (Machano 2005), but low motivation due to a lack of financial incentive to take part in the monitoring programme proved to be the overriding problem. It is very important to provide financial support for village collaborators, such as the data collectors, or else efficient management will not be achieved.

Effectiveness of community involvement in enforcement

Patrols have led to a more sustainable level of fishing effort. Since the park's establishment, dynamite-fishing has stopped completely, even by Jibondo Island, which is considered to notorious in the dynamite activities. More patrolling since 2002, especially by VEUs, has led to less unsustainable fishing through confiscations of illegal fishing gear such as beach seines, purse seines and nets with small sized mesh and to higher compliance due to the fear of being arrested (Fig. 5). Particularly, in the specified user zone in Chole Bay, there has been much improvement in the sustainability of the fishery due to committed community involvement.

Although non-resident permits have been issued since 1999, the western part of park, where non-residents from Kilindoni and further a field often engage in fishing, has been difficult to monitor. Such an uncontrolled influx of migratory fishers and fish traders impairs the sustainable fishing effort of indigenous fisher communities. The management has also struggled to police non-resident communities, who continue to engage in dynamite fishing at Mafia Island small islets fishing camps outside MIMP.

Because of its dependence on the ocean for up to 80% of the island's income and few alternative economic opportunities, Jibondo is particularly difficult to manage. This has resulted in the Jibondo community disregarding the zoning scheme and continuing to degrade Kitutia reef, a core zone. Fish species abundance has decreased on Kitutia compared to Utumbi, a specified-use zone, where an increase in fish abundance has been recorded since 2000 (Machano 2003). This is probably due to continued fishing of the Kitutia reef by Jibondo fishermen and better policing of Chole Bay, which contains the Utumbi reef.

The Jibondo fishing community has also not been cooperating in reporting non-resident fishermen through their VEU. Seine-net fishers and fish buyers from Dar es Salaam have been reported to bribe them with gifts, such as free fishing gear.

The usefulness of the VEUs is undeniable. Knowledge about the marine park, its goals and strategies for sustainable resource use, sustainable fishing methods and management of coral harvesting, is spread through the VEUs and VLCs. The more villagers are trained and incorporated into the management of the park, the more understanding of the marine park's aims and objectives has spread to the local communities. Through the VEUs and VLCs the local community has also gained a greater sense of ownership of the resources that are being conserved in MIMP.

Nevertheless, progressive community based monitoring needs to be continued in order to help to develop policy recommendations for sustainable fisheries and its links to poverty reduction and environmental issues. This is in line with national policies and Millenium Development Goals.

Recommendations

- Community involvement is of undeniable benefit to managing MIMP. By involving the community in monitoring and research and in the enforcement aspects of the park's management, they are made to feel responsible for the marine park's resources. Through training, the village-based resource use monitors come to understand more about the marine resources, sustainable fisheries, and the goals of the park.
- Involving the VEU spreads the understanding of the park's rules and regulations, and the resource-using community becomes less inclined to engage in illegal fishing, because of the fear of being caught. Also, use of unsustainable fishing gear decreases.
- Thorough training of the community personnel involved in the management of the park is recommended, so that the message of sustainable resource management is spread within the stakeholder communities. The village-based monitors should be updated on any research findings, such as differences in fish abundance and diversity between the zones. The more educated the community-based personnel are, the more they will spread their knowledge to the rest of the park's community, hence providing a feedback mechanism for the research findings to the communities. This is fundamental to engagement with the park's aims.
- More effort should be directed at the implementation of alternative livelihood activities that can be established and sustained locally through advice from MIMP. These may form catalysts in diverting pressure from fishing to other activities, thus reducing reef damage.
- MIMP should continue lobbying to assist the local community to engage in some of the activities that are currently being done by Tourist Lodges (for

example, training to guide tourists to snorkelling and/or picnic sites on local dhows). Such activities will both help to diversify sources of income for the communities and are compatible with MIMP goals and objectives.

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Successes and disappointments of MPAs in the Western Indian Ocean: the case of Mombasa Marine Park and Reserve

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Abstract
Concerns about the effectiveness of marine protected areas (MPA) as conservation and fisheries management tools have led to a growing interest in conducting evaluations. Protection from fishing leads to increases in biomass, abundance and average size of exploited species and to increased diversity. Such effects are of great interest to fisheries managers because rebuilding exploited populations in marine parks offers prospects of fisheries enhancement. This paper reviews the conservation and fisheries management issues surrounding the Mombasa Marine Park and Reserve. Since effective protection, the park has seen increases in live coral cover while sea urchin populations have gradually decreased. Both fish biomass and density have dramatically increased over time and there is evidence that this has enhanced the adjacent fisheries. Gear restrictions in the surrounding reserve would have been more effective if the regulations were well enforced. For instance, beach seines are banned but seining still continues despite growing evidence that this gear is greatly impacting coral reef biodiversity. The management issues surrounding the park therefore include the enforcement of MPA regulations and mechanisms for raising education and awareness of conservation among stakeholders. Nevertheless, the park's establishment has helped restore coral reef habitats and enhance adjacent fisheries yields. The lessons learned concerning the process of the MPA establishment should form the basis for solutions regarding compliance of regulations.

Introduction

As governments and organizations around the Western Indian Ocean promote the establishment of protected areas to preserve marine biodiversity and prevent environmental degradation, recognition of the successes and disappointments of the current marine protected areas (MPAs) in the region has increased. As a result, many methods have been developed to analyse the success of MPAs including the IUCN's "How is Your MPA doing?" workbook (Pomeroy *et al.* 2004), the United Nations Foundation's "World Heritage Management Effectiveness Workbook" (Hockings *et al.* 2004), and the IUCN Eastern African Regional Programme's Workbook for the Western Indian Ocean (Mangubhai 2003).

How MPAs perform in terms of protecting fish stocks has been the focus of many studies. A common conclusion is that there is an increase in fish numbers in the MPA compared to adjacent areas and/or compared to the situation before the MPA was established (e.g. Watson and Ormond 1994, McClanahan and Obura 1995, McClanahan *et al.* 1999, Halpern 2003). Evidence that MPAs enhance fisheries in the adjacent fished areas is also accumulating (e.g. Russ and Alcala 1996, McClanahan and Mangi 2000, Roberts *et al.* 2001). Most such studies have used direct methods such as fish tagging experiments (e.g. Munro 2000, Zeller and Russ 2000, Kaunda-Arara and Rose 2004) and indirect methods such as fish trapping studies (e.g. Ratikin and Kramer 1996, McClanahan and Mangi 2000) to study migrations of fish from parks to adjacent fished areas.

The purpose of this paper was to review the potential of the Mombasa Marine Park and Reserve to support fisheries development in Kenya. This was achieved through a number of studies looking at the dispersal of exploitable fishes from the park to the adjacent fished area, changes in fish catches in the adjacent areas over time and the effects of gear restrictions on habitats around the park. The management issues and lessons learned are discussed.

Background

MPA approaches in Kenya

Kenya's MPA system is based on the protection of core areas as no take zones with the surrounding buffer areas designated as limited use zones. Thus, the marine parks are encompassed within larger marine reserves where fishing gear types are restricted. Kenya has four marine parks (no-take areas) located in Malindi, Watamu, Mombasa and Kisite, with corresponding marine reserves (gear restricted areas) surrounding each park. The fisheries resources of Kenya are managed by the Fisheries Department under the Fisheries Act, and, where designated as

Protected Areas, by the Kenya Wildlife Service (KWS) under the Wildlife and Conservation Act.

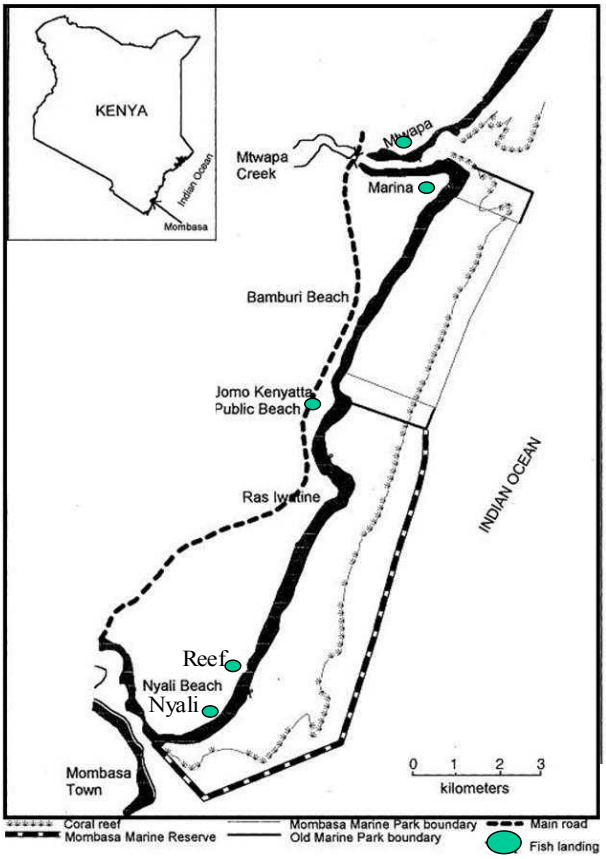

Fig. 1. Map of the Mombasa Marine Park and Reserve showing the different management areas, border changes and landing sites.

Mombasa Marine Park and Reserve

The Mombasa Marine Park was declared a protected area excluding fishing in 1987, but total exclusion of fishers did not occur until 1991 (McClanahan and Kaunda-Arara 1996). As is the case in other MPAs in Kenya, Mombasa Marine Park was established after a great deal of pressure on the Government by the tourism sector. Most stakeholders were therefore not adequately consulted prior to the legal gazettement by the government. The information that was used to justify the creation of the park came mainly from coral reef studies although other marine habitats such as seagrass beds occur in the Park as well (McClanahan *et al.* 2005a).

After creation, management of the park changed following recommendations by a coastal zone management study completed in 1994 -1995 (Coast Development Authority 1996). Originally the park excluded fishers from an 8.2 km^2 area (shore to reef), which was eventually reduced to a 6.2 km^2 area in October 1995. The southern side of the park was established as a reserve (traditional gears only) and therefore, beach seines were eliminated from this part of the reserve (Kenyatta fishing ground, Fig. 1) in April 1995. In 1996, trap fishers were allowed to fish a narrow band on the northern side of the park (Marina). Fishing in this small area requires a license. The local fishers' association decides who will fish in this area and passes their names to the Kenya Wildlife Service (KWS) who issue them with licenses. Beach seining continued in the northern end of the park edge (Mtwapa).

Evidence for recovery of the reef

The area surrounding the park was heavily fished before protective management. Fish landing data and underwater fish biomass studies suggest that before the park's creation fishes were heavily exploited (McClanahan and Kaunda-Arara 1996). Live coral cover and fish density were low while sea urchin populations were very high (McClanahan and Shafir 1990). After effective protection the park saw dramatic increases in diversity and abundances of both finfish and benthic communities (Fig. 2). Fish biomass increased by a factor of five from 1991 to 2004, while coral cover in the park increased from 21% to 27%. The percentage increase could have been higher had it not been for the 1998 coral bleaching and mortality event. Sea urchin populations have steadily decreased in the park as predation rates on them have increased (McClanahan *et al.* 1999).

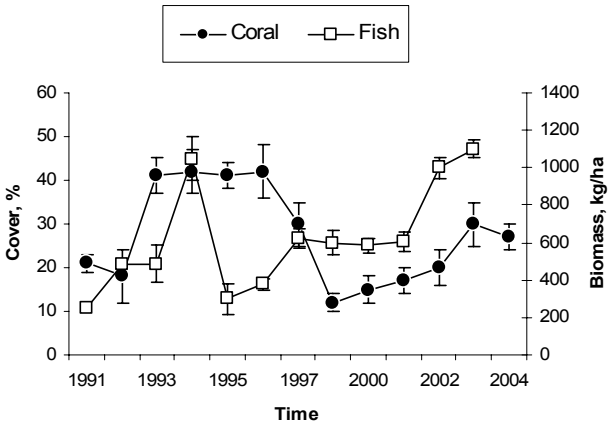

Fig. 2. Live coral cover (%) and estimated fish biomass (kg.ha^{-1}) in the Mombasa Marine Park (source: McClanahan *et al.* 2005a).

Evidence for fish spillover to adjacent fished areas

Evidence that the Mombasa Marine Park is beneficial to the adjacent fisheries comes from a series of trapping studies by McClanahan and Mangi (2000). They placed baited traps on both sides of the park to measure fish spillover from the park. Their results showed that the total wet weight of catches per trap, average size of trapped fish, and the number of species caught per trap declined as a function of distance from the park edge on both the southern (gear restricted) and northern (unprotected) sides (Fig. 3). Spillover was greatest for the dominant fisheries species most of which were moderately vagile such as rabbitfish, emperors and surgeonfish.

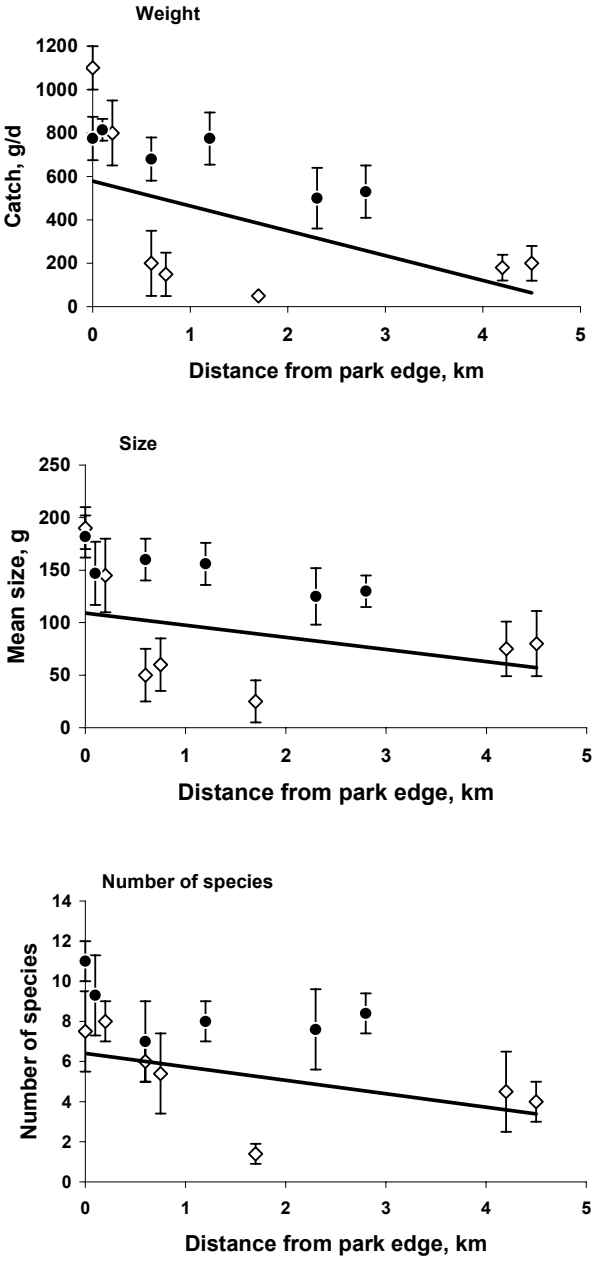

Fig. 3. The total fish catch by weight ($g.d^{-1}$), mean size of fish (g) and number of fish species over a 14 day sampling period as a function of distance away from the park border for the southern (black circles) and northern (white diamonds) sides of the park (Source: McClanahan and Mangi 2000)

McClanahan and Mangi (2000) also studied the behaviour of trap fishermen fishing on the southern side of the park. They surveyed the number and position of their traps with respect to the park edge, and using fish landing data worked out each fisher's catch. Results showed that more traps were placed nearer the park edge than away from the park (Fig. 4). The fishers who fished nearer the park edge caught more than those who fished away from the edge. McClanahan and Mangi (2000) also reported an independent assessment of the fish-border relationship using seagrass blades to tease out the presence of herbivorous fish and sea urchins along a gradient from inside to outside the park borders. At a series of distances from the park edge, they made 3-5 collections of 50 *Thalassia hemprichii* blades and examined them for bite marks. They determined whether the bites on each seagrass blade originated from fish or sea urchin and calculated the frequency of those bite types. The results showed that the frequency of fish bites decreased with distance from the park border and the inverse for sea urchin bites. The results from these three studies suggest that the fishery adjacent the Mombasa Marine Park benefits from adult spillover. Trap fishers are aware of and have adapted to the spillover effect.

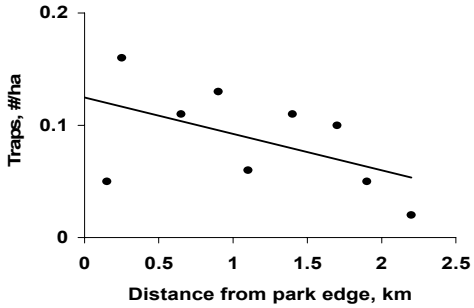

Fig. 4. Density of traps as a function of the distance from the park's southern boundary.

Similar results have been reported from marine reserves in other parts of the world e.g. St. Lucia (Roberts *et al.* 2001), Philippines (Russ *et al.* 2004) and Great Barrier Reef (Zeller and Russ 2000). A network of marine reserves in St. Lucia increased adjacent catches of artisanal fishers by 46–90% within 5 years of creation (Roberts *et al.* 2001). Fish tagging experiments of exploited species in Malindi and Watamu Marine parks found that three species of commercial importance exhibited consistent out-migrations from the parks into adjacent fishing grounds (Kaunda-Arara and Rose 2004).

Changes in fish catch over time

Analysis of fish landing data from the Kenyatta landing site (fish caught in the Mombasa Marine Reserve) and Diani sites (non-reserve) between 1995 and 2000 showed that on an annual basis, total catch declined in all the landing sites (McClanahan and Mangi 2001). The rate of decline in catch was, however lower in the reserve at around 250g per day compared to 380g per day in the non-reserve sites (Fig. 5). On a per area basis, there was a large difference in mean catch between the landing sites. The reserve showed higher yields (5.5 $kg.ha^{-1}.mo^{-1}$) than the non-reserve sites (4 $kg.ha^{-1}.mo^{-1}$) despite having the highest number of fishermen (7 ± 2 fishers $ha^{-1}.mo^{-1}$; Fig. 6). These results confirm the potential of the Mombasa Marine Park to increase catch rates. The reasons why the reserve had the slower decline in

catch rate and maintained a higher catch was due to the increase in fish biomass in the park and the dispersal of fish from the park to the adjacent fishery.

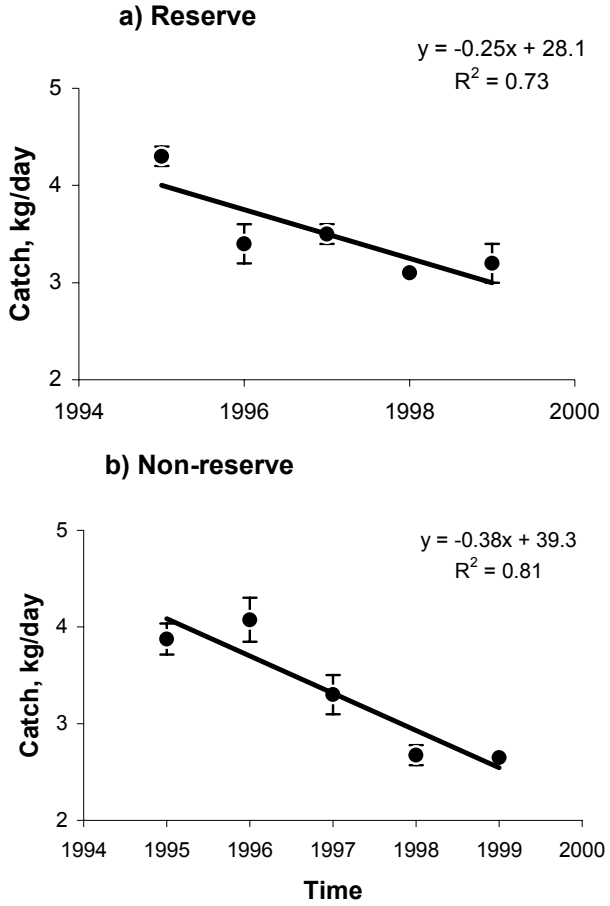

Fig. 5. Annual daily catch per fisherman from 1995 to 1999 comparing the trend in the a) Mombasa Marine Reserve and b) non-reserve sites.

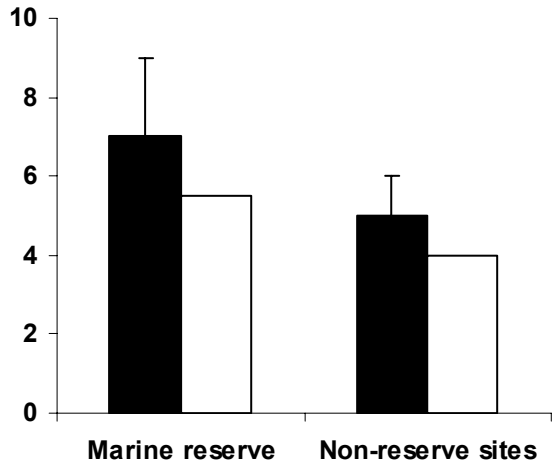

Fig. 6. Comparison of mean catch rates (kg.ha^{-1}.mo^{-1}) in white and density of fishermen (#.ha^{-1}) in black (± SD) in the Mombasa Marine Reserve and non-reserve sites.

Gear restrictions

Environmental impacts

Understanding the impacts of the various gear types used is necessary in order to evaluate the effects of gear restrictions in the Mombasa Marine Reserve. The impacts that have been quantified include the proportion of juvenile fish, by-catch, coral damage per catch and per area (Mangi and Roberts 2006). These impacts have been quantified for the principal gears used in the reserve including large and small traps, gill nets, beach seines, hand lines and spear guns. The results indicate that fishers using beach seines, spears and gill nets cause the most direct physical damage to corals. Spear fishers showed the highest number of contacts to live corals per unit catch followed by fishers using gill nets (12.6 (SD ± 1.8) and 5.9 (SD ± 2.0) coral contacts per kg fish caught per trip respectively (Fig. 7). Fish discarding by six beach seine boats fishing in the reserve showed that 6.5% of the daily catch was discarded into the sea as it was too small (Table 1). Beach seines were also associated with the highest percentage of juvenile fish (68.4 ± 15.7%, Table 2). In general, the size and maturity stage at first capture for 77% of all species caught by all gear types in this fishery was well below the lengths at which they mature. For example, 100% of *Lethrinus xanthochilus,* 99% of *L. nebulosus* and 94% of *L. harak* caught were juveniles. The results of these studies indicate that beach seines have the greatest impact on coral reef biodiversity providing further evidence why they are banned in the reserve. Their continued use however poses questions on the enforcement of gear regulations.

Table 2. Proportion of juvenile fish (%) in catches for the different fishing gear types showing the number of fisher groups examined for each gear.

Gear	Mean	SD	n
Big trap	48.9	27.4	434
Small trap	39.8	21.6	45
Gill net	49.4	28.4	139
Beach seine	68.4	15.7	63
Hand line	55.6	27.2	241
Spear gun	38.2	25.9	588
Total	50.1	22.7	1510

Comparison of gear based fishing regimes

Based on the type of gears used, the fishing grounds surrounding the Mombasa Marine Park can be grouped into three gear regimes: 1) a trap only ground where only authorised basket traps are allowed; 2) fishing grounds where almost all gear types are used other than beach seines; and 3) fishing grounds that are unrestricted and fishermen use any type of fishing gear, particularly beach seines to catch fish. Studies focusing on fish, sea urchin and substratum characteristics from these grounds indicate

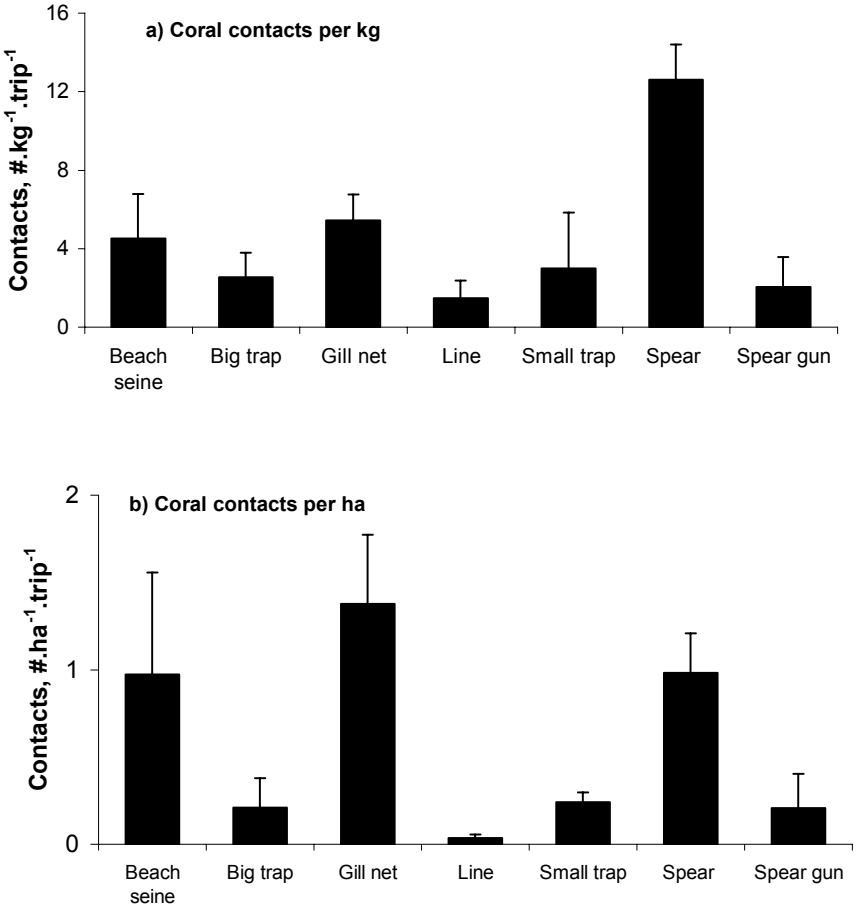

Fig.7. Mean number of contacts (± standard deviation) between fishers and/or their gear and live corals on the basis of the a) fish catch (kg.trip^{-1}) and b) area fished (ha.trip^{-1}) by each of the gear types.

that sites fished by all gear types, including beach seines, have the lowest fish density, coral cover and topographic complexity (Mangi and Roberts 2006, 2007). Most corals were overgrown by algae and were found hidden in pockets of rubble and surrounded by seagrass. This is probably due to the dragging of nets through the bottom substrate. Net dragging across the seafloor has a number of consequences. It can lead to resuspension of bottom sediment that results in increased turbidity and the smothering of benthic organisms (Jones 1992). It can also lead to the removal or crushing of epibenthic organisms e.g. sponges (Sainsbury *et al.* 1997), coral and epibenthic flora such as seagrass (Northridge 1991) along the path of the net. The considerable length of the beach seine and the pulling and dragging nature of its operation makes it very mobile. Beach seining can therefore be expected to affect the seafloor habitat with an intensity and spatial extent orders of magnitude greater than other disturbances to the same environment (McManus 1997, Watling & Norse 1998, Auster 1998). These findings reveal that destructive gears, such as beach seines are reducing the habitat structure of the reefs, supporting the need for enforcement of gear restrictions in the Mombasa Marine Reserve.

Management issues

Enforcement of regulations

The park and its adjacent fisheries are the focus of various government institutions, concerned either with the conservation of the reef resource (Kenya Wildlife Service – KWS), the management of the local fishery (Fisheries Department) or for the development and welfare of local fishing communities (Coast Development Authority). This has created overlap in mandates reducing the effectiveness of management. For instance, despite zoning for fishing and tourism activities, there are ongoing conflicts between fishers and recreational users requiring managers to spend a great deal of time in conflict resolution. The mechanisms and processes to resolve some of the conflicts are, however, either not present or are inadequate leading to conflicts being resolved in an ad hoc manner.

Fisheries management in Kenya has focused on prohibition of illegal gears, which currently covers the beach seines and spear guns. This management policy

Table 1. The volume of catch (cm^3) and percentage of catch discarded for six beach seine boats showing the approximate cut off length for the discarded catch. n = number of days when catch data were recorded for each of the boats. Big catch is the catch that is usually reported in most catch statistics and is comprised of big individuals weighed and sold at the landing site.

Captain	Landing site	Number of fishermen			Discarded catch, cm^3 (< 6 cm)		Landed catch, cm^3 (*Dagaa* 6-8 cm)		Landed catch, cm^3 (big > 9 cm)		Discards as % landed big catch	Discards as % total catch	Commonest genera
		n	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Ali Shante	Reef	167	13	2	1162.8	522.3	5917.4	2664.3	30557.0	19087.0	3.8	3.1	*Leptoscarus, Siganus,*
Faki	Reef	209	11	2	1362.1	813.2	5658.7	2905.9	30974.1	19847.4	4.4	3.6	*Sphyraena, Lethrinus,*
Suleiman	Reef	104	13	2	1309.0	648.0	6044.7	3079.5	25938.2	15932.3	5.0	3.9	*Plectorhinchus* and
	Average		13	2	1278.0	661.1	5873.6	2883.2	29156.4	18288.9	4.4	3.5	*Lutjanus*
Shame Ali	Marina	226	20	3	5165.3	2433.5	11834.1	7140.6	42350.8	23715.1	12.2	8.7	
Sheha	Marina	186	19	3	4288.4	1684.9	7770.2	4298.8	31102.8	12676.0	13.8	9.9	
Suleiman Mweusi	Marina	40	15	2	4716.8	2635.1	13970.0	6352.7	45542.4	16789.2	10.4	7.3	
	Average		18	3	4723.5	2251.2	11191.5	5930.7	39665.3	17726.8	11.9	8.5	
Total			93		18004		51195		206465		8.7	6.5	

has received good support from older fishers who mainly use traditional gear, and very little support from young fishers who use modern gear. Nevertheless, gear restrictions and mesh size limits form the main fisheries management tools employed by the fisheries regulatory authority – the Fisheries Department. Despite the existence of such gear restrictions, beach seines and spear guns still account for a very high percentage of reef fish landings from the Mombasa Marine Reserve (Mangi 2006). This must be attributed to the increasing poverty among fishers which hinders their ability to invest in more expensive gears. New entrants to the fishery usually select beach seines or spear guns, as they are the least cost gears to the fishermen (Glaesel 2000, Mangi *et al.* 2007). It could also be due to the lack of political will to enforce regulations. The predominantly small-scale and subsistence nature of the coastal fishery means that the real benefit of the coral reef resource is often overlooked by the government. In Kenya, marine fisheries comprise less than 5% of the national fisheries production (Obura 2001). Further, the Fisheries Department has scarce staff, some of whom are unskilled, and lacks resources for detailed study, monitoring and enforcement of complex multi-species multi-gear fisheries. KWS patrols in the park and reserve to enforce regulations have been fairly effective in the park and less effective in the reserves as KWS concentrates on enforcing regulations in marine parks where most revenue is collected (Muthiga 2001).

Research and monitoring

The reef lagoon in Mombasa has been a magnet for research and scientific interest that has raised the profile of the reefs to global significance. As a result a number of studies focusing on artisanal fishing (e.g. McClanahan & Mangi 2001, McClanahan and Kaunda-Arara 1996), coral reef ecology (e.g. McClanahan and Shafir 1990, McClanahan *et al.* 1996) and social dimensions of fishers (e.g. Glaesel 1997, 2000) have been conducted. A number of government departments e.g. Kenya Marine Fisheries Research Institute (KMFRI) and Kenya Wildlife Service (KWS), non-governmental organizations e.g. Coral Reef Conservation Project (CRCP) and Coral Reef Degradation in the Indian Ocean (CORDIO), and universities e.g. Moi and Nairobi have offered scientific expertise to study the various aspects of the reefs. Many studies have focused on the effect of protective management on fish populations and have made comparisons based on fished and unfished areas. Few detailed studies have been conducted on the response of catches to gear restrictions. Reporting of the results from most studies have targeted publications in peer-reviewed journals, theses or local project reports and have rarely been presented in a simple way for policy makers or resource users.

Management of the fisheries also requires information on the resource. In Kenya, fisheries statistics collected from most landing sites by Government Fisheries Officers are still not reliable and comprehensive enough to provide a complete picture of the status of the resources. While landing data collected by NGOs e.g. CRCP and CORDIO East Africa is fairly good and reliable, it is mainly focused at a few landing sites.

Awareness and education

Education and awareness are major components of any interventions associated with preventing reef decline and are an important part of developing a better understanding of issues amongst user groups as a means of creating a willingness to change attitudes and behaviours. Education is often focused on informing user groups of the negative impact of their actions on the health of the reef and can be used as a means of informing locals of the objectives of an intervention in order to gain their support. Awareness raising programmes and local community involvement in management initiatives therefore needs to be a key part of the management plans early on before the intervention is implemented. Education and awareness on reef conservation and management issues has generally lagged behind in Mombasa. The MPA and fisheries regulations were initiated without adequate consultation and participation of the local communities (Muthiga 2001). This has led to a series of conflicts and slowed down implementation of management plans. However, recently education and awareness campaigns have improved with educational activities such as marine environment day and international coastal clean up taking place annually, involving school students, fishers and boat operators. Research NGOs including the Coral Reef Conservation Project (CRCP) and Coral Reef Degradation in the Indian Ocean (CORDIO) East Africa have also recently initiated annual meetings involving local fishers and Fisheries Officers where monitoring data on fish catch and other environmental data such as live coral cover, fish and sea urchin biomass are presented and discussed.

Lessons learnt

Process of establishing the MPA

The process leading to the establishment of an MPA is critical as it can support or hinder effective management. The Mombasa Marine Park and Reserve was initiated without adequate consultation and participation of the local community. This has led to conflicts and slow implementation of management plans (Muthiga 2001). To win the support of the communities, KWS has had to use dialogue and community projects including assistance with boats and fishing gears. When communities perceive tangible benefits of MPAs they are more likely to comply with regulations.

Restoration of coral reef habitats

The establishment of the park has led to a marked improvement in the coral reef habitats. Coral cover as an indicator of reef health has increased over the years. Fish biomass and sizes have also increased and the sea urchin biomass has also gradually decreased over the years (McClanahan and Kaunda-Arara 1996). Protection has therefore been beneficial to the Mombasa Marine Park.

Supporting adjacent fisheries

The elimination of fishing in the park has led to an increase in fish biomass that is dispersing into the adjacent artisanal fishery hence supporting the fishery. Because the park contains more and large fish, protected populations can potentially produce many times more offspring than can exploited populations. The increase in egg output will supply adjacent fisheries through export of offspring on ocean currents. In addition, as protected stocks build up, parks are predicted to supply local fisheries through density dependent spillover of juveniles and adults in to fishing grounds.

Compliance with MPA regulations

The level of compliance with MPA regulations differs among stakeholder groups.

Stakeholders who depend mostly on tourism show higher levels of compliance mainly because they understand the benefits of a managed system and improved habitats to their businesses. Fishermen groups on the other hand show a lower level of appreciation and compliance to park regulations (McClanahan *et al.* 2005b).

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The effect of a major coral bleaching event on the abundance and composition of carnivorous reef fish in Aldabra's marine protected area

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Abstract An increasing challenge in marine protected area management is how to deal with coral bleaching events, which could occur on an annual basis in the not too distant future as global temperatures continue to rise. Coral bleaching is relevant to fisheries management as fish populations may respond to changes in reef viability. Successive degradation of the reef framework is likely to follow bleaching events. Most reef associated fish depend on coral structures for shelter and are expected to be influenced by this loss of habitat. As a result of the limited anthropogenic disturbances in MPAs they hold the potential to host empirical studies that will allow us to assess the effect of bleaching events on reef associated organisms. The MPA around Aldabra is particularly relevant because its remote location coupled with the inhospitable terrestrial environment have resulted in minimal direct human influences. The present study reports on information gathered from a small scale subsistence fishery at Aldabra. In 1998 a major coral bleaching event resulted in the mortality of between 38 and 66% of coral at Aldabra. Since 1998 details of all fishing trips around Aldabra have been recorded, including species composition, weight for each species, number of lines and duration of the fishing trips. This allowed us to estimate annual catch per unit effort (CPUE), which is a standard index of abundance, for the period 1998-2006. These estimates were compared over time to determine whether CPUE declined after the 1998 coral bleaching event. We demonstrated a significant decline in CPUE over the study period and argue that this was a likely response to climate mediated habitat degradation.

Introduction

Predictions of the future of coral reefs world-wide are bleak (e.g. Hoegh-Guldberg *et al.* 2007) and marine protected areas, which are exposed to limited anthropogenic influences, can serve a critical role in testing some of these predictions. The symbiotic relationship between corals and zooxanthellae breaks down at a threshold water temperature when zooxanthellae leave the tissues of their host (Glynn and D'Croz 1990; Lesser *et al.* 1990). This is known as coral bleaching and often leads to coral mortality. These threshold water temperatures, thought to be around 30°C (Brown 1997) are being reached increasingly frequently as temperatures rise due to the accumulation of atmospheric greenhouse gases (Bijlsma *et al.* 1995). By as soon as 2050 it is thought that bleaching may become an annual event in most oceans (Hoegh-Guldberg 1999).

Reef-building corals provide the primary shelter for most organisms associated with coral reefs. Changes in the abundance of these corals are therefore likely to influence almost all constituents of coral reef systems. As habitat composition and complexity is altered due to a reduction in live coral cover and dead coral structures, the abundance and diversity of fishes can be expected to change (Roberts and Ormond 1987; Lindahl *et al.* 2001; Booth and Beretta 2002; Spalding and Jarvis 2002; Wilson *et al.* 2006; Graham *et al.* 2007). It is consequently thought that fishing yields could be vastly reduced as reef viability decreases (Munro 1996; Öhman 1999), and this could have major socio-economic implications (Cesar 1999).

Marine protected areas (MPAs) are generally exposed to limited and controlled direct anthropogenic effects. They are therefore critical for empirical studies aiming to quantify the impact of bleaching events on coral associated organisms. Information obtained from such studies is in turn important for decision makers managing these areas. Knowledge of the relationship between coral bleaching and the abundance of target species can be applied to more effectively manage fishing effort in MPAs to meet stipulated goals.

Historically marine resources at the raised coral atoll of Aldabra have been conserved by virtue of the atoll's isolation and inhospitable environment. Consequently, Aldabra forms an ideal laboratory to study the marine environment as it has been little affected by human presence. Aldabra received formal conservation status in 1981 when it became a Special Nature Reserve (and then a UNESCO World Heritage Site in 1982), but prior to this there would have been minimal or no commercial exploitation since the early

1960s when the Royal Society of London took over the administration of the Atoll. From this period limited exploitation to supply the small number of residents at the research station would have been in place. Reef associated fish at Aldabra are consequently likely to have been among the least affected worldwide by fisheries.

Aldabra is situated in the southwest of the exclusive economic zone of the Republic of Seychelles (9°24´S, 46°20´E), 420 km to the north of Madagascar (Fig. 1). The MPA at Aldabra extends one kilometre outwards from the coastline and comprises 89 km^2. Including the lagoon inside the atoll, the total area is 282 km^2.

The 1998 coral bleaching event, considered to be the most severe and geographically extensive bleaching event on record (ISRS 1998; NOAA 1998), had a major effect on coral reefs in Seychelles (Teleki *et al.* 1998), including the southern island of Aldabra (Spencer *et al.* 2000). Mortality of coral at Aldabra following the bleaching event was approximately 66% at 10 m depth and 38% at 20 m depth with no significant recovery of hard corals since (Stobart *et al.* 2005).

The objective of this study was to estimate Catch Per Unit Effort (CPUE), a standard index of abundance, from a small scale subsistence fishery at Aldabra over the period 1998-2006. Fishing pressure has been similar over this period (see Results, Table 1). Thus if the decline in live coral has affected populations of fish species important in the local catch, then a decline in CPUE might be expected following the 1997-1998 bleaching event.

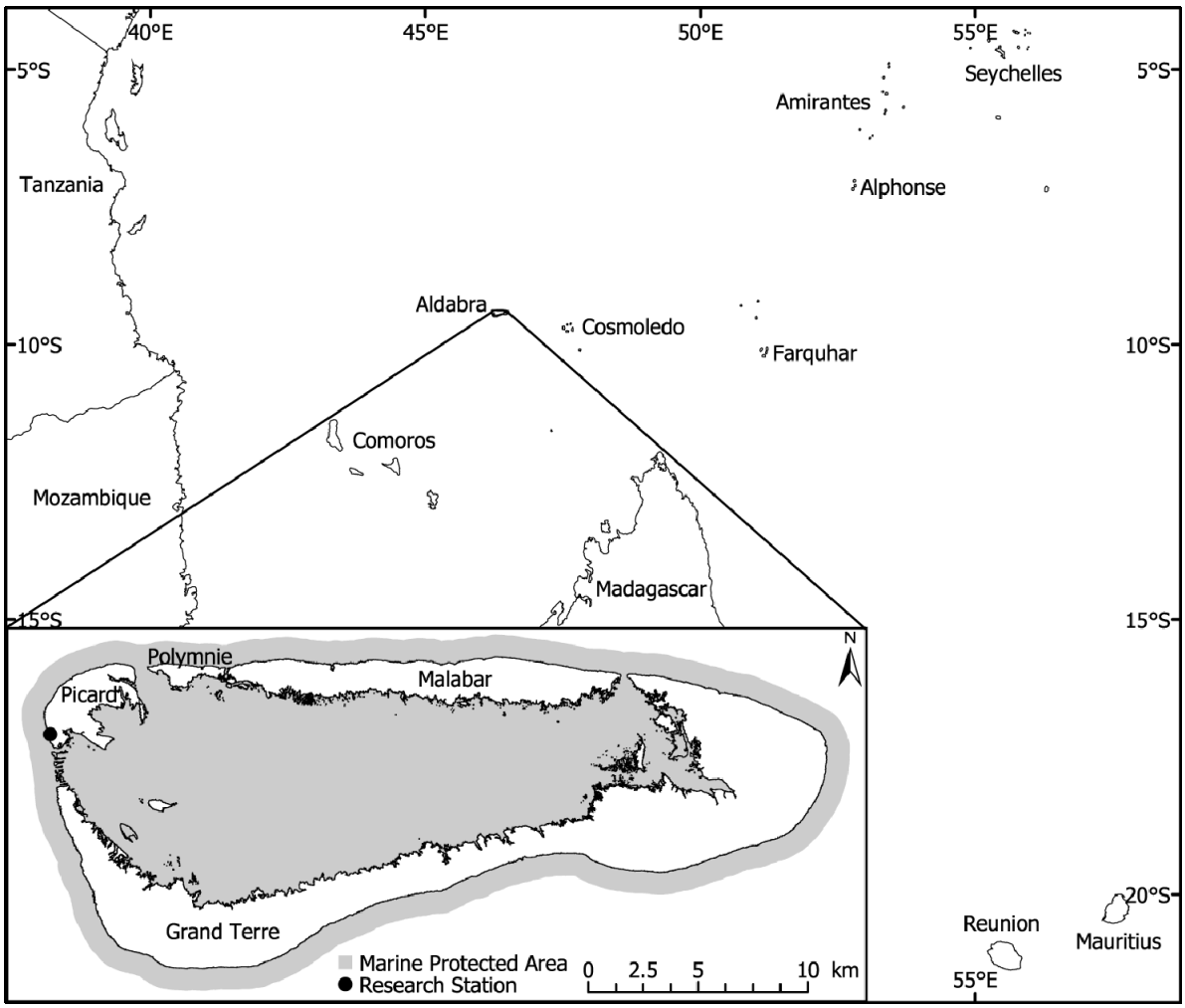

Fig. 1. The location of Aldabra Atoll in the Western Indian Ocean.

Materials and methods

Fishing was based on the reefs around the perimeter of the atoll. Fish were caught using hand lines with baited hooks. During fishing, the boat was not anchored and would drift. Fishing effort was distributed over large parts of the atoll but was mostly centred in the western, north- and south-western side of the atoll in close proximity to the research station. Since 1998, all fishing activities at Aldabra have been monitored. The duration of the fishing trip, location, number of fishers, number of fish of each species caught and their total weight were recorded. This

information was stored in an Excel spreadsheet. CPUE was calculated as kg per fisher per hour and the trip estimates were averaged to get annual estimates. We tested that our CPUE trip estimates were normally distributed, after which we regressed these against year. The three primary families making up the bulk of fish caught at Aldabra were the Serranidae (groupers), Lethrinidae (emperors) and Lutjanidae (snappers). We calculated the annual proportion of weight from each family making up the total catch from the three families. These were compared over the study period.

Results

From 1998 to 2006, details from 230 fishing trips were reported on Aldabra. A total of 7197 bottom fish were caught and weighed with a total weight of 14 378 kg (Table 1). The annual range in number of fish caught and their weight varied between 601 and 991 weighing 991 kg and 2242 kg respectively. From the landings, 49 species were identified and the 15 most important in terms of biomass caught are listed in Table 2 in order of importance. The following species, *Variola louti, Lutjanus bohar, Lethrinus nebulosus, Epinephelus multinotatus* and *Epinephelus polyphekadion* made up 80% of the total catch over the study period.

Annual CPUE varied between 3.01 and 5.10 $kg.h^{-1}$ per fisher during the study period (Fig. 2). The CPUE trip estimates were not normally distributed and the data was square root transformed to achieve normality. Using these data, we found a significant decline in CPUE since 1998 (F_{229}=5.93, p=0.015). It is interesting to note that there was not much change in CPUE the first three years after the bleaching event. Averaged over three year intervals, CPUE was 4.97 from 1998 through 2000, and 3.67 from 2004 through 2006. CPUE was therefore about 25% lower over the last three years of the study relative to soon after the bleaching event.

Table 1. Total weight of demersal fish caught at Aldabra during the period 1998-2006

Year	Catch (kg)
1998	1,742
1999	1,430
2000	1,817
2001	2,246
2002	1,309
2003	991
2004	1,147
2005	1,748
2006	1,948
Total	**14,378**

Over the study period there was a significant relative increase in the proportion of weight contributed by the grouper family (Mann-Whitney U test; Z-Value= -6.07, p<0.001) with a significant reduction in weight by the emperor family (Mann-Whitney U test; Z-Value= 7.21, p<0.001; Fig. 3).

Table 2. Total weight of the 15 most important fish caught at Aldabra between 1998 through 2006.

Scientific name	Common name	Weight (kg)
Variola louti	Yellow-edged lyretail	3094
Lutjanus bohar	Twinspot snapper	3034
Lethrinus nebulosus	Spangled emperor	2269
Epinephelus multinotatus	White blotched grouper	1611
Epinephelus polyphekadion	Camouflage grouper	1592
Epinephelus tukula	Potato grouper	668
Plectropomus punctatus	Marbled coral grouper	331
Lethrinus rubrioperculatus	Redgill emperor	240
Epinephelus fuscoguttatus	Brown marbled grouper	226
Cephalopholis miniata	Coral hind	141
Epinephelus macrospilos	Snubnose grouper	134
Plectropomus pessuliferus	Roving coral grouper	122
Lutjanus gibbus	Humpback snapper	120
Sufflamen fraenatum	Bridled triggerfish	92
Lethrinus olivaceus	Longface emperor	87
Rest		583
Total		**14344**

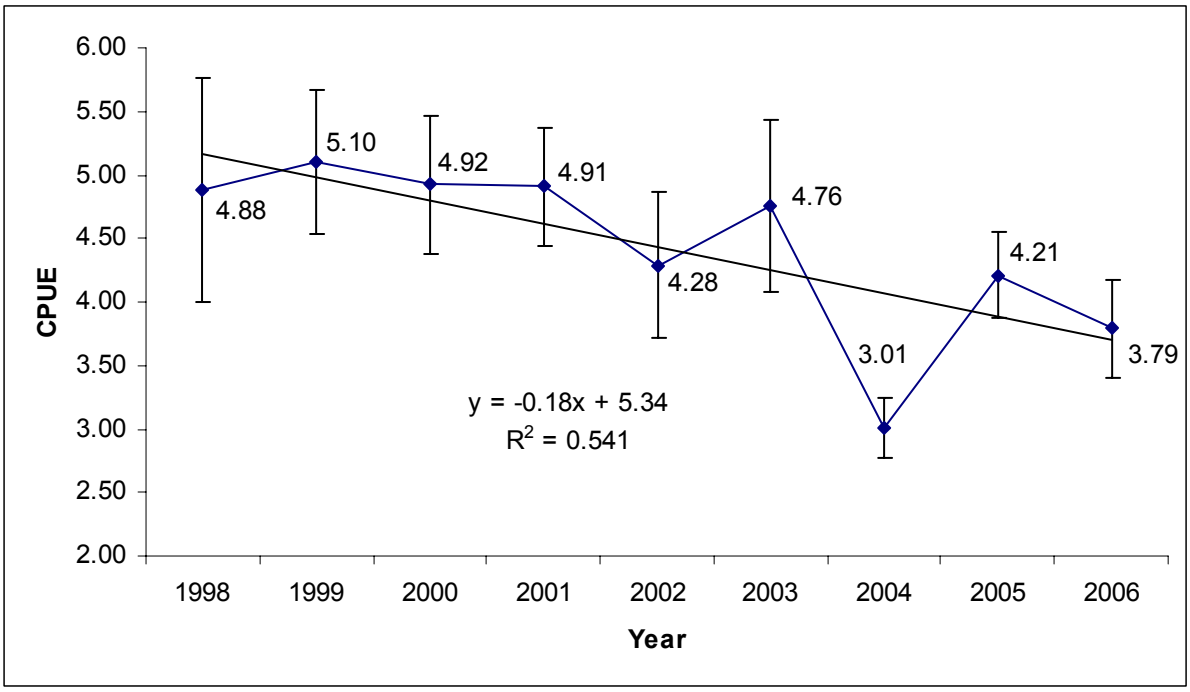

Fig. 2. Catch per unit effort estimates (kg.h^{-1} per fisher ±SE) from a small scale subsistence fishery at Aldabra for the period 1998-2006.

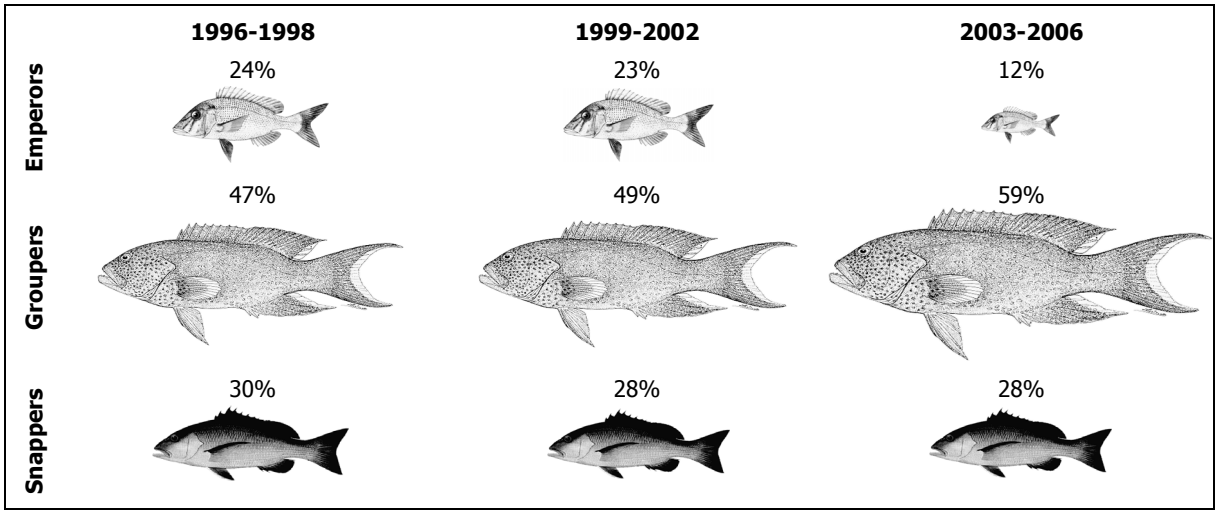

Fig. 3. Changes in catch composition in terms of weight of the three major fish families (Lethrinidae, Serranidae and Lutjanidae) caught at Aldabra.

Discussion

It is well accepted that reef fishes worldwide are under much pressure due to increasing human demand and life-history characteristics that render them susceptible to overexploitation (Jennings *et al.* 1999; Sadovy 2005; Newton *et al.* 2007). A more recent concern relates to the effect of coral bleaching events on reef associated fish (Booth and Beretta 2002; Sano 2004; Graham *et al.* 2006). In the likelihood that continued reef degradation will be an ongoing phenomenon, it is of vital importance to establish to what extent reef fish stocks are affected by coral bleaching and the associated loss of habitat complexity. Although the severe ecological consequences of the coral bleaching event in 1998 have been realized, much less is known about the socio-economic implications of such an event. Results from the current study suggest that carnivorous species, which many people in the Indian Ocean depend on for subsistence or revenue, are at least in some cases negatively influenced by coral bleaching events.

In the remote and relatively pristine waters surrounding Aldabra, it is very unlikely that the trend observed in this study was a result of direct anthropogenic influences. According to the maximum

reef fish production rates predicted by published models and theory, an annual off-take of 10 $t.km^{-2}$ could be achieved sustainably (Dalzell 1996; Polunin *et al.* 1996). Empirical studies of coral reefs have shown long term yields of between 2-4 $t.km^{-2}$ and 15-20 $t.km^{-2}$ per year, although at a risk of fishing down the food web so that fast growing herbivores, detritivores and invertivores dominate the catch (Maypa *et al.* 2002; Kaunda-Arara *et al.* 2003). We therefore expect the harvesting of only 1-2.3 tonnes of fish per annum at Aldabra to have a negligible effect on the fish resources here. Illegal fishing activities on the reefs of Aldabra have also very seldom been observed. Such activity is unlikely to go unnoticed as a result of the regular presence of field rangers at the field camps all around the atoll.

Other factors that may influence CPUE estimates include fishing gear used as well as the locations that are fished. Fish abundance can be expected to vary to some extent around the atoll and more productive areas may have been fished in some years. The fishing gear used has, however, remained consistent and there does not appear to have been any substantial differences in the areas fished throughout the study.

Few studies have focused on the changes in abundance of reef associated fish following coral degradation. Both Öhman *et al.* (1999) and Sano (2004) found no reduction in fish abundance the year following the 1998 bleaching event and suggested that as long as the structural complexity of the reef is maintained, abundance could remain unaffected. The importance of long-term monitoring of fish assemblages following habitat alteration have been demonstrated by Garpe *et al.* (2006) and Graham *et al.* (2006, 2007). Over the short-term they found no reduction in abundance or species diversity after the 1998 bleaching event but over the long-term significant changes were observed. The current study lends further support to this notion as CPUE remained stable for the first few years after the bleaching event before declining. CPUE data from coral reefs in Kenya have been compared prior and after the bleaching event (McClanahan *et al.* 2002). Although a decline in CPUE was observed it was argued that this might have been a result of a concurrent increase in fishing effort. The importance of MPAs, where changes in fishing effort are not a confounding factor, in such studies is thereby accentuated.

The Aldabra Marine Programme was established in 1999, soon after the 1998 bleaching event, and has been monitoring the coral reef ecosystem at Aldabra Atoll ever since (Teleki *et al.* 1999). No significant recovery of hard corals had been found here up to 2003 (Stobart *et al*. 2005). Likewise, fish-species diversity appeared to remain unaffected during this period (Downing *et al.* 2005). Piscivore numbers ranged widely over time, probably as a result of the limited surface area covered (Downing *et al.* 2003). Worth noting is that fish numbers in several families, including serranids, were correlated with the percentage of live coral. Accordingly, coral mortality following bleaching events is expected to influence abundance of many reef associated fish.

The proportion of emperors in the catch declined through the study suggesting that they might have been more influenced by the bleaching event than the other two dominant families. Both groupers and snappers feed primarily on fish but also crustaceans. Invertebrates form a larger part of the diet in emperors (Nelson 1994), and these may have been negatively influenced by the loss of coral, thereby resulting in increased mortality in this family.

Although reef fish assemblages may vary spatially as a result of prevailing conditions, the CPUE estimates from the present study may serve as a useful benchmark for MPA managers in the region. The current study suggests that reefs that are exposed to very limited fishing pressure would be expected to yield around 3–5 $kg.h^{-1}$ per fisher using similar fishing techniques. By contrast, studies of heavily exploited reefs suggests yields of 0.7–2 $kg.h^{-1}$ per fisher (Amar *et al.* 1996, Laroche *et al.* 1997, Maypa *et al.* 2002).

Marine protected areas can and should play a key role in ascertaining the effect of large scale phenomena, such as bleaching events, on reef associated organisms. In most parts of the Indian Ocean, regulation of fishing effort is non-existent. The large number of small fishing vessels from which so many Indian Ocean fishers operate makes monitoring of their activities and their impact on the environment difficult. It is therefore important to realize the value of MPAs where reef systems that are exposed to limited and measurable human disturbances can be monitored.

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Integrated coastal management in West Africa. Integration in process: the case of Cayar, Senegal

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Abstract Depuis quatre ans, le WWF travaille avec le Ministère de l'Environnement, la Direction des Pêches, la Mairie, et les citoyens de la ville de Cayar (50 km au nord de Dakar) pour établir un système de gestion intégrée de la zone côtière. Cayar est un des plus importants sites de débarquement de poisson au Sénégal. Cinquante mille tonnes y sont débarquées annuellement.

L'approche adoptée est à la fois pragmatique, dynamique et évolutive. Nous avons choisi comme point de départ la gouvernance de la pêche. Puis, à un rythme dicté par la population, d'autres aspects dont la transformation, la commercialisation, la résolution des conflits, la salubrité et la communication ont été progressivement abordés.

Les techniques développées à Cayar sont actuellement en train de se faire adapter pour d'autres sites au Sénégal.

Ce processus est toujours en phase de mise en œuvre. Par contre, les leçons les plus importantes que nous avons retenues sont :

- Toutes les parties prenantes doivent se mettre d'accord sur les problèmes à résoudre et les actions prioritaires à mener. Convertir les passagers en équipage.
- Il est important que le processus d'intégration évolue graduellement au lieu d'essayer de tout organiser dès le commencement. Cette évolution doit être dirigée directement par les parties prenantes - y compris l'Administration, les utilisateurs et les organisations non gouvernementales.
- La gouvernance (qui fait quoi, comment, quand, etc.) et le contrôle du processus doivent être basés sur l'approche participative. En apportant des solutions aux priorités identifiés par la population, un climat de confiance s'installe et les parties apprennent à travailler ensemble ; ce qui facilite l'intégration graduelle d'autres secteurs moins directement liés à la zone côtière tels que la gestion des déchets ménagers et la radio communautaire.
- La GIZC est un outil puissant pour montrer les liaisons entre la bonne gestion de l'environnement, l'amélioration du cadre de vie (y compris la réduction de la pauvreté et le renforcement de la sécurité alimentaire) et la résolution des conflits.

Abstract WWF, the Senegalese Ministry of Environment, the Department of Fisheries, the Mayor's office, and the citizens of Cayar (a small town 50 km north of Dakar) have been working toward integrated coastal management (ICM) system since 2002. Cayar is one of the most important fish landing sites in Senegal with about 50 000 tons of fish debarked annually.

The approach to ICM has been pragmatic, dynamic, and adaptable. Fisheries management was chosen as the starting point as it is at the center of commercial, cultural, and political life. The approach has been gradually expanded from a purely fisheries focus to include fisheries management (creation of a 171 km² MPA and a change in national legislation), fish processing by local women (improved quality of product, improved hygiene), marketing, micro-finance, conflict resolution, sanitation (household rubbish collection) and community radio.

The techniques developed through the Cayar experience are currently being adapted for other Senegalese sites.

This is a work in progress. However, the key lessons learned thus far are:

- All the stakeholders have to agree on what problems need to be resolved and the highest priorities for action. Turn passengers into crew.
- It is important that the process of integration evolve gradually rather than trying to implement a comprehensive programme all at once. The evolution of the programme must be piloted by the stakeholders-including central and local governments, resource users, and NGOs.
- Governance (who does what, how and when) should be based on a participative approach. By finding solutions to issues identified by the stakeholders, confidence is built between the various parties. This facilitates a gradual expansion of the areas of intervention to those less directly linked to the coastal zone (e.g. household rubbish collection, community radio, etc.);
- ICM is a particularly powerful tool to demonstrate linkages between sound environmental management, improved quality of life (including poverty reduction and improved food security), and conflict resolution.

The evolution of integration in Cayar, Senegal

Most people would agree that integrated coastal management provides the most effective overall framework for coastal development- including the establishment of marine protected areas (MPAs) (SEACAM 2001). Including MPAs in a broader planning context, helps conservation takes its rightful place as a *bona fide* land use rather than being perceived as an activity isolated from the outside world and reduces the risk of having MPAs develop as islands of nature disconnected from surrounded areas (Salm et *al.* 2000). However, due to the sectoral nature of government (Talbot and Wilkinson 2001) and the narrow focus of special interest groups, achieving broad-based consensus on what "integration" means and how it can be achieved, can stall progress for years.

WWF's work with the community of Cayar has taken a different tack. Rather than attempting to push for the complete integration of all the various social, environmental and political agendas we chose to work outwards from a "consensus point" and gradually expand the scope of integration through a more "organic" process.

The most important single issue facing Cayarois is fishing (WWF-WAMER 2006). From the onset, everyone in the community, which is dependent on fisheries and related activities for jobs, food, and social stability, agreed that local fisheries resources were dwindling and that strengthening management was critically important. The fishers had established a voluntary management system whereby access and catches were limited but their system threatened to break down as migrants from other parts of the coast fished local waters. In Senegal, the fisheries sector is not decentralized and the sea is seen as a common resource. Local communities do not have a legal right to establish management regimes. Disputes between line fishers and net fishers, between locals and visitors, were common and sometimes violent (Fisheries Department, personal communication).

WWF, the Mayor's office, representatives of central government, and those involved with fisheries and related economic activities (fishers, women fish processors, sellers, etc.) met to discuss how to make fishing sustainable, and to identify what was not working and how to fix it. This led to the development of a set of prioritized activities including helping the various factions reach agreement on local fisheries management rules and a recognition of the need to promote a change in government regulations to allow local actors to participate as co-managers with officials of the Fisheries Department. A committee was established with representatives of all the groups- including the migrants- to agree the "rules of the game". At the same time WWF and its Senegalese partners pursued efforts to promote a change in regulation allowing the legal establishment of co-management committees.

Over the course of discussions, several important issues were raised- one being that while fisheries management wasn't decentralized, the establishment of protected areas was. Citizens recognized that by establishing a marine protected area, they could establish zoning and protect key fish spawning, nesting and nursery areas- thereby promoting stock replenishment and sustainability. A decision was made to set up an MPA which would protect fishing and also provide a starting point for ecotourism.

Economic development was identified as a high priority and, while improving fishing and establishing an MPA were welcomed, it was clear that in order for a new equilibrium to be established, the needs of other key players had to be addressed. This led to the construction of improved smoking ovens which increased yields and reduced costs (and the need for fire wood) and the upgrading of the processing areas by tiling and the introduction of running water. Improved hygiene standards resulted in increased profitability.

Each activity resulted in improved civic awareness of the importance of managing the wider environment. Improved awareness coupled with concrete advances generated ever increasing local support.

Another issue raised, primarily by women, was a need for access to credit with which to buy better equipment, to allow them to sell more widely, and to diversify from just fish related activities to opening small shops and small scale agriculture projects. The fisheries committee, the Mayor's office and WWF raised funds to establish a local credit union which provided access to small capital (WWF-WAMER 2006). The credit union was initially capitalized with about 18 000 euros which, after less than two years, has now been repaid. The credit union will be able to absorb staff costs within another year so the whole activity will be self supporting. The General Assembly of the Credit Union decides how to spend the profits from interest payments and this year contributed to building a mosque (the center of community life), build an enclosure around the local cemetery, and clean up the beach and fish market.

In addition to improving fishing management, fish processing, and making small loans available, sanitation was another high priority identified during community meetings. Over the course of 18 months, WWF worked with the Mayor's office, two local NGOs and various civic committees to set up a rubbish collection scheme which created employment for 6 people and generates enough money to be self sustaining.

The most recent addition to the ever widening sphere of integrated activities is the construction of a community radio station which will be operational early in 2009. In addition to entertainment, the station will provide information of sea conditions, market conditions, and provide a forum for public debate. It will also be a vehicle to communicate messages and programmes about environmental issues and

sustainable use of natural resources. The station will be a source of community pride and serve as a very strong social "glue" allowing the community members access to valuable information tailored to the local situation.

As all this has been evolving the Government has passed new regulation officially recognizing the Local Artisanal Fishing Committee as a *bona fide* entity- meaning that decision taken are legally binding. Users have become managers.

Where do we go from here?

- Monitoring: quantifying the gains.
- Joint coastal use planning at the level of the mayor's office.
- Spreading the model to other towns through the use of exchange visits, and Cayarois "ambassadors".

Lessons learned

1) Integrated Coastal Management can evolve organically- in ways that are difficult (if not impossible) to predict but the results are clear: Social, Environmental, Political and Commercial interests working together to achieve the sustainable use of coastal resources.
2) Initiating activities based on priorities identified by the local community not only has direct social impact but also build credibility for WWF and make people more open to hearing about (and addressing) environmental issues.
3) Confidence building is an essential step. By helping improve people's standards of living, we not only promote sustainable utilization but also build the partnerships upon which extended environmental management can be based.
4) Communication is the key. Every society has its own way of doing things so social integration is the cornerstone to eventually integrating technical sectors. Committee meetings take time but place responsibility on local shoulders. Passengers become crew.
5) Sustainability is essential. Each step forward needs to be carefully sculpted to ensure that when support from outside ends, progress is maintained.

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Useful websites

www.defra.gov.uk/environment/water/marine/uk/iczm/
ec.europa.eu/environment/iczm/home.htm
www.pap-thecoastcentre.org/itl_public.php?public_id=85&lang=en
www.solentforum.hants.org.uk/CoastalMgt/ICZM.htm
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oceanservice.noaa.gov/

Conflict management in Mombasa Marine National Park and Reserve, Kenya: a spatial multicriteria approach

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Abstract Multiple uses of the marine and coastal environment inevitably lead to spatial conflicts. This paper examines a methodology designed to inform management decisions on conflict management by identifying conflict hotspots and determining optimal feasible use patterns. The methodology involves three stages: multicriteria decision analysis (MCDA), geographical information systems (GIS) and integer goal programming (IGP). We use the case study of Mombasa Marine National Park and Reserve to illustrate how the methodology can be implemented. We make suggestions of further work that is needed in order to validate and improve the methodology developed here.

Introduction

Marine and coastal environments host a multitude of human activities. Near-shore activities include sailing, swimming, jet skiing and some fishing (e.g. beach seining). On the shore activities include commercial ventures on the beaches (e.g. curio selling, tour boat operators) and recreational pastimes (e.g. cycling, walking). Out on the reefs activities include gleaning, leisure walking on the exposed reefs at low tide, snorkelling and diving. In each of these areas there are critical habitats which are under threat from these human activities such as coral reefs, seagrass beds, and turtle nesting grounds. Conflicts can exist between human activities and habitat protection and also between competing activities such as fishing and water sports. This paper looks at the case of the multiple use of a marine protected area (MPA) in Mombasa, Kenya to investigate how conflicts can be managed and minimised.

The approach used in this study combines three methodologies – multicriteria decision analysis (MCDA), geographical information systems (GIS) and integer goal programming (IGP). MCDA was applied to incorporate the preferences of interest groups into a formal decision analysis procedure. Spatial information about the physical environment, the ecosystem and social structures was integrated into the multicriteria framework. This spatial information was overlaid in a GIS to identify overlapping interests and areas of intense conflicts. IGP involving optimization of a choice function was employed to find the best solution for optimal resource use that would minimize conflicting objectives.

Mombasa Marine National Park and Reserve (MMNP&R) are characterised by multiple-use in which conservation is balanced with various socio-economic activities. Prior to the establishment of the MPA, consultations with key stakeholders were not adequate and today different interests still conflict and activities remain uncoordinated. The nature of these conflicts between different resource users is mostly associated with location and physical space. Conflicts related to control and access in the MPA occur between: 1) same resource users; 2) different resource-users; and 3) between different management agencies. Conflicts between fishers occur when different fisher groups apply different fishing gear and when they compete for sole fishing rights in the MPA. Fishers also compete for space with other users like divers and jet-ski users. Protection of critical habitats is threatened by increased tourism activities and unsustainable fishing practices. Recreation activities that include diving, snorkelling and reef walking at low tide are responsible for degradation of seagrass beds near the shore and the disturbance of intertidal and reef organisms. A wide range of institutions and agencies are involved in the management of marine and coastal resources in Kenya. These include the MPA authority, Fisheries Department, tourism department, the Maritime Authority and the local authority. The majority of these have divergent goals, objectives and interests and implementation of their policies results in resource use conflicts.

MCDA is a methodology that has been used in the context of environmental planning and project appraisal to address conflicting objectives between stakeholders over the use of scarce natural resources (Malczewski 1999; Edwards-Jones *et al*. 2000; Belton and Stewart 2002). Information about the physical environment, the ecosystem and social structures can be integrated in a multicriteria framework. With the help of this information, critical incompatibilities and

overlapping interests can be discovered. When MCDA is combined with GIS it provides the decision makers with a more rational, objective and unbiased approach to spatial decision making (Heywood *et al*. 2002). A combination of MCDA and GIS in marine spatial planning has been used in a number of studies (e.g. Villa *et al*. 2001; Brown *et al*. 2001; Brody *et al*. 2004, 2006). Combined multicriteria - optimization approaches are increasingly being used in environmental planning to facilitate spatial planning, particularly as a means of reducing conflict. Malczewski (1997) developed a combined Multicriteria Analysis and integer goal programming approach for land use analysis to allocate land to specific uses in a 19,000 km^2 region of Baja California, Mexico. In his approach he applies the Analytical Hierarchy Process, a MCDA method, to structure the land suitability problem. Romero and Rehman (1987) give a detailed review of applications of mathematical programming techniques to planning and management in water, fisheries, forestry and land resources. To our knowledge no research to date has applied a combination of MCDA, GIS and IGP in Marine Spatial Planning as we do in this study.

The study area

Mombasa Marine National Park and Reserve (MMNP&R) is a marine protected area (MPA) that lies between Mtwapa Creek and Tudor Creek in the North of Mombasa District of Coast Province, Kenya.

The MPA lies between 3^o 57 S' and 4^o 9'S, and 39^o 41'E and 39^o 52'E. The MMNP&R is zoned as two areas: Park and Reserve (Fig. 1). The park measures 10 km^2 and is a "no-take" zone. The area is open to public recreation but extractive uses are prohibited. The reserve measures 200 km^2 and is the area where public access and controlled extractive use of resources is allowed. The lagoonal part of the reserve is where most of the activities are concentrated and is the focus of this study. The study area covers 38.09 km^2 (3809 ha). The MMNP&R is an important location to study environmental conflicts in the coastal zone for the following reasons: 1) The MPA has a critical habitats – seagrass beds, coral reef, sandy beaches and intertidal flats – that are under numerous threats and require preservation; 2) these habitats are an important source of coastal livelihood fishing and tourism activities, 3) a wide range of interests and associated stakeholders use the MPA for a variety of purposes including fishing, tourism and beach developments, 4) different agencies are responsible for managing stakeholder activities in the MPA, and 5) the MPA is adjacent to a populated city making a place prone to environmental conflicts.

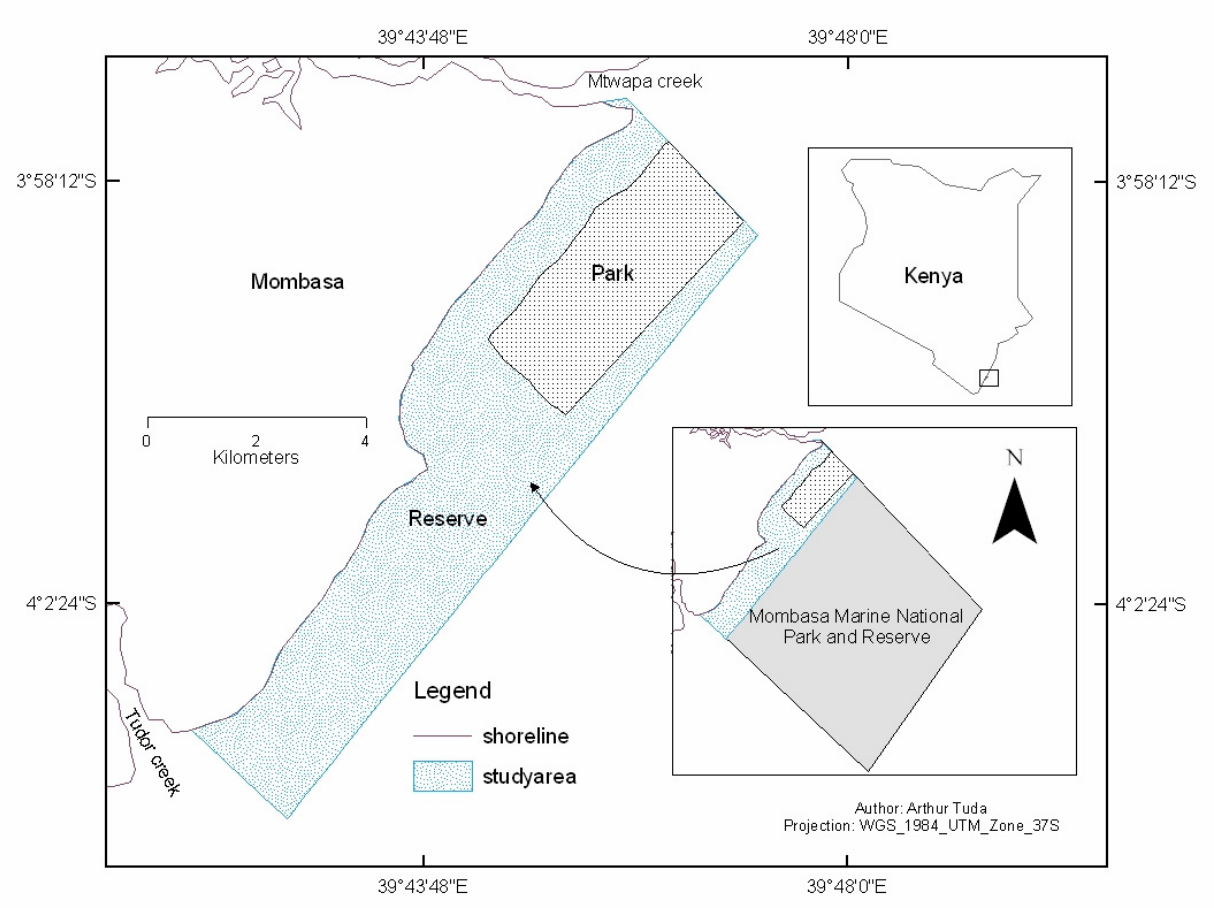

Fig. 1. Map of the study area, the lagoonal area of Mombasa Marine National Park and Reserve, Kenya.

Methodology

A schematic diagram showing the logical steps followed in this study is shown in Fig. 2. The conflict analysis applied consists of three basic phases. Firstly the conflicting stakeholder values causing conflict are determined. These values are structured hierarchically into objectives and attributes using the Analytical Hierarchy Process (AHP). Secondly Geographical Information Systems (GIS) is applied in evaluating the conflict areas. Thirdly Integer Goal Programming (IGP) is applied in finding optimal spatial allocation to minimize conflict.

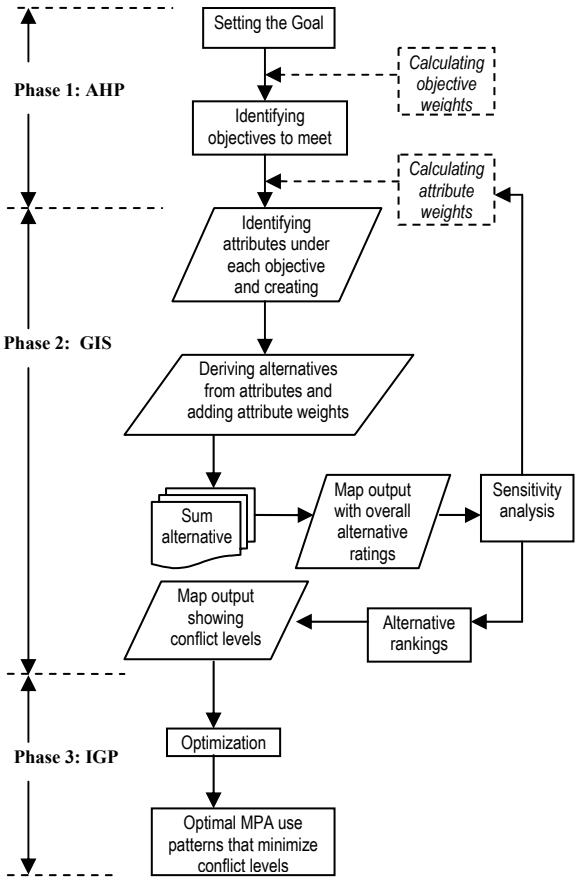

Fig. 2. A schematic diagram of the methodological steps followed in the analysis. AHP = Analytical Hierarchy Process, GIS = Geographic Information System, IGP = Integer Goal Programming.

Phase 1: The Analytical Hierarchy Process (AHP)

AHP is used to structure the problem and to incorporate the conflicting stakeholder values into a formal procedure (Saaty 1980, 1981; Hunjak 1997; Malczewski 1999). The basic steps of constructing and examining an AHP model are used: (1) decomposing the problem into a hierarchical structure, (2) performing judgments to establish priorities for the elements of the hierarchy, (3) synthesising the model, and (4) performing a sensitivity analysis.

The problem is constructed in a hierarchical structure consisting of goal, objectives, attributes and alternatives (Fig. 3). A goal is what the decision maker wants to achieve (Malczewski *et al*. 1997). To achieve this, a set of evaluation criteria (Eastman *et al*. 1995) which include objectives and attributes are needed. The objective and attribute are the measurable basis on which decisions about the extent and location of conflicts are made and here they are the stakeholder values. The attributes are related to geographical entities and are therefore represented as maps which are referred to as attribute maps. The value of an attribute is measured by an alternative. These alternatives are represented as cells or pixels in raster GIS.

After constructing the AHP hierarchy, weights of relative importance are assigned to individual objectives and attributes in each level of the hierarchy. The weight indicates the degree of importance attached to the objectives and attributes relative to others under consideration. The pairwise comparison technique is applied in assigning the weights (Saaty 1980; Saaty and Alexander 1981). The method involves pairwise comparison to create a ratio matrix. The method uses a scale with values ranging from 1 to 9 (1 equal, 3 weak, 5 strong, 7 very strong, 9 absolute). The AHP has the subjective judgement of the decision maker as the input and the quantified weight of each objective and attribute as the output. The output is a ranking of weights indicating the overall importance for each of the objectives and attributes in achieving the goal. First, judgements are made to establish the relative importance of each objective to another within a specified scenario. The objectives were compared under four MPA management goals (scenarios):

1) Present scenario where the overall MPA goal is to promote a balanced MPA use to meet biological, social and economic objectives.
2) Potential scenario where there is increased use of the MPA for exploitation (i.e. extractive uses mainly fishing).
3) Potential scenario where there is increased use of the MPA for recreation and public access.
4) Potential scenario where there is increased use of MPA for habitat and species protection.

The comparisons between objectives were made by asking the question: of two objectives which one causes more conflict more within a specified scenario? The objective weights were assigned by the MPA management team members of which have a good knowledge of the objectives and their roles in contributing to conflicts. The next step was to assign weights to the attributes under each objective. This was done by three experts having respective interest in and knowledge of environmental conservation, tourism and fisheries. These experts were from government agencies mandated to manage Wildlife, Tourism and Fisheries respectively. Employees of the Kenya Wildlife Service, which is responsible for the

management of the MPA, weighted the attributes under the critical habitat protection objective; the tourism expert weighted the attributes under the sea access, recreation and commercial activities on the beach objectives and the fisheries expert weighted the attributes under the fisheries objectives (Fig. 3). Comparisons of attributes were made by asking the question: of two attributes which is more important with respect to contributing to MPA user conflict within a particular objective. Weights were generated following the method described by Saaty (1980). The vector of weights arranged the relevance of each attribute. The vector of weights for each attribute was multiplied by the weight of the corresponding objective to determine the overall contribution of each attribute to the goal for each management scenario.

Phase 2: GIS

The GIS phase involved representing each attribute as a map layer in the GIS database. Different habitat maps were developed using Landsat Enhanced Thematic Mapper (ETM+) sensor images while stakeholder activity maps were developed from primary data collected of the GPS locations of these activities. The attribute weights derived in Phase 1 were then multiplied by respective attribute map layers in the GIS database to determine the coefficient of conflict of each attribute. The coefficient serves as a rating of the effectiveness of each attribute in achieving the goal (A high coefficient value indicates a higher effectiveness and vice versa). The resulting map layers were combined linearly to obtain the overall conflict ratings. The attribute maps layers were processed using the Environmental Systems Research Institute's (ESRI) ArcMap 9.1. To ensure that all maps in the GIS database were overlayed accurately they were projected to the same coordinate system. The output maps contain quantitative real values that are standardized and ranked to obtain qualitative maps that are easier to interpret visually. Five levels of criticality are defined as lowest, low, moderate, high and highest. A sensitivity analysis was then performed on the calculated weights to evaluate the stability of results with respect to the variation in objective weights (Triantaphyllou 1997**;** Malczewski 1999; Belton *et al.* 2002). In this study a ± 0.005 perturbation was imposed on the objective weights. The degree of variation was determined based on the range of the objective weights. The lowest objective weight was 0.043 and so a range of variations of 0.001 to 0.01 were considered appropriate. To avoid excessive iteration 0.005 was taken as the mid value. This method was selected based on a judgement that is widely used for SMCDA.

Phase 3: Integer Goal Programming (to find optimal use patterns)

An optimal MPA use pattern is considered here to be one that minimizes the levels of conflict between different stakeholder values (attributes). An optimal spatial use pattern for a geographical location within the MPA with a particular conflict value is achieved by satisfying two goals: 1) selecting an activity or a combination of activities that will minimize the value to a level desired by the decision maker; 2) allocating optimally the total area under a particular level of conflict to selected stakeholder values or activities.

Integer Goal Programming (IGP) (Romero and Rehman 1987; Malczewski 1999; Edwards-Jones *et al*. 2000; Winston 2004; Anderson *et al*. 2005) is applied to find optimal MPA use patterns. The IGP model is formulated to satisfy the two goals for optimal allocation. The IGP model is formulated as binary linear programme functions that are solved simultaneously to determine the point that best satisfies the two goals as desired by the decision maker. The first function is solved. Then in the set of optimal solutions, with respect to the first, the second function is solved. The IGP model was designed to ensure that all habitats are selected and any conflicting stakeholder values that conflict intensely are not selected. The IGP model helps to select stakeholder values on the basis of their contribution to the overall conflict score subject to a set of constraints and assumptions imposed by the decision maker and the spatial requirements. Two assumptions were considered: 1) the stakeholder values are selected for a particular location in the MPA according to their conflict scores in such a way that the higher the score the less likely that the activity will be selected and; 2) conflicting uses, for example beach seining and sailing, cannot be allocated to the same geographical location. The IGP model was implemented using Lindo 6.1 (Roe, 1997; Winston, 2004). Optimal spatial solution was only considered for the present MPA management scenario.

Illustration of results

Analytical Hierarchy Process (AHP)

The results of the AHP for the MMNP&R are illustrated in Fig. 3 and the concepts are described in Table 1. In the AHP, the problem is separated into simpler decision problems to form a decision hierarchy. When developing a hierarchy, the top level is the ultimate goal of the decision. The hierarchy decreases from the general to more specific until a level of attributes is reached. Each level must be linked to the level above. In this problem the goal is to identify and minimize user conflicts in the MMNP&R. To achieve this goal a set of objectives and attributes is needed. The objectives are the criteria (factors) on which decisions about the extent and location of conflicts will be made. Attributes are the information sources for formulating and achieving the objectives. Attributes in this study correspond to the different stakeholder values (MPA habitats and stakeholders activities) and are represented as attribute maps in GIS showing their locations in the MMNP&R

Table 1. AHP concepts used for conflict analysis in the MMNP&R.

Objectives	Attributes (activities / habitats)	Description (mapped attributes)
Critical habitats (CH)	Seagrass beds	Locations of sea grass (dense/ medium/sparse/patches). Sea grass beds are areas of submerged vegetation associated with coral reefs
	Coral reef	Location of corals and the reef. They occur as coral flats, lagoons, reef platforms and as fringing reefs
	Intertidal mud/ sand flats	Locations of habitats that are periodically inundated and exposed to the tidal ebb. The habitats are foraging grounds for many shore and migratory birds
	Sandy beach	Areas characterized by bare sand. They are often slightly vegetated by highly specialised colonising plants
	Turtles nesting grounds	Important nesting areas for endangered marine turtles (especially the *Chelonia mydas*)
Sea access and anchorage (SA)	Sailing	Locations used for water sports like sailing, windsurfing
	Jet skiing	Jet ski designated areas
	Anchoring, mooring of vessels	Areas used for vessel anchoring
Offshore and shoreline recreation (REC)	Scuba Diving	Location of diving areas including the coral gardens and wreck dives
	Snorkelling	Locations of coral gardens used by tourist for snorkelling
	Inshore recreation	Locations of intertidal areas used by public for swimming and leisure walking
Commercial activities on the beach (BA)	Curio dealers	Location of curio traders on the beach
	Safari sellers	Location of safari sellers on the beach
	Boat operators	Location of boat operators on the beach
	Other activities	Location of various activities on the beach e.g. hawking
Artisanal fishing (FSH)	Basket / trap fishing	Areas where fishermen place their fishing traps (*malema*)
	Gill netting and line fishing	Location where fishermen commonly use gill nets (*nyuzi*) and lines
	Gleaning	Locations mainly on the reef where fishermen collect octopus and other invertebrates
	Beach seining	Locations of beach seining and spear fishing methods
	Landing and mooring sites	Areas used by fishermen for boat anchorage and landing catches

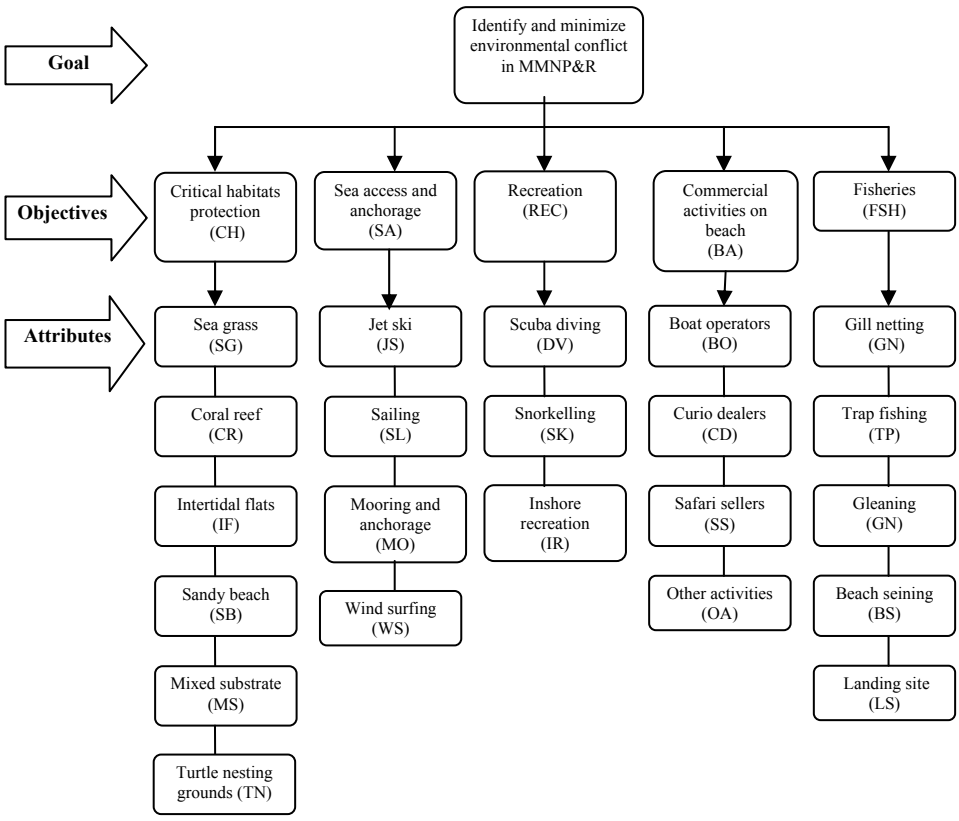

Fig. 3. Analytical Hierarchy Process (AHP) – the structure of conflict analysis for MNP&R showing goal, objectives and attributes.

Spatial coverage of conflict

The results of conflict analysis (Fig. 4) show spatial coverage for different levels of conflict under the four management scenarios. Conflict scores ranged from 0 to 1. Scores of 0.2, 0.4, 0.6, 0.8, and 1 represented lowest, low, moderate, high and highest levels of conflict respectively.

The total coverage of the area under study is 3809 ha. In all the management scenarios over 80% of study area is under the lowest level of conflict. These locations are associated with single, complementary or non-conflicting objectives.

Under the present management scenario (Fig. 4a), low levels of conflict occur in both the park and reserve. Low levels of conflict occur in areas of coral reef and seagrass which are also snorkelling, sailing, diving and trap fishing areas. High levels of conflict are caused by beach seining (a destructive fishing method) in seagrass beds and the intertidal mud flat areas. The park is characterized by lowest and low conflict levels because it is a no fishing area.

The other three scenarios were used to assess what would happen to the status quo if the MPA management priorities changed. The results reveal that changing MPA management strategies will lead to changes in the spatial extent and location of different levels of conflict (Fig. 4b, 4c and 4d). A summary of the areas covered by highest to lowest areas of conflict under the four scenarios is presented in Table 2.

Increased use of the MPA for exploitation would potentially increase the spatial extent of present low and moderate levels of conflict (Fig. 4b). Total area under low levels of conflict would increase from 208 ha to 483 ha. The increase is in areas associated with diving and snorkelling which are highly incompatible with fishing. Moderate conflict levels would occur on the reef and beach increasing in spatial extent from 7 ha to 150 ha. Overall increased use of the MPA for exploitation would potentially intensify present levels of conflict more than in other management scenarios. The area characterised as having lowest levels of conflict would decrease from 3504 ha to 3158 ha.

In comparison to present status, intensifying recreational activities in the MPA would increase the spatial coverage of low, moderate and high levels of conflict (Fig. 4c). Low levels of conflict would increase from 208 ha to 266 ha. Locations of low conflict in the MPA would coincide with areas used for trap fishing and gill netting in the seagrass beds. These activities also compete with sailing and jet-skiing. The total area under moderate conflict would increase by from 7 ha to 57 ha.

High conflict levels would occur in the same locations as at present, however 38 ha would now be under highest conflict levels. Highest levels of conflict would primarily be due to the existence of beach seining which is incompatible with both sailing and inshore recreation.

Increased protection of habitats would potentially reduce total areas of low and high levels of conflict from 208 ha, and 86 ha to 163 ha and 0 ha respectively (Fig. 4d). However, the spatial extent and intensity of highest level of conflict would be 90 ha, far greater than those under the present (4 ha), exploitation (0 ha) and recreation (38 ha) scenarios. These conflicts would occur in areas associated with beach seining, seagrass and corals. The highest level of conflict would occur in particular locations where activities pose a threat to the habitats. Under both the recreational and habitat protection scenarios the present locations of the lowest and low conflicts would remain unchanged.

Table 2. Total area (in hectares) under varying conflict levels for the four management scenarios.

Scenarios	**Conflict levels**				
	lowest	***low***	***moderate***	***high***	***highest***
Present	3504	208	7	86	4
Exploitation	3158	483	150	18	0
Recreation	3353	266	57	95	38
Protection	3514	163	42	0	90

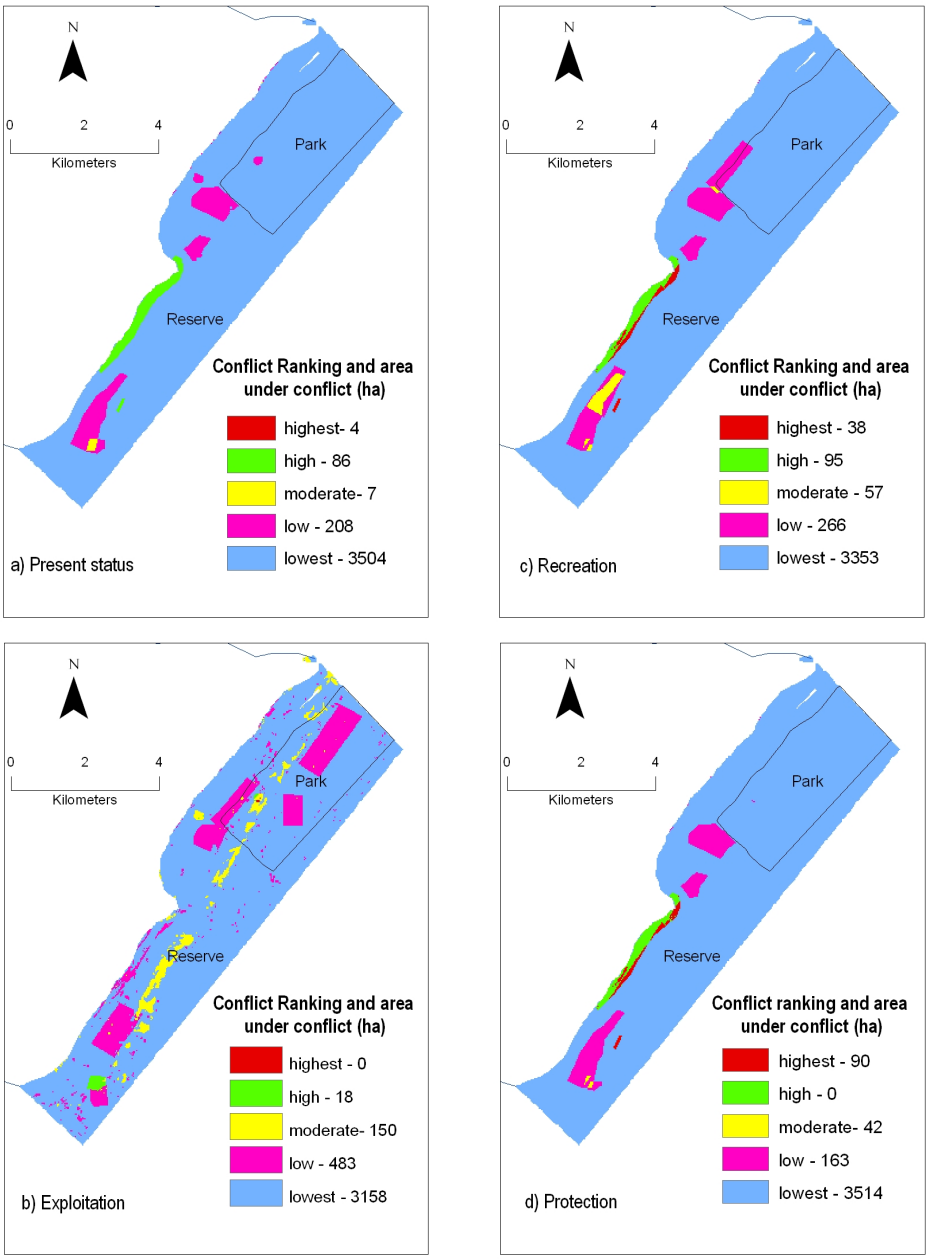

Fig. 4. Maps showing the locations of conflict levels under the present management scenario (a) and three potential management scenarios: exploitation (b); recreation (c) and; protection (d).

Optimization to find optimal use patterns for present management status

Figure 4 shows that even under the present management scenario conflicts still exist in the MPA. To find the optimal use pattern the Integer goal programming (IGP) method was applied to select activities that will minimize the conflict levels in the present management scenario to the lowest level.

Areas of low, moderate and high conflicts levels were evaluated. All activities and habitats that contribute to the conflict are identified within these geographical locations (Fig. 5). An optimal use pattern is one that will minimize the conflict score to the lowest level of 0.2 and below. To achieve this, the IGP model is formulated to select activities such that the higher the contribution to the overall conflict scores, the less likely that the activity will be selected with exception of all habitats which cannot be replaced. Incompatible uses, for example beach seining and sailing, cannot also be allocated to the same geographical location. Optimization equations were formulated for each of the conflict locations to achieve the lowest conflict level. The areas under low level conflict were grouped into two geographically distinct blocks labelled 'Low 1' and 'Low 2' therefore four locations were analysed (Fig. 5).

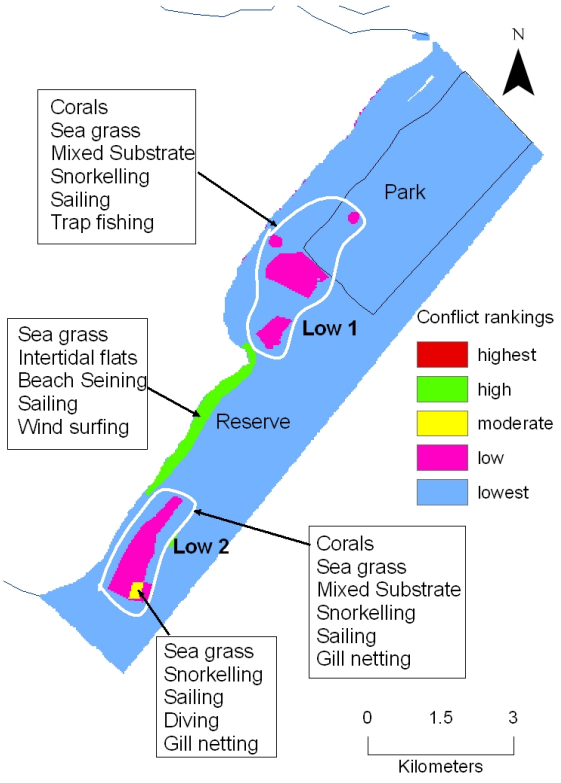

Fig. 5. Map showing locations of low, moderate and high levels of conflict under the present management scenario and associated attributes (activities and habitats).

Figure 6 shows the results of the optimization with selected activities within particular habitats. In the area labelled Low 1, out of three competing activities, the model selected trap fishing. In Low 2, gill netting was selected. In locations of moderate conflict, diving and sailing were eliminated. In the high level area beach seining was eliminated. This would be the optimal use pattern for MMNP&R if spatial conflicts were to be reduced from current levels to the lowest levels. This however depends on the decision maker's objectives and what is realistically achievable.

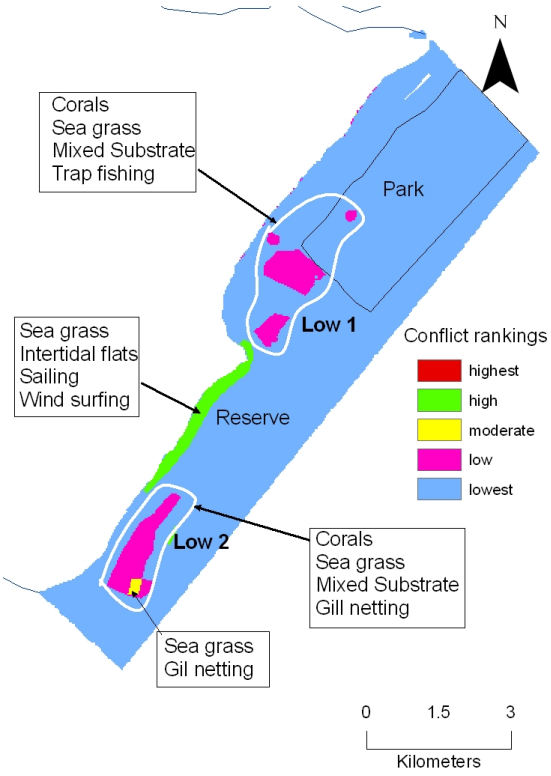

Fig. 6. Results of optimization showing a selection of activities that will minimize the conflicts to the lowest levels.

Discussion

The current conflicts in MMNP&R can be described as minimal and are localized in the lagoonal areas near shore. The analysis of environmental conflicts in the MMNP&R for four management scenarios reveals important trends. Conflict in the MMNP&R will arise whenever the activities of one stakeholder reduce the capability of the marine area for other stakeholders' activities.

This study will help the MMNP&R management address three important management issues: 1) identifying and mapping competing user values that are likely to cause spatial conflicts; 2) assessing user conflicts under changing MPA management scenarios; and 3) developing an optimal MPA spatial use pattern or a zoning plan.

The results of this study have shown that the under the present MPA regime spatial conflicts are not at a critical level. Over 90% of the study area is under the lowest level of conflict. Either these areas support ecologically sustainable use and public recreation that are consistent with MPA objectives or users are not actively using these areas. The area designated as park is under the lowest conflict because extractive activities like fishing are prohibited. Intense conflicts under the present, recreational and protection management scenarios are associated with the fisheries objective. Beach seining causes the highest level of conflict among the activities
under the fisheries objective. Changing use patterns may result in intense conflicts spreading to other areas presently not under low levels of conflict. Any management interventions that change the MPA use patterns must be thought out carefully before implementation because the present conflict situation may be worsened. Present conflicts also need to be resolved otherwise it may generate additional conflict in the future therefore limiting the efficiency or effectiveness of conservation measures.

To achieve optimal use devoid of conflict some stakeholder activities have to stop in certain locations. For conflicts to be minimized completely under the present management status, beach seining has to be eradicated or only allowed to continue in areas where no other uses occur. Areas used for snorkelling, diving and sailing should also be re-designated in the reserve.

Spatial conflicts in the MMNP&R have existed since the establishment of the MPA. However there is no formal conflict-resolution mechanism that operates impartially and represents all stakeholders' interests equally. Rather conflicts emerge and are generally addressed on an ad hoc basis or ignored until they reach a crisis point. The methodological approach applied in this study intends to address this gap by developing an MPA planning model that incorporates users' conflicts and critical ecosystems into a multi-objective decision making framework. It provides a flexible way of dealing with the problem of conflicts in MPAs. The approach allows for the integration of stakeholders in different ways: in data collection and in assigning weight of importance to activities. The stakeholder activities used in this study are by no means exhaustive. Other interest groups, like researchers who have been monitoring sites in the MPA and the Port Authority who have interest in shipping routes, were not considered. Stakeholder participation in this study was particularly helpful in defining the objectives and attributes and eliciting the preferences of MPA stakeholders. Incorporating more stakeholders in this analysis is likely to improve greatly the chances of success in achieving MPA goals. Using this method in a collaborative context, where different stakeholders can understand how their own interests relate to specific locations and where they might conflict with others, may be its most effective application.

The main limitation of this approach is in the subjectivity introduced in the MCDA, particularly in the choice of criteria and relative weights and the verbal rankings given to conflict scores. Verbal ranking may not accurately represent the conflict situation on the ground. This process, however, helps the decision maker in qualitatively describing the different locations of possible conflict and the levels of conflict. Despite the inherent limitations of the model it is useful as a tool for tackling stakeholder conflict and it also facilitates informed decisions when planning for multiple MPA objectives. This method answers key elements that are required in conflict management: 1) information development and analysis; 2) conflict assessment (what are sources of conflict); and 3) strategy and procedural decision (deciding upon the process for addressing conflict). It answers the questions: who, what, where, when and how? It, therefore, provides an important step toward resolving stakeholder conflicts in the MPA and integrating conflicting objectives in a decision framework. The accuracy and usefulness of this study would be enhanced by involving all stakeholders in the initial mapping of attributes and the validation of the graphic results.

Conclusion

This paper focuses on developing a MCDA methodology for environmental conflict management in the MMNP&R in Kenya. The effectiveness of the MPA in achieving it objectives can be hampered by existing stakeholder conflicts. The multitude of sometimes conflicting resource uses and activities require a more elaborate and systematic planning. This study is an important contribution as it provides a methodological approach that can be applied in resolving marine and coastal use conflicts whilst simultaneously maximizing ecosystem gains.

Spatial conflict analysis can be used proactively to understand the degree of controversy associated with the MPA and use it to develop planning accordingly. It is important that potential conflicts are assessed to anticipate and reduce unnecessary conflicts before they occur. Locating exactly where conflict hotspots are likely to emerge in response to changes in management policy can alert policy makers and enable them to avoid those areas or to design a process that includes conflict management.

Marine and coastal spatial planning is crucial for the optimal and sustainable use of marine and coastal resources from economic, social and ecological perspectives. The methodology employed in this study may be useful in establishing rules of allocation of resources between conflicting uses and therefore help in conflict avoidance. Mapping environmental conflicts can be used as a tool that can guide planners to make informed policy decisions with economic, social and ecological objectives in mind.

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Integrating socio-economic monitoring at coastal management sites in the Western Indian Ocean

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Abstract Coral reefs form the basis of the livelihoods of hundreds of thousands of people in the Western Indian Ocean (WIO) region with numerous poor coastal households depending very highly on marine resources. Coral reefs are often an economic resource of last resort for food and income, through extractive uses such as fishing. Coral reefs are also important for their non-extractive uses such as tourism

Climate change, destructive fishing, sand mining, pollution, and other human activities threaten coral reefs in the WIO region. Various approaches including Marine Protected Areas (MPAs) and Integrated Coastal Management (ICM) have been used along the coasts of the WIO to try and mitigate threats to marine biodiversity and to improve fisheries management. However, marine resources management is as much about managing resource users' attitudes and behaviour as the resources themselves. Thus to manage resources effectively, it is essential to understand the context within which marine resource users live, their livelihood constraints and opportunities.

It is increasingly recognised in the region that for resource management to be effective in the long term, MPA and fisheries management need to adapt and respond to changes in marine resource users' socio-economic context. The Socio-economic Monitoring Initiative for Coastal Managers of the Western Indian Ocean (SocMon WIO) aims to increase the capacity of coastal managers to understand and incorporate the socio-economic context into coastal management programmes. SocMon WIO is a regional programme that builds on local-level monitoring systems. It is based on community members' participation and is implemented at the local level by projects, marine protected area authorities, local area management authorities, fisheries officers or community groups.

The SocMon WIO network expanded to 12 sites across the region in 2007. The sites include nine managed MPAs, three of these being ICM/Co-management sites. One is an East Africa Marine Eco-region sites of regional importance (WWF-EAME). This paper presents the experience of SocMon in the WIO since 2002, the challenges encountered, and how these were addressed.

Introduction

The role of social science research in improved management of the coastal and marine environment in the WIO cannot be overstated. The link between how people use their resources and the socio-economic background within which they live is so close. For management at any site to assess, predict and manage the utilization of resources, it must first understand the socio-economic context of the people and their activities (Pomeroy *et al.* 2004). It is now recognized in the region that incorporating socio-economic considerations can determine the success or failure of any coastal management initiative whether Integrated Coastal Management (ICM) planning, establishment of Marine Protected Areas (MPAs), or other initiatives such as co-management. Socio-economic information enables reef managers to:

- Incorporate *stakeholder* group concerns and interests into the management process.
- Determine the effects of management decisions on the stakeholders.
- Demonstrate the value of the reef resources and services to the general public, stakeholder groups and policy-makers.
- Identify trends, which if negative can act as an early warning system to guide strategies to be put in place in time to improve the resource status.

Social science therefore plays a key role in informing and guiding the management process.

Marine Protected Areas, community-based projects and fisheries initiatives in the Western Indian Ocean (WIO) all have socio-economic objectives, yet a paucity of socio-economic monitoring data still exists as well as a lack of capacity to carry out socio-economic analysis within the marine science realm (WIOMSA/IUCN 2003). A regional workshop (WIOMSA/IUCN 2003) put forward a strong case for encouraging social scientists' involvement in coastal management and research. The workshop identified the region's constraints as follows:

1. Few data available from socio-economic research and assessment of ICM and MPA initiatives.
2. Limited use of socio-economic research and assessment by management. Most research was not published in peer-reviewed journals.

Recommendations to address the region's constraints

The main approaches identified to remedy constraints in socio-economics at the WIOMSA/IUCN 2003 workshop were:

- Identification of a key focal point (preferably an institution) that would coordinate the building of a network of social scientists with an interest in coastal research, and
- Organization of workshops/courses on specific aspects relevant to social sciences such as methodologies and data analysis techniques.

A separate "Needs Assessment for Social Sciences Research in the Marine Environment" suggested capacity-building activities through programmes to facilitate research development i.e.:

- Facilitation of systematic programmes e.g. monitoring, and wider advertisement of available opportunities.
- Other related activities: information sharing through networking, institutional linking and a regional focus for social sciences.

3. Lack of, or few and isolated, trans/multi-disciplinary research undertakings involving social scientists.
4. Inadequate capacity and interest in social sciences.
5. Poor networking. There was a clear need for a network forum to facilitate and encourage communication between social and natural science researchers and facilitate information dissemination.

The SocMon WIO initiative started in 2005 in response to the identified needs. The initiative followed up on a Global Coral Reef Monitoring Network (GCRMN) workshop in 2000 on "Training of resource managers in socio-economic assessment & monitoring methods". The workshop trained more than 30 managers and project staff from the region thus laying a foundation for socio-economic monitoring in East Africa. SocMon WIO is a collaborative approach between organizations within the region and adapts materials from the GCRMN *Socioeconomic Manual for Coral Reef Management* (Bunce *et al.* 2000). The objective of the SocMon WIO programme is to establish a regional network of locally based teams for conducting regular monitoring of socio-economic indicators to provide data for local management decisions. *SocMon* WIO targets the 'coastal manager'; variables monitored under SocMon address the following management goals:

- Identifying threats, problems, solutions and opportunities;
- Determining the importance, value and cultural significance of resources and their uses;
- Assessing positive and negative impacts of management measures;
- Assessing how the management body is doing (management effectiveness);
- Building stakeholder participation and appropriate education and awareness programs;
- Verifying and documenting assumptions of socioeconomic conditions in the area, community dynamics and stakeholder perceptions; and
- Establishing baseline household and community profiles.

However, the coastal manager and site monitoring team need to tailor these goals to the needs at their site. More importantly, socio-economic monitoring is also of use to the other stakeholders who should be considered and fully involved in the process.

Building partnerships

Institutional collaborations between governments, NGOs and project sites are key to the SocMon WIO initiative. For socio-economic monitoring to be sustainable in the long term, it needs sustainable partnerships at local, national, regional and global levels to provide the institutional and financial support. Implementation is undertaken as a partnership activity with contributions and guidance from regional partners and respective commitments at site-level implementation.

i) *Site level partnership:* SocMon builds on local monitoring systems and is based on participation by community members. Implementation is by the existing local-level partners at the site. These may be fisheries department staff, local project staff, marine protected areas' authorities, local area management authorities, or community groups. The aim of local level partnerships is to develop a monitoring process and the associated information management system at the local/project level. It involves reviews, identification of the suitable socio-economic indicators, provision of monitoring training and tools and implementation of the monitoring plan.

In 2007 SocMon WIO has a network of 12 participating sites spread across the region (Table 1, Fig. 1). These will increase to 14 in 2008. Information collected directly by the concerned area management authority is more relevant for improving management of marine resources at the site. It also allows resource managers and conservationists to understand communities better and thus improve working relations among stakeholders. Participatory monitoring, using members of the community to collect data, promotes ownership, understanding, and acceptance of the whole process. It is holistic and people-centered; it involves all the stakeholders including local community groups, researchers, reef managers, reef users, government agencies, site projects and other

Table 1: List of SocMon sites and implementing partners.

SocMon site	Country	Local implementing institution	Category of site
Tana Delta	Kenya	Kenya Wildlife Service/Kenya Marine Forum	Ecoregion site of regional importance
Diani-Chale	Kenya	CORDIO East Africa	MPA/Co-mgt
Mwambweni	Kenya	Fisheries Department	Fisheries
Shimoni-Muheza Trans-boundary	Kenya and Tanzania	Kenya Marine Forum/Tanga Coastal Zone Conservation and Development Project (TCZCDP)	Co-mgt/ Fisheries/MPA
Tanga	Tanzania	TCZCDP	MPA/Co-mgt
Rumaki Seascape	Tanzania	WWF- Mozambique	MPA
Mnazi Bay-Ruvuma Estuary Marine Park	Tanzania	Tanzania Marine Parks	MPA
Quirimbas Marine National Park	Mozambique	WWF- Tanzania	MPA
Andavadoaka	Madagascar	Wildlife Conservation Society/Blue Ventures	MPA
Rivière Banane	Rodrigues, Mauritius	Rodrigues Regional Assembly/Shoals Rodrigues	Fisheries/MPA/ Co-mgt[1]
Mitsamihouli	Comoros	AIDE	MPA
Velondriake	Madagascar	Blue Ventures/World Conservation Society	MPA/Co-mgt

[1] Management in process of being implemented.

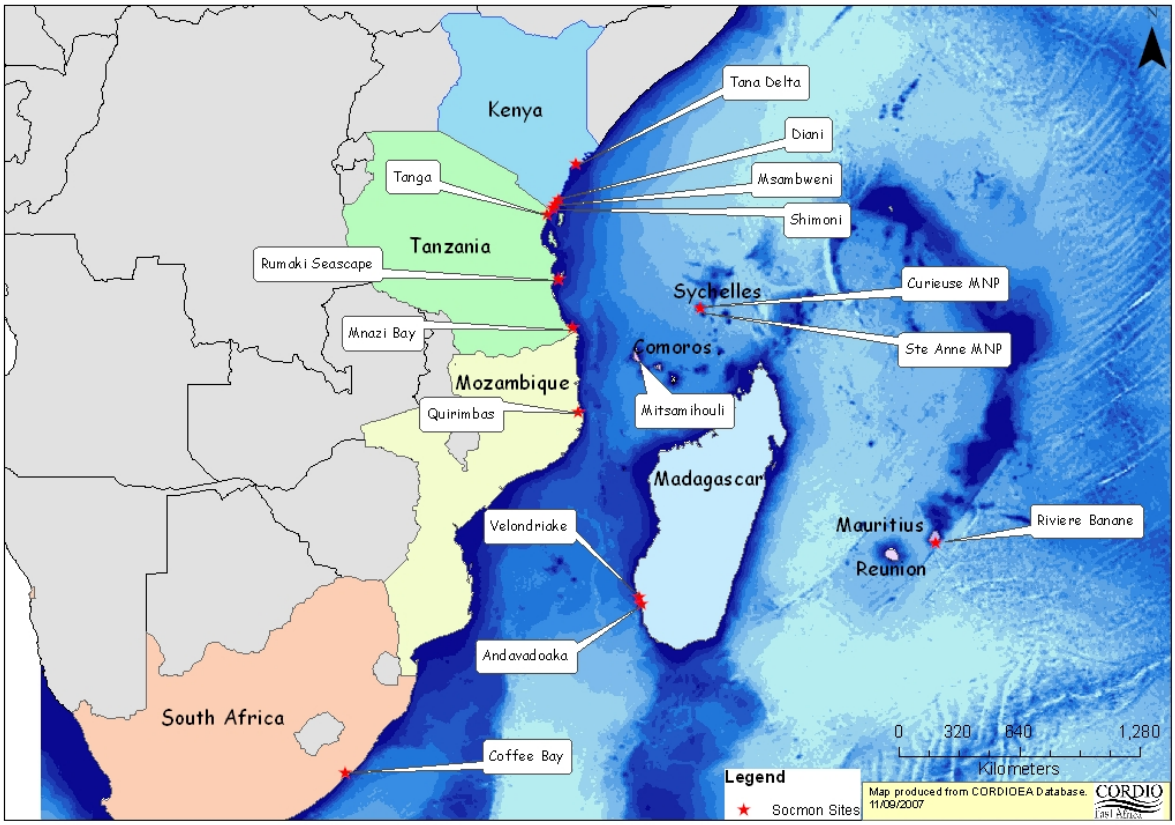

Fig. 1. The SocMon WIO network of sites in 2007 (CORDIO EA GIS Database).

institutions. SocMon WIO encourages a blend of participatory and process oriented monitoring; the process of collecting information and the learning mechanisms are as important as the information collected with all groups learning from the process.

ii) *Regional partnership:* In the WIO there have been very few collaborative projects that included social science. The WIOMSA/IUCN 2003 workshop laid a foundation for development of a regional network of social scientists. Partnerships among the region's institutions and projects to undertake socio-economic monitoring are the key to the successful implementation of the SocMon WIO initiative. The operational structure of SocMon WIO includes the SocMon WIO advisory committee. This committee represents the primary partners; these are: Coral Reef Degradation in the Indian Ocean (CORDIO East Africa) as lead implementer, the IUCN-World Conservation Union, the Western Indian Ocean Marine Science Association (WIOMSA), the Seychelles government and World Wide Fund for Nature Ecoregion programme (WWF-EAME). Regional co-ordination facilitates provision of support including technical expertise, monitoring guidelines and additional monitoring tools, data storage/analyses, coordinated communication and reporting among participating sites.

iii) *Global partnership:* these are represented by the Global Coral Reef Monitoring Network (GCRMN) Socioeconomic Monitoring Initiative and ReefBase. *SocMon WIO* is based on Bunce *et al.* (2000). Earlier regional SocMons are *SocMon Caribbean* and *SocMon Southeast Asia (SocMon SEA)*. SocMon WIO has benefited from being a part of a global initiative through the transfer of technical skills already developed in other regions.

Important components

SocMon WIO is implementing a Regional Socio-economic Monitoring Strategy formulated by partners (CORDIO/WIOMSA 2005). This includes a functional structure made up of the network of 12 sites, a regional socio-economic working group of over 120 individuals, country focal points and the SocMon WIO advisory committee. The goal of SocMon WIO is to establish a functional regional socio-economic monitoring network. This has been achieved through the following components:

1. A Regional Partnership Workshop. The Regional Partnership Workshop 2005 (CORDIO/WIOMSA 2005) brought together participants representing multiple institutional partners in East Africa who confirmed their commitment to develop socioeconomic monitoring. The workshop set the stage for SocMon and delivered a common vision for promoting the integration of social science in ICM/MPA/fisheries management and research, specifically: *"The identification of stakeholders, their needs, perceptions and relationships, their opportunity to be involved in management and provide feedback, the identification of threats to the marine environment and their causes, assessment of the impact and effectiveness of management strategies, and methods of improving management."*
2. A drafting workshop to provide a SocMon WIO manual. Participants discussed SocMon variables with the remit to adapt, omit or add new ones tailored for the Western Indian Ocean situation.
3. Publishing of standardised regional guidelines. *SocMon WIO* (Malleret-King *et al.* 2006) is the third in the series of regional SocMon guidelines after SocMon SEA (Bunce and Pomeroy 2003a) and SocMon Caribbean (Bunce and Pomeroy 2003b). SocMon WIO was launched at global level at ITMEMS 3, Cozumel, Mexico (Wanyonyi *et al.* 2006) and regionally during the SocMon WIO Training of Trainers (ToT) workshop, Mahé, Seychelles 2007. The SocMon WIO manual describes the monitoring variables and prioritises them according to what they signify for the WIO including how they could be monitored.
4. Translation of the regional guidelines into the region's main languages - English, French, Kiswahili and Portuguese.
5. Establishment of SocMon and expansion to new sites – 14 were planned by 2008. SocMon WIO has provided full support to the SocMon network of sites through training and technical assistance in socio-economic monitoring techniques, provision of SocMon trainers and coordination.
6. A SocMon WIO site level database has been developed to address the challenges associated with ineffective data management and analysis procedures. Integration of site level databases at a regional level and compatibility with the Global SocMon database will allow broader comparisons between sites and improved information sharing.
7. Facilitation of reporting and awareness products for different target audiences. Basic reporting needs have been identified to enable sites to produce outputs that are relevant to their local and immediate needs at the click of a button. Similarly, more complex and academic reporting needs will be identified that will be more useful at higher (national/regional) levels and for analytical assessments of sites.
8. A SocMon WIO Training of Trainers workshop (ToT) in January 2007. This boosted the capacity for socio-economic monitoring in the region by increasing the number of SocMon resource persons from 3 to 14 trainers spread across all WIO countries.

Challenges related to implementation of SocMon WIO

- *Prioritization of variables for the whole WIO region:* different areas may have different monitoring priorities.
- *High cost of publication:* the region's many languages require translation of the manual and

documents for effective communication.

- *Tedious process:* the translation had to be done by the respective countries targeted by each language to maintain the context of the information in all the translated versions.
- *Incorporating all the different assessment approaches into SocMon:* there were pre-existing assessments at some WIO sites.
- *Financial support to implement SocMon:* funding limitation determines the maximum number of sites funded.
- *Sites implemented in partnership between two institutions:* additional costs due to co-ordination needs.
- *Internal institutional issues:* interferences and delays in monitoring at some sites due to problems associated with lack of computer knowledge by staff, restructuring and high rates of staff turnover.
- *Few SocMon trainers:* this led to some sites being slow to start monitoring; the ToT resulted in 14 trainers.
- *Local differences at sites:* necessity for adaptation of the trainings to local site needs and technical preparation work to simplify training and monitoring, especially for sites with teams from purely biological backgrounds or community members.
- *Sustained funding and follow-up by coordinating institution:* necessary to facilitate active participation of the SocMon WIO working group members and two-way communication with the SocMon WIO Network of sites.
- *Lack of capacity in data entry, management, analysis:* addressed by the use of site and global SocMon databases and providing training.
- *Lack of capacity to produce required reporting and outputs at some sites:* sites require consistent facilitation and technical assistance to produce all outputs targeting feedback to communities, project/institutional reporting and management.

Lessons learned

1. Participatory monitoring with communities should involve them early in the process.
2. The authority in charge of site management should be directly involved in monitoring so as to act immediately on the outcomes of monitoring. At times communities may expect immediate solutions to their problems.
3. Results should be disseminated to a wider forum and co-ordination with other participating sites should be improved.
4. A complete training of the team in management of socio-economic data (i.e. using basic computer application packages such as Excel, databases, and Word) for staff involved in data management.
5. Consistent financial support at global, regional and local levels is required to enable coordination of sites that incorporate socio-economic monitoring in their management activities.
6. Support from national policies, institutions and legal frameworks are required for socio-economic monitoring to be effective.
7. Socio-economic monitoring requires a locally adaptive approach. What works in one place does not always apply equally successfully at all sites without being adapted.

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3. PRESENTATION ABSTRACTS

Community involvement in marine protected areas

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Abstract

Research and experience from around the world have demonstrated the importance of community support and participation in the success of marine protected areas. Whilst approaches to community involvement and the level of participation of stakeholders in marine protected area selection, establishment and management have varied from case to case, a number of key points have emerged:

1. The role of awareness of marine conservation and fisheries management issues in key stakeholders and the wider community.
2. The importance of regular, accessible communication with key stakeholders and the wider community from an early stage in the process of marine protected area establishment.
3. The importance of correctly identifying and involving key stakeholders. In particular, differentiating between sub-groups within stakeholder groups which may have conflicting opinions.
4. The importance of local knowledge combined with good scientific information.
5. The importance of discussion of socio-economic implications with stakeholders at an early stage in the process.
6. Once an area is established, the importance of persistence in communicating the details of the area reasons for establishment and research on its effectiveness to stakeholders and the wider community.

Drawing from case studies from a wide geographical range, including the British Isles, Caribbean and Indian Ocean, this paper demonstrates the importance of these and other key considerations. Lessons are taken from the successful Soufrière Marine Management Area in St Lucia, West Indies, a failed Marine Nature Reserve and successful fisheries closed area in the Isle of Man in North West Europe and experiences from Rodrigues.

Successful marine protected areas are often associated with a high level of community involvement, good general awareness of the reasons for protection, effective use of local knowledge and good representation of all key stakeholder groups. This paper acknowledges the many different routes which are taken to marine protected area establishment and discusses how some of these community involvement approaches can be practically incorporated under widely varying circumstances.

La démarche participative pour la mise en place du Parc Marin de Mohéli, Union des Comores

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Abstract

Le parc Marin de Mohéli, est créé officiellement le 19 avril 2001 par le gouvernement comorien par un décret qui s'est inspiré des accords de cogestion.

La démarche adoptée pour la mise en place du Parc Marin de Mohéli, est une démarche participative, basée sur le mode de cogestion. Ce mode de cogestion consiste à une gestion rationnelle des ressources naturelles par la responsabilisation des communautés et organisations locales par la vulgarisation de techniques de gestion participative. Bref les communautés locales et les autorités publiques négocient, définissent et garantissent le partage entre eux des fonctions, droits et responsabilités dans la gestion des ressources naturelles.

L'unique aire marine protégée de Comores est située à Mohéli, la plus petite des îles Comores avec 211 km^2, dans sa partie Sud-est de l'île connue pour sa richesse en faune et flore et couvre une superficie de 404 km^2.

Elle est un sanctuaire de la biodiversité mondiale, où des milliers d'oiseaux nichent, 8 îlots d'une grande valeur esthétique, faunistique, floristique et culturelle, des sites de ponte des tortues marines, une zone de passage, de reproduction des mammifères marins telles que les baleines et les dugongs.

Elle regroupe dix villages de Mohéli : *Itsamia, Hamavouna, Nkangani, Wanani, Ziroudani, Nioumachoi, Ndrondroni, Wallah I, Wallah II et Miringoni*.

L'objectif du Parc Marin de Mohéli est de : Assurer la conservation de la biodiversité marine et côtière, favoriser les activités génératrices de revenus auprès des communautés locales et enfin assurer une utilisation durable des ressources naturelles.

Pour sa mise en œuvre, le Parc s'appuie sur une équipe technique composée du responsable des activités, un ingénieur halieutique et 12 éco gardes ; puis un comité de pilotage, organe consultatif, qui regroupe un ensemble d'acteurs qui interviennent pour la gestion durable de ressources naturelles à Mohéli. Au total 16 acteurs dont 4 du pouvoir public, 10 représentants des communautés et deux de la société civile.

Supporting environmental stewardship. Conservation, livelihoods and environmental education in Lakshadweep

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Abstract

The paper discusses a combination of community-based strategies being carried out in Lakshadweep Islands with micro budgets to address the issues concerned with coral reef conservation and livelihoods. The program is based on our belief that the local community will pay more attention to environmental issues if they have been involved in data gathering, analysis and establishing key learning's. They will then be able to speak with conviction and generate support for local management solutions.

1. Establishing a community based socioeconomic monitoring team at Agatti. Workshops for environmental wardens and local NGO's and educated youth for conducting socioeconomic assessments, reef related activity monitoring and ecosystem health monitoring. These workshops led to the formation of a local team called the ACRMN.
2. The coral reef awareness and education project included environmental orientation workshops for schoolteachers and children (classes 6-9) so as to bring in local environment and cultural features in their teachings. The final output was to get a children's perception of their environment and to correlate this with topics in their syllabus.
3. Discussions with fishers and women using the participatory appreciative enquiry approach and the Sustainable livelihoods framework to establish a livelihood strategy to increase incomes from fisheries. This led to the establishment of the Maliku Hikkimass Producers society at Minicoy.

This paper will discuss the processes adopted; key learning's from each of the projects and provides recommendations for the future.

Encouraging community involvement in MPAs – issues and approaches

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Abstract

Marine protected areas (MPAs) are widely recognised as an important tool for the management of fisheries and coastal and marine environments. There is increasing awareness of the role local communities and resource users can and should play in their management. Working closely with people in and around MPAs – addressing their needs and concerns and encouraging their involvement in management – can improve the effectiveness of MPAs.

This paper gives an overview of different types of management arrangement involving local communities/stakeholders, and gives examples of approaches and tools for involving communities in MPA management. Factors that influence success, and potential probems and pitfalls of the interactions between local communities and MPAs are discussed and examples are given from East Africa, Caribbean and the Philippines.

Resource users can be involved in data collection and assessment as well as in management and decision making. Participatory Fisheries Stock Assessment (ParFish) is presented as an approach to resource assessment that involves resource users, incorporates many of the principles of involving local communities in MPA management and provides a range of tools for doing so. It incorporates fishers' knowledge on the resource and is based around a participatory process that supports co-management and the involvement of resource users in decision-making by bringing together fishers, scientists, managers and other stakeholders in a dialogue for more effective resource management.

Managing MPAs: A toolkit for the Western Indian Ocean

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Abstract

Article 10 of the Nairobi Convention for the Protection Management and Development of the Marine and Coastal Environment of the Eastern African region states: "Contracting Parties shall, individually or jointly, take all appropriate measures to protect and preserve rare or fragile ecosystems as well as rare, depleted, threatened or endangered species of wild fauna and flora and their habitats in the Convention area. To this end the Contracting Parties shall, in areas under their jurisdiction, establish protected areas, such as parks and reserves, and shall regulate and, where required and subject to the rules of international law, prohibit an activity likely to have adverse effects on the species, ecosystems or biological processes that such areas are established to protect".

However, despite the growing evidence on the importance of marine protected areas, the Governments of the region are yet to embrace Marine Protected Areas (MPA) management as a science requiring dedicated managers that are trained on a standardized curriculum. It is widely accepted that Marine Protected Areas provide an effective way for conserving marine biodiversity and at the same time serve as an important coastal management tool for sustainably harnessing fisheries and tourism resources to alleviate poverty without compromising the integrity of the marine and coastal ecosystems.

It was against this background that, IUCN Eastern Africa Regional Office (EARO), UNEP, WIOMSA, WWF and other collaborating partners with the assistance of NORAD Funds, implemented a project on "Development of Partnerships for Implementation of the Jakarta Mandate in the Eastern African region". One of the projects aim, was, to develop a tool kit for MPAs managers, and initiate a program for assessing the management effectiveness of MPAs.

The toolkit aims to act as a compliment to on-going training courses conducted at the national and regional level, and as the first point of call in search for information on issues that managers and practitioners face in day-to-day operations.

Challenges of funding community-based fisheries-related projects

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Abstract

The Global Environment Facility Small Grants Programme, launched in 1992, aims to deliver global environmental benefits in the GEF Focal Areas of biodiversity conservation, climate change mitigation, protection of international waters, prevention of land degradation (primarily desertification and deforestation), and elimination of persistent organic pollutants through community-based approaches. Funded by the Global Environment Facility (GEF) as a corporate programme, SGP is implemented by the United Nations Development Programme (UNDP) on behalf of the three GEF implementing agencies, and executed by the United Nations Office for Project Services (UNOPS). Since its inception, the GEF SGP has occupied a strategic niche within the GEF, particularly by supporting community-based initiatives and interventions responding to the criteria, objectives and priorities of the GEF.

Notably, the SGP:

- supports outreach and awareness raising activities on selected environmental concerns;
- builds the capacities of non-governmental organisations (NGOs), community-based organisations (CBOs) and local communities in addressing such environmental concerns; and
- provides a mechanism for demonstrating and disseminating community-level or community-led interventions and solutions to such environmental concerns.
- There are 116 country offices and two regional offices, with day-to-day management by SGP National Coordinators
- SGP features decentralized decision-making about grant awards, based in strategic direction by a voluntary National Steering Committee in each participating country.
- A small central programme management team, based in New York, is headed by a Global Manager.

The GEF Small Grants Programme in the Republic of Mauritius:

- Mauritius joined the GEF SGP in 1995
- 75 projects have been funded since its inception The in-depth analyses made during the Biennial Programme Review of the Programme in February 2002 and ex-post study held in 2005 have shown that the GEF-SGP has built very significant capacity in its partners both directly and through project implementation.
- Some projects have led to a clear increase in public awareness of global environmental problems and solutions.

A National Steering Committee (NSC) – composed of voluntary representatives from NGOs, government agencies, the University of Mauritius, the private sector and the UNDP office - approves projects and guides the implementation of the Programme, which is managed by a National Coordinator.

The SGP has worked with fishing associations and conservation NGOs in Mauritius and Rodrigues on fisheries and MPA related projects, and has gained experience in creation of alternative livelihood for fishers and income generation through this work.

The biggest challenges in these projects:

- community participation
- government commitment
- bad weather allowance
- working relationship between local authorities and NGOs/CBOs.

An MPA in La Réunion: Here it is, at last!!

Emmanuel TESSIER and Bruce CAUVIN

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Abstract

In Réunion island, the coral reefs are located on the west coast. With a total surface of about 12 km², these young fringing reefs have an high sensitivity and have to face a high and increasing human pressure. They ensure physical protection against waves and are of major interest for tourism. Landscapes associated with coral reefs are the first motivation of tourists coming to Réunion and allow many activities (surf, kayak, sailing, diving, fishing, etc.) to develop. Fishing is practised both on foot on the reef flat and by boat on the reef slope.

From the early 80's scientists have demonstrated that coral reefs are becoming degraded, and they raised political consciousness of the risks of this degradation for human activities. Local collectivites therefore decided to create in 1997 an association completely involved in coral reef preservation "le Parc Marin de la Réunion". However, the regulation (no-take areas) was unsuitable for a global management. In 2001, the environment administration (Direction Régionale de l'Environnement) was commissioned by local collectivities to create a National Marine Reserve. It became effective in February 2007 after 6 years of participatory process.

The MPA is 35 km² large, only at sea, and divided in three zones of increasing protection : general perimeter, no-take areas, sanctuaries. The most important stakes are to maintain the local biodiversity and to allow the recovery of overexploited fishery resources. The way to attain these objectives will be defined by all the stakeholders in a five years management plan.

Bad impacts due to human activities make this ecosystem more fragile and decrease its resilience. In this way, it is less fit to resist exceptional climatic disturbances and the global change. The managers aim to decrease direct anthropogenic impacts (due to uses of the marine area) and indirect impacts (associated to economical development on the watershed, mainly agriculture and urbanization).

Madagascar Foundation for Protected Areas and Biodiversity

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Abstract

Madagascar is host to a wide array of natural habitats, ranging from lush tropical forests to barren dry lands. It is home to fauna and flora which cannot be found anywhere else.

In addition to its outstanding diversity, Madagascar is also renowned for its high levels of endemism. Indeed, 80% of flowering plants in Madagascar are endemic, which 98% of its palm tree species are endemic. This is the case for 95% of reptiles and 98% of frogs as well. All of its primates, the lemurs, are endemic to the island.

The variety of ecosystems and the endemism of species easily qualify the island as one of the Mega-biodiversity countries.

Throughout the last fourteen years, much effort has been allocated to the creation of protected areas. In particular, a 1.7 million-hectare "Protected Area Network" has been created, which is managed by PNM-ANGAP.

After a few years of implementation of the National Environmental Plan, the question of the financial sustainability of protected areas arose.

In April 2003, an agreement was concluded between the Malagasy and German governments for a so-called "debt-for-nature swap". This agreement came as an opportunity for the Malagasy government to accelerate the creation of the environmentally-oriented Trust Fund.

The creation of a Trust Fund required revision of the Malagasy law regulating foundations. A new law was therefore duly adopted and promulgated in August 2004.

In order to create the Madagascar Foundation for Protected Areas and Biodiversity, the Malagasy government, WWF and Conservation International (CI) joined forces to make the first contribution to the new Foundation's capital endowment.

The core mission of the Foundation is to provide financing for the management of existing protected areas and to support the creation of new protected areas.

In order to accomplish that mission successfully, the Foundation will invest its endowment fund on international capital markets and use the revenues to finance protected areas and biodiversity conservation. The Foundation will also manage specific sinking funds those with a predetermined life span according to its mission; these funds will be used the purposes that match both the Foundation's mission and the donor's wishes.

Regardless of the nature of the donation, all allocation of funds to a project will follow rigorous and transparent procedures.

Since the creation of the Madagascar Foundation for Protected Areas and Biodiversity, other donors have contributed to it.

Financing protected areas is a form of investment in biological rarity and diversity. The Foundation's contribution must therefore aim to be both *useful* to the conservation of species and habitats, and *efficient* in the establishment of a sustainable solution to the problems of the protected areas it supports.

Promotion of non-fishing income generating activities and access to micro-credit schemes

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Abstract

The fishing sector is dominated mainly by traditional fishing (harpoon for octopus, traps and line fishing for small fish) in small boats within the lagoon. But now as the lagoon has been silted and overexploited, the catches are decreasing substantially. Most of the fishers, especially the fisherwomen who fish mainly octopus, are forced on a seasonary basis to look for supplementary sources of income, but they have difficulties in identifying good opportunities.

However, due to micro-climatic characteristics, it is recognised that some Rodriguan agricultural products contain a differential advantage. With adequate support, these products could be transformed and become added value income generating activities and generate chains of value.

The business opportunities could come from an explicit market need, but also from an existing resource. The exploitation of this resource may (i) induce a new unexplored demand in the local market, (ii) export the products derived from that resource to other markets, (iii) substitute imported products, and (iv) attract investment in the area.

These better opportunities would have to be supported and become competitive through IGAs management training, technical assistance and credit.

Turning MPA waste into an MPA solution

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Abstract

Marine protected areas are impacted by many local and external problems. One of these is waste. In fact, MPAs and other marine and coastal environments in the WIO are blighted by many man-made products, momentarily useful then discarded, leaving a dirty scar on the land or sea. They are also mistaken for food by many marine species such as turtles, whale sharks and whales, resulting in their death.

Successful MPA conservation efforts require workable and realistic socio-economic solutions that complement traditional lifestyles. These are not easy to find as a balance between generating an income and lifestyle is needed; one that allows development but not at the expense of the environment on which traditional communities are dependent.

In the recent past, many alternative livelihood schemes have been established in MPAs in the WIO. Most have been supported by NGOs and/or interagency support and aim to improve livelihoods, reduce the imbalance existing within communities and reduce pressure on certain natural resources. But, many of these initiatives have not survived without donor support.

The Flip-Flop initiative provides an example of an income generating activity for local communities adjacent or within MPAs, and environmental clean-up linking waste back to the consumer world which generated it in the first place. It all started on the north coast of Kenya, Kiunga Marine National Reserve, Lamu in an effort to improve nutritional requirements of the community, clean up the beaches and allow for cleaner nesting ground for turtles. Since 1997, the local women, young men and children collected washed up flip-flops that arrives from as far afield as Japan, Indonesia, Malaysia and China and turned this rubbish into saleable products such as bags, sculptures and jewelry.

To ensure the recycling – income generating concept lasts, the flip-flop initiative became a business and Uniqueco (the Flip-Flop Recycling Co.) was established in August 2005. With its profit-making focus the business aims to reward those who help themselves, build a model for future income generation and give individuals involved a measurable sense of pride and satisfaction in their achievements. It is not the panacea for all environmental and poverty problems, but many lessons have been learned, and to date over 100 women depend on recycled flipflops as an income, and over 100,000 flipflops are collected from the beaches in Kenya per year.

Marine National Parks of the Seychelles

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Abstract

The islands of the Seychelles lie between 3º41′ and 10º17′ South and 46º15′ and 56º18′ East in the western Indian Ocean. The archipelago consists of 115 small granitic and coralline islands occupying a total terrestrial area of 445 km^2 and surrounded by an Exclusive Economic Zone of 1.3 million km^2. The Seychelles archipelago is comprised of two distinctive groups of islands. The northern group of 41 Precambrian granitic islands is where the majority of the population lives and is the centre of tourism activities, with the three major islands of Mahé, Praslin and La Digue housing more than 95% of the population. The remaining 74 islands are coralline in nature and are of two distinctive types: sand cays and raised atolls.

There are a total of 14 MPAs in the Seychelles designated under three different Acts; the National Parks and Nature Conservancy Act (CAP 141), Fisheries Act (CAP 82) and the Protected Area Act (CAP 185. There are six Marine National Parks (MNPs), three Special Nature Reserves (SNR), four Shell Reserves (SR) and one Protected Area (PA). The Marine National Parks are managed by the Seychelles Centre for Marine Research and Technology – Marine Parks Authority (SCMRT-MPA), a parastatal company of the Government of Seychelles.

A Marine National Park in the Seychelles is legally described as *an area of shore, sea or seabed together with coral reef and other marine features set aside for the propagation, protection and preservation of wildlife or the preservation or places or objects of aesthetic, geological, prehistoric, historical, archaeological or other scientific interest for he benefit, advantage and enjoyment of the general public.*

Marine National Parks constitute a total area of 61.77 km² and are established around the islands of Sainte Anne, Curieuse, Silhouette, Ile Cocos and the bays of Port-Launay and Baie-Ternay. Within these sites which have been designated under the Nature and Conservancy Act (Cap 141), all wildlife and nature is strictly protected; no fishing, collection of shells, removal, disturbance or damage of any living or dead flora or fauna is permitted.

Parc National Nosy Hara: aire protégée marine et cotière, Madagascar

Jaomanana

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Abstract

L'Aire Protégée Marine et Côtière est encore mal représentée au sein du Réseau des Parcs Nationaux et Réserves de Madagascar. Le Programme Environnemental phase-II (2003 au 2008) a fixé comme des objectifs l'augmentation en nombre et superficie des Aires Protégées Marines à Madagascar.

L'Archipel de Nosy Hara est parmi les sites jugés prioritaires du Gouvernement Malagasy pour être classés en Parc National, vu son importance en matière de diversité des habitats à haute importance écologique comme le mangrove, les zones d'herbiers, les récifs coralliens et les îlots, et aussi évidement une biodiversité exceptionnelle que cette zone abrite.

Pourtant cette zone n'est pas à l'abri des pressions humaines et du changement global du climat ceux qui entraînent des perturbations des communautés spécifiques et de destructions des habitats notamment : la destruction mécanique des coraux, la surexploitation de certaines espèces à haute valeur marchande, la déforestation des mangroves, l'ensablement des zones d'herbier de phanérogames. En plus du nombre des pêcheurs immigrants qui augmente en surcroît durant la haute saison de pêche qui dure dans les 7 mois de l'année.

Des séries d'études scientifiques, socioéconomiques et culturelles ont été réalisées depuis 1998 pour étayer les arguments pour la nécessité de la mis en place d'une mode de gestion durable des ressources marines et côtières de l'archipel de Nosy Hara. Une fois de plus à part l'importance écologique, la population locale a montré aussi leurs intérêts communs à l'utilisation rationnelle des Ressources Naturelles. Ceux qui ont abouti à l'acquisition de financement de la part du Gouvernement et des bailleurs de fonds.

Les parties prenantes (population locale, autorités locales et régionales) ont été impliquées dès le début du processus et ils ont une part de responsabilité sur la surveillance du Parc National. On adopte une gestion collaborative, des autres organes consultatifs et exécutifs se sont prévues de mettre en place pour améliorer la mis en œuvre de ce mode gestion nouvellement appliquée à Madagascar.

Finalement le Parc National de Nosy Hara d'une superficie de 147.228 ha est subdivisée en 6 noyaux durs d'une superficie de 1.872 ha et 5 zones tampon de 6.320 ha et une zone de protection de l'ordre de 139.126 ha. Les trois objectifs principaux sont la protection des habitats, l'utilisation rationnelle des ressources naturelles (pêche responsable et transfert de gestion des mangroves et forêts littoraux) et le développement de l'écotourisme. Un vision commune, des axes stratégiques et des actions prioritaires ont été définies ensemble dans le but d'instaurer une bonne gouvernance pour la gestion durable de Nosy Hara.

Using length-frequency data to identify management options: a case-study based on five years monitoring of the large seine net fishery of Rodrigues Island, Indian Ocean

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Abstract

The large seine-net fishery in the 240 km² shallow lagoon of Rodrigues Island is of great socio-economic importance in terms of both protein and employment. Seine net fishing is undertaken by teams of fishers, usually with between 15 and 30 men using four to eight boats. Annual landings from the fishery of 190 tonnes to almost 300 tonnes have been recorded since 2000. Working with local fishing cooperatives, the NGO Shoals Rodrigues has monitored the seine catch since 2002, recording the species and total length of each fish caught during 125 sampled fishing days. A total of over 68,000 fish in about 110 species have been sampled over the five years with data on each individual entered on a specially designed database to facilitate analysis. The fishery is diverse and the most commonly caught species include the rabbitfish *Siganus sutor*, mullet *Valamugil seheli*, surgeonfishes *Naso unicornis* and *Acanthurus triostegus*, emperor *Lethrinus nebulosus*, goatfish *Mulloidichthys flavolineatus*, jack *Caranx melampygus*, and the mojarra *Gerres longirostris*.

Analysis of the length-frequency distributions for the primary species in the catch allows the total mortality rates and lengths at first capture to be estimated. The former can be compared to estimates of natural mortality rates available from FishBase to find out whether exploitation levels are likely to be sustainable or not. The latter can be used to find out what the effects of changing mesh size would be on the fishery. Analysis suggests that several of the main species caught are being severely overexploited but that others are being exploited sustainably at close to optimal levels of effort. The overexploited species tend to be those that are deeper bodied (e.g. the rabbitfish, *Siganus sutor*) and thus caught at a younger age, whereas the sustainably exploited species tend to be those that are shallow-bodied (e.g. goatfish and mullet) and thus caught much later in life.

A surplus yield model based on government fisheries statistics on catch and effort suggests that the fishery, following a major reduction in effort in 1998, is sustainable overall. However, the length-frequency data shows that several species are heavily overexploited. The data on length at first capture shows that due to the mix of the main species that contribute to the large seine net catches, an increase in mesh size is unlikely to be beneficial. The proposed network of four marine reserves and a MPA appear to be the best way of ensuring that the overexploited species continue to provide valuable fish protein and support employment.

Programme régional de gestion côtière des pays de l'Océan Indien (ProGeCo): composante «Appel à Propositions»

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Abstract

C'est un programme de la COI financé par l'UE (€ 18M) impliquant : Maurice, Madagascar, Comores, Seychelles, Kenya, Tanzanie et Somalie. La Réunion, le Mozambique et l'Afrique du Sud sont également associés à la mise en œuvre.

Au niveau de chaque pays, un Point Focal National coordonne les actions sous la supervision des Ministères techniques concernés. L'objectif spécifique est de renforcer les capacités de tous les acteurs en vue de promouvoir la gestion durable des ressources marines et côtières à travers la promotion de plans nationaux de gestion intégrée de la zone côtière (GIZC).

Sept résultats sont attendus:

1. Amélioration des connaissances de la biodiversité et conservation et valorisation des ressources marines et côtières
2. Renforcement des capacités des centres de formation de la région à former des professionnels du domaine de la gestion marine et côtière.
3. Amélioration de l'accès à l'information et de la sensibilisation du public ;
4. Elaboration et adoption des plans nationaux de gestion intégrée des zones côtières :
5. Amélioration des capacités des pays à prendre part activement aux négociations internationales relatives aux questions environnementales :
6. Participation active des acteurs non étatiques dans l'élaboration et la mise en œuvre des plans GIZC : Une procédure d'appel à propositions permettra de sélectionner et subventionner des projets liés à la GIZC, préparés et proposés par les acteurs non étatiques.
7. Développement d'un consensus régional sur une approche commune en matière de gestion durable des ressources des zones côtières :

L'Appel à Propositions concerne donc la mise en œuvre du Résultat 6. Le budget total de cette composante est d'environ € 6 M. Il est envisagé que le premier « Appel » soit lancé au mois de septembre 2007 pour un montant de € 2,5 M. Le deuxième Appel sera lancé un an après le lancement du premier.

Les règles et les procédures à suivre sont définies dans un Manuel qui sera largement diffusé dans les pays bénéficiaires. Le montant maximum de la subvention à accorder à un projet sera de €100 000, et le maximum de €10 000. Les organisations bénéficiaires sont : les associations, ONGs, et les communautés de base, mais aussi les institutions décentralisées élues démocratiquement telles que les municipalités et les conseils de districts.

Le bénéficiaire potentiel préparera lui-même son projet qu'il soumettra au PROGECO pour financement. Les projets seront sélectionnés par un Comité d'évaluation qui sera constitué à cet effet.

La durée maximum de la mise en œuvre d'un projet sera de 24 mois. Chaque projet doit concourir à la promotion de la GIZC dans le pays ou la région concernée.

Les thèmes prioritaires identifiés pour promouvoir le GIZC dans la région sont : Le renforcement du cadre légal GIZC, l'érosion des sols, l'érosion côtière, la gestion des ressources du lagon, la pollution du lagon. Mais pour chaque thème, des actions prioritaires sont définis pour chaque pays. Il sera possible également de proposer un projet concernant plusieurs pays de la région.

Les organisations qui voudront proposer des projets bénéficieront d'une formation et d'un encadrement conséquent les aidant à identifier, formuler et mettre en œuvre leurs projets.

Durant la mise en œuvre, le PROGECO assurera le suivi/monitoring des activités.

How is your MPA doing? Management effectiveness of MPAs in the WIO

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Abstract

An international initiative to investigate the effectiveness of the management of marine protected areas was initiated in the East Africa and Western Indian Ocean region in 2006. Cousin Island Special Reserve was the only site outside East Africa chosen as part of the study. The initiative was carried out by the United Nations Environment Programme (UNEP), the International Coral Reef Action Network (ICRAN) and the World Conservation Union (IUCN). Other sites selected to be included in the assessment were: Malindi/Watamu Marine Parks and Reserves in Kenya, Mnazi Bay-Ruvuma Estuary Marine Park and Mafia Marine Park on mainland Tanzania and Chumbe Island on Zanzibar.

The final Report by IUCN, UNEP and ICRAN on the management effectiveness of all the sites is available on-line. It concluded that Cousin Island Special Reserve is a long-established protected area (30 years since designation) that is managed by the NGO Nature Seychelles with well trained staff and substantial investment in skilled management and scientific expertise. The report also found that the assessment for Cousin was of high quality, reflecting the experience and technical competence of the NGO managing this MPA. For all sites, with the notable exception of Cousin the IUCN/UNEP/ICRAN Report found that data were lacking to assess many of the desired outcomes, despite the long existence of some of the included MPAs and the considerable investment towards monitoring activities within the region.

The report concludes that Cousin is well run and is achieving great progress towards its aims in regards to biodiversity and socio-economic objectives. Within the Special Reserve the status and trends are known for the land and seabirds, turtles and coral species diversity and % cover. These trends are considered to be good and are contributing to the success of the area and its aims. However, it notes that monitoring of marine species is inadequate and that the funding base for the MPA is weak as it relies solely on tourism income. The findings of the report in regards to Cousin Island Special Reserve are further discussed and the lessons learned from the assessment outlined as practical solutions to problems faced in the management of Marine Protected Areas.

Implications of biodiversity conservation in urban marine protected areas: the case of Mombasa Marine National Park

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Abstract

The global threat to ecosystems as a result of climate change due to human activities has generated much debate of late. There is particularly a great uncertainty for peri-urban ecosystems where the rate of population growth and industrial development is high. Observations made from ecological monitoring of coral reef ecosystems in protected areas in Kenya, revealed that the abundance of *Acanthaster planci* (COTs) was higher in peri-urban Mombasa Marine National Park (MMNP). *A. planci*, a voracious predator of live corals, causes significant damage to coral reefs at high abundances. Surveys conducted between August 2004 and January 2005, indicated that densities varied between 26 and 40 individuals ha^{-1}, close to the threshold of a population outbreak. This increased three-fold between January and June 2005, to more than 100 individuals ha^{-1}, prompting COTs removals from the reef as a control. The densities of COTs declined significantly after the first removal session, in June 2005, from a mean of 105 to 15 individuals ha^{-1} in the park, and from 80 individuals ha^{-1} to 15 individuals ha^{-1} in the reserve. Data from an independent study, documenting natural levels of *A. planci* predation on permanently marked corals was assessed in relation to the removals. A separate study on the mangrove ecosystem and water quality of the creeks neighbouring the protected areas indicated a degraded mangrove forest and significant pollution from domestic and industrial sewage. The observed degradation can be linked to land use patterns that directly impacts marine ecosystem. The management of these systems requires an integrated approach, based on landscapes and seascapes approach, boosting ecosystem resilience to the ever increasing threats. This can be achieved through an effective Integrated Coastal Zone Management framework, rather than conserving small areas.

4. MARINE PROTECTED AREA TABLES

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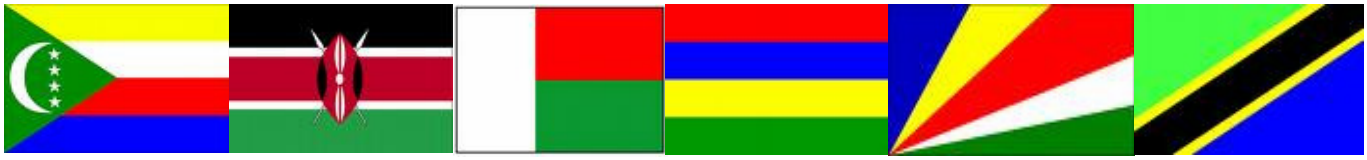
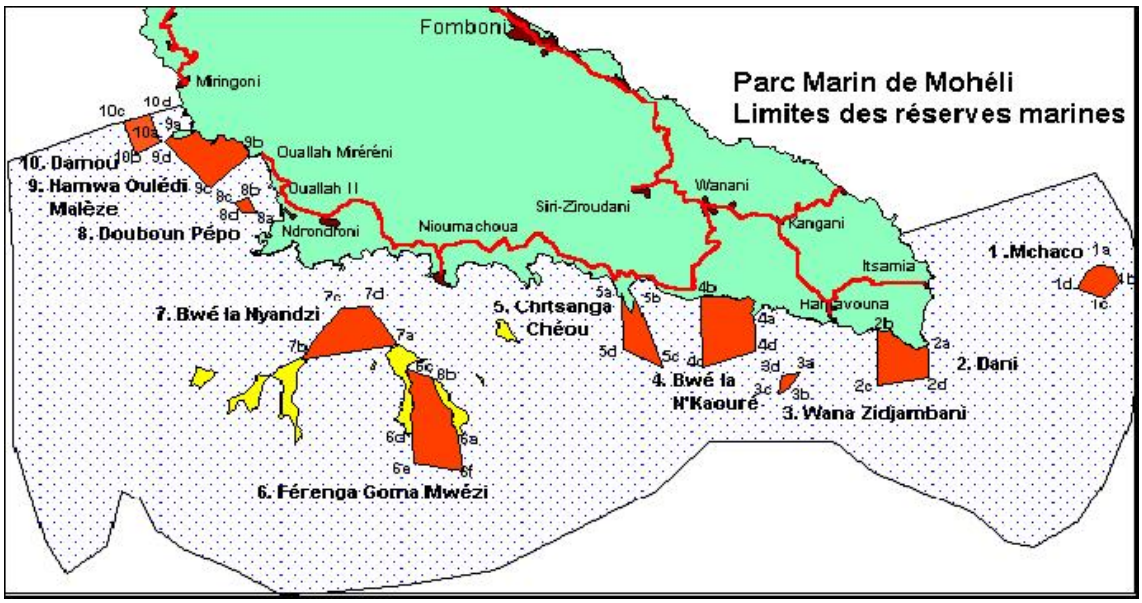
MPA tables edited by Alasdair Edwards,
Emily Hardman and Tara Hooper

Newcastle University, Newcastle upon Tyne;
Shoals Rodrigues, Pointe Monier, 2007



COMOROS

Name of MPA	Parc Marin de Mohéli, Union des Comores
Location	Latitude 11°20' – 13°04' Sud; Longitude 43°11' – 49°19' Est
Size	404 km^2
Status	Parc National, établissement public à caractère administratif
Date established	1998 "Conservation de la biodiversité et développement durable aux Comores », financé par le gouvernement comorien, FEM/ PNUD avec l'assistance technique de l'IUCN.
Date effective protection commenced	Créé le 19 avril 2001, par décret présidentiel N°01 – 053 / CE
Purpose of protection	Assurer la conservation de la biodiversité marine et terrestre, assurer une utilisation durable des ressources halieutiques, Favoriser le développement des activités éco touristiques, Renforcer l'éducation relative à l'environnement, la formation et la communication.
Focus species/habitats	Mangroves, tortues marines, dugong, récifs coralliens, plages, herbiers marins, roussettes de livingstone.
Zonation & restrictions	Techniques de pêche interdites (filets, tephrosia, pêche sous marine au harpon, dynamites), déversement d'ordures d'hydrocarbures et autres déchets, braconnage tortues, dugongs & dauphins, prélèvement des œufs de tortues, toutes formes de destruction des coraux morts ou vivants, destruction de la mangrove.
Temporal regime	Protection et restriction permanente
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1. Ministère de l'environnement de l'Union des Comores 2. Programme des Nations Unies pour le Développement «PNUD» Moroni Comores 3. Université des Comores 4. Centre d'Etudes et de Découverte des Tortues Marines de la Réunion «CEDTM – kélonia».
Sources of funding	100 % PNUD sur accord du gouvernement de l'Union des Comores.
Extent of community involvement	Approche participative, mode de congestion (consultation, règlement des conflits, protection & sensibilisation)
MPA monitoring & success	Usage du savoir faire comorien Transparence dans les mécanismes de prise de décision Conseils et appui technique du PNUD & IUCN
References	1. Conservation de la biodiversité aux Comores : Parc National de Mohéli, Abdou Soimadou Ali & Aboulhouda Youssouf, 1996. 2. Bilan de quatre années d'activités pour la création et la mise en opération d'une aire protégée marine, B.Paris 2003. 3. Plan d'exploitation du Parc Marin de Mohéli, Ministère du Développement Rural, de la Pêche, de l'Artisanat et de l'Environnement, Novembre 2005. 4. Programme d'aménagement du Parc Marin de Mohéli, Projet Conservation de la Biodiversité et Développement Durable aux Comores, PNUD/GEF-COI/97/G32/A1/1G/99, Juillet 2002.



Zonation of the Mohéli Marine Park

Local fishermen in the park

View over the park area

KENYA

Name of MPA	Kisite Mpunguti Marine National Park & Reserve
Location	Kisite Marine National Park: within area bounded by UTM Northings 947600 – 9482350 and Eastings 536000 – 544350 Mpunguti Reserve: within area bounded by 4°40'2.15" – 4°42' 53.2" S and 39°23'22.2" – 39°25'25.6"E
Size	Park: 28 km^2; Reserve: 11 km^2
Status	Active.
Date established	25th October 1973
Date effective protection commenced	1978
Purpose of protection	Habitat protection, fisheries sustainability & tourism.
Focus species/habitats	Corals, dolphins, turtles and coconut crabs.
Zonation & restrictions	The park is a core no take zone while the reserve can be fished with gear restrictions, licenses to fish are required
Temporal regime	Permanent. No fishing in the park all year round, while fishing gear is regulated in the reserve. Access to the protected area by both tourists and locals is by entry fee all year round
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	 1. Kenya Wildlife Service, PO Box 82144, 80100 Mombasa, Kenya 2. Kenya Wildlife Service (KWS) 3. KWS 4. KWS
Sources of funding	100% from Government – all collections from protected areas in Kenya are sent to the headquarters in Nairobi and then reallocated.
Extent of community involvement	Role of community groups in different phases e.g. consultation/management/ enforcement
MPA monitoring & success	Extent and nature of monitoring activities and evidence of MPA success
References	Reports, published articles, website URL, or other sources of further information

Whale shark (*Rhincodon typus*) in Kisite Marine Park

Swimming with a Whale shark in Kisite Marine Park

Name of MPA	Mombasa Marine National Park & Reserve
Location	Mombasa Marine National Park: within area bounded by Northings 9556850 – 9562000 and Eastings 582200 – 587000 Mombasa Marine National Reserve: within area bounded by Northings 9548350 – 9560450 and Eastings 576850 – 588200
Size	Park: 10 km^2; Reserve: 200 km^2
Status	Active
Date established	December 1986
Date effective protection commenced	1989
Purpose of protection	Habitat protection, fisheries sustainability & tourism.
Focus species/habitats	Corals, turtles and fish.
Zonation & restrictions	The park is a core no take zone while the reserve can be fished with gear restrictions, licenses to fish are required.
Temporal regime	Permanent. No fishing in the park all year round, while fishing gear is regulated in the reserve. Access to the protected area by both tourists and locals is by entry fee all year round.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	 1. Kenya Wildlife Service, PO Box 82144, 80100 Mombasa, Kenya 2. Kenya Wildlife Service (KWS) 3. KWS 4. KWS
Sources of funding	100% from Government – all collections from protected areas in Kenya are sent to the headquarters in Nairobi and then reallocated
Extent of community involvement	Role of community groups in different phases e.g. consultation/management/enforcement. Community organisations for boat tour operators, beach curio traders and fishermen have been established and regular meetings are organised with the warden.
MPA monitoring & success	Extent and nature of monitoring activities and evidence of MPA success There is currently management plans for all MPAs, and a Management effectiveness assessment has already been done. The management plans are now under review, but in general concrete measures and structures are in place to manage and enforce the conservation of the MPAs.
References	Reports, published articles, website URL, or other sources of further information. See the MPAs annotated bibliography

COTS (Crown-of-Thorns Starfish) control in Mombasa

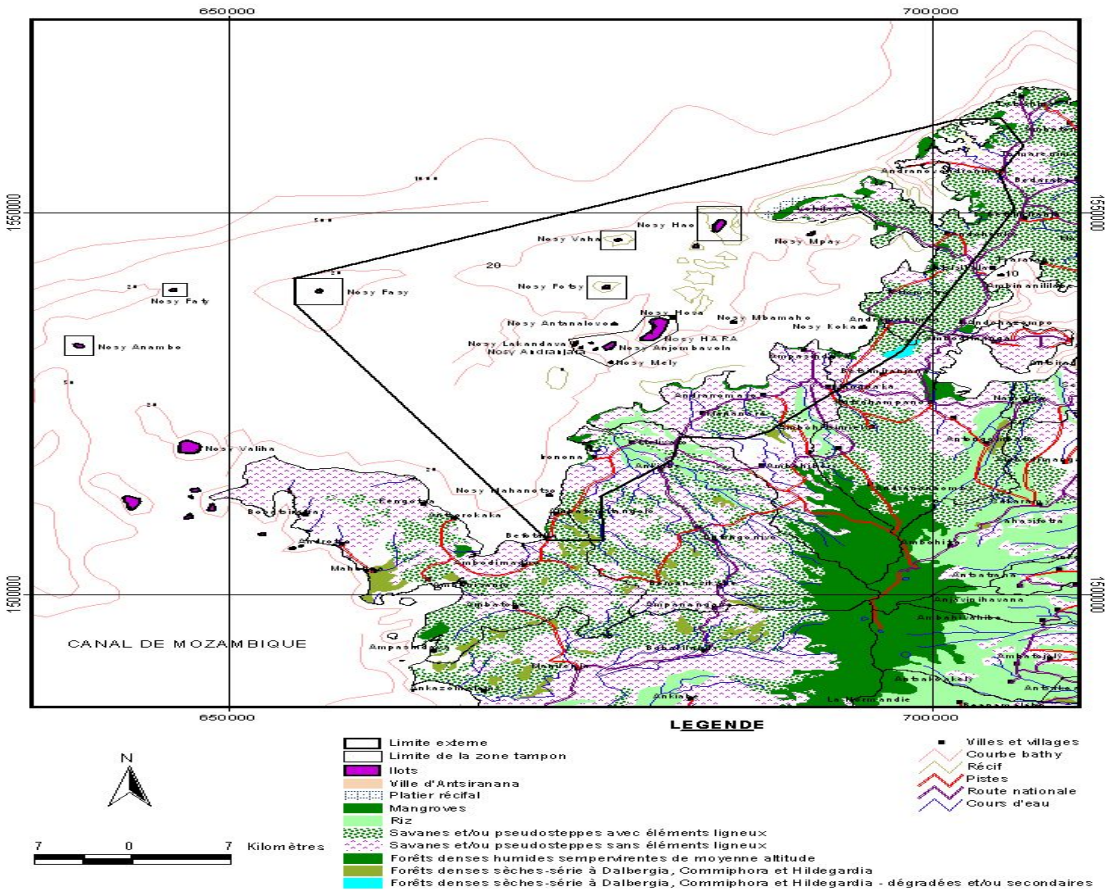
Mangrove planting in Mombasa

Fisherman with mangrove crab

MADAGASCAR

Name of MPA	The Velondriake Network of Marine and Coastal Protected Areas
Location	The Andavadoaka region, southwest Madagascar (central point 43.197 E 22.123°S)
Size	
Status	In development
Date established	N/A
Date effective protection commenced	Habitat protection, fisheries sustainability, tourism, mariculture
Purpose of protection	Habitat protection, fisheries sustainability, tourism, mariculture
Focus species/habitats	Coral reefs (patch & fringing), mangroves, seagrass, deciduous dry forest, lagoon
Zonation & restrictions	Marine areas closed permanently to fishing; Marine areas closed temporarily to octopus fishing; Marine areas closed seasonally to octopus fishing; Marine areas set aside for mariculture; Terrestrial areas reserved for ecotourism.
Temporal regime	Permanent closure of octopus fishery in SW Madagascar (all fishing sites) 15th December – 31st January each year (commenced December 2005) Additional *ad hoc* temporary closure of selected reef flat areas to octopus fishing (ongoing, decided locally)
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1. Velondriake MPA committee 'Velondriake'; 3 regional MPA sub-committees (north committee 'Vezo Milagnoriake' = 8 villages, central committee 'Milasoa' = 7 villages, south committee 'Fagnemotse' = 9 villages), Blue Ventures Conservation, Wildlife Conservation Society 2. None 3. Blue Ventures Conservation, Wildlife Conservation Society, ARVAM, Institut Halieutique et des Sciences Marines (University of Toliara) 4. Blue Ventures Conservation; Wildlife Conservation Society
Sources of funding	Approximately 80% of research, monitoring and MPA development costs are funded through revenue generated through marine ecotourism expeditions (Blue Ventures). The remaining funding has been provided by grants (CORDIO, FSP, FFEM, PSDR, DFID, Rufford, PADI, Seaworld, NGS, RGS), private donations & fundraising events (Blue Ventures) and through in kind support by IHSM, WCS and ARVAM. There is currently no funding from government or independent (nontourists
Extent of community involvement	Regional MPA committee and 3 regional sub-committees, grouping MPA representatives from 24 villages Direct employment of community members to support research and monitoring (Blue Ventures)
MPA monitoring & success	Ecological monitoring – long term coral reef monitoring (benthic, fish and macroinvertebrates). Fisheries monitoring – long term monitoring of catches from local fisheries (octopus, fin fish, shark & turtle). Socioeconomic monitoring – socioeconomic baseline assessment (using CORDIO-WIO methods and protocols) of all villages involved in MPA
References	http://www.andavadoaka.org http://www.blueventures.org/research_update.htm

Name of MPA	Parc National Nosy Hara
Location	Ce sont des coordonnées Laborde que nous utilisons. Part-1 : Sud Est (X 672.628; Y 1007.184), Sud Ouest (X 657.984; Y 1541.366), Nord (X 704.877; Y 1562.841). Part-2 : NW (X 640.301; Y 1533.876), NE (X 638.220; 1533.876), SE (X 638.220; Y 1531.179), SW (X 640.301; Y 15341.179). Part-3 : NW (X 647.029, Y 1540.782), NE (645.289; 1540.782), SE (X 645.289; Y 1538.950); SW (X 647.029; Y 1538.950).
Size	147 km², 228 ha.
Status	En cours de création.
Date established	
Date effective protection commenced	15 août 2005.
Purpose of protection	Habitat protection. Pache responsable. Ecotourisme.
Focus species/habitats	Habitats: récif corallien, mangrove, zone d'herbier et îlot. Espèces: tortues marines (*Caretta caretta, Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea*), *Dugong dugon, Haliaeetus vociferoides*. Pache responsable et écotourisme.
Zonation & restrictions	Core no take zone: 1.872 ha Buffer zone (limited take zone) pour la population locale seulement et pour la pratique de pêche traditionnelle: 6.320 ha. Zone de protection (marine et terrestre : utilisation règlementée), activités jugées non destructives: 139.126 ha. Pas d'exploitation industrielle pour toutes les ressources naturelles.
Temporal regime	Permanent
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1. Association National Pour la Gestion des Aires Protégées (ANGAP) et WWF 2. ANGAP et WWF 3. ANGAP, WWF et Université d'Antsiranana. 4. ANGAP, WWF et DREN (Direction Régionale de l'Education Nationale)
Sources of funding	La part du gouvernement 30% du Fond IDA qui apporte les 70%. Une autre moitié pour 3 ans : Fondation Mac Arthur.
Extent of community involvement	Consultation, patrouille et surveillance.
MPA monitoring & success	Habitat protection: récif corallien, mangrove, zone d'herbier et îlot. Espèces: tortues marines (*C. caretta, C. mydas, E. imbricata, L. olivacea*), Dugon *(Dugong dugon),* Madagascar fish-eagle *(Haliaeetus vociferoides)*. Pache responsable et écotourisme.
References	



Zonation of Parc National Nosy Hara

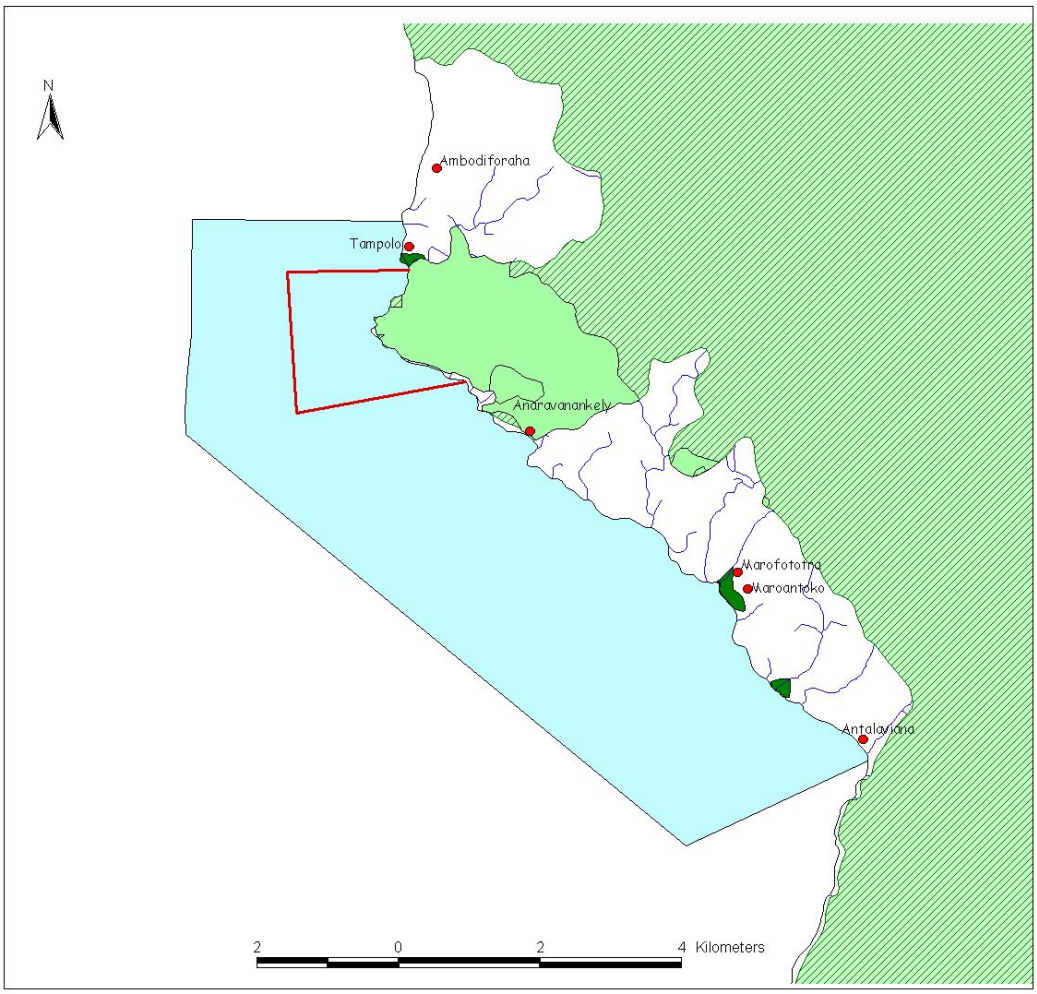
Name of MPA	Parc Marin de Nosy Antafana
Location	Nord-Est de Madagascar, juste à l'entrée sud de la Baie d'Antongil. Coordonnée: 16°20'S 49°51'E (Projection Laborde: X=764.500 et Y= 1080.750)
Size	Surface Totale: 1 000 ha (10 km²)
Status	Active
Date established	Décret 89/216 du 25 Juillet 1989
Date effective protection commenced	Octobre 1988
Purpose of protection	1. Richesse en biodiversité et habitat (un monde marin à la miniature) 2. Pressions (proximité des villages riveraines et pratique de pêche destructrice)
Focus species/habitats	*Habitats* La forêt littorale sur sable, les forêts littorales sur granite, la mangrove, les plages, les pentes externe, les platiers interne (lagon), falaises rocheuses, passes, fond sableux et les herbiers à phanérogames. *Biodiversité marine* 122 espèces de coraux, 32 espèces d'algues, 9 espèces de phanérogames, 6 espèces de palétuviers, 64 espèces de mollusques, 30 espèces d'échinodermes et 140 espèces de poissons. *Biodiversité terrestre* 9 espèces de reptiles, 1 espèce d'amphibiens, 2 espèces de mammifères, 8 espèces d'oiseaux et 98 espèces végétales.
Zonation & restrictions	1. le Noyau Dur (controle stricte et régie par le Code de Gestion des Aire Protégée). 2. la zone de droit d'usage ou Zone d'Utilisation Contrôlée « ZUC » (Controle modérée) régie par le Code de Gestion des Aire Protégée, Réglementations de Pêche et DINA (convention locale).
Temporal regime	Permanent.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1. ANGAP, 2. Intercoop (IC), 3. Gouvernement Malgache, 4. CORDIO (WCS).
Sources of funding	ANGAP & Gouvernement malagasy (RPI): 26 %. UE: 68 %. IC: 6 %
Extent of community involvement	- Participation aux contrôle et surveillance du Parc (4 surveillants villageois); - Participation à utilisation des ressources halieutiques dans le «ZUC»; - Participation à l'établissement ou renouvellement de la convention locale «DINA»; - Guidage et transport des touristes
MPA monitoring & success	• Contrôle et suivi de capture de quelques familles de poissons les plus prisées par les pêcheurs; • Suivi de la santé des récifs coralliens en dehors et dans le Parc marin (CORDIO); • Participation de la population à la gestion du Parc par le biais du droit

	d'usage; • Arrêt de pratique de méthodes de pêche destructrices de coraux; Protection des espèces menacées de surexploitation (ex concombres de mer, coquillages); protection des espèces de poissons bio indicateurs de la santé des récifs
References	*Rapports:* Contribution à la recherche d'indicateurs de durabilité: application au Parc marin de Nosy Antafana. A. Poirier, Octobre 1996. Rapport d'inventaire écologique du récif de Nosy Antafana. J. Maharavo, 1998. Rapport de la mission d'évaluation tripartite (projet éco-dévéloppement des populations de base pour la conservation de la Réserve de Biosphère de Mananara-Nord. A. Ebregt et al., 1999. Inventaire ornithologique dans la Réserve de Biosphère de Mananara-nord. L. Rene de Rolland. 2000. Les Reptiles et Amphibiens de la Réserve de Biosphère de Mananara-Nord. O. Ramilison, 2001. La Réserve de Biosphère de Mananara-Nord, un défi pour la conservation et le développement intégré. C. Huttel, 2002. Coral reef monitoring in marine reserves of Northern Madagascar. CORDIO, November 2006. Plan d'aménagement et de gestion 2002-2006 du Parc National de Mananara-Nord. ANGAP, 2002. Plan de gestion de la conservation du Parc National de Mananara-Nord. ANGAP, 2005. Plan de gestion du réseau des aires protégées à Madagascar. ANGAP, 2001. Adresse e-mail: pnmnra@ angap.mg

Name of MPA	Parc Marin «PM» Tampolo, PM Masoala, PM Tanjona/Parc National Masoala
Location	Nord-Est de Madagascar, autour de la presqu'île Masoala 1 - *Parc Marin Tampolo* A: 15°43'20''S 49°57'30''E B: 15°47'15''S 50°57'01'15''E C: 15°43'20''S 49°57'E D: 15°47'15''S 50°00'30''E 2 - *Parc Marin Masoala* A: 15°58'30''S 50°09'E B: 15°1'S 50°10'E C: 15°58'30''S 50°08'40''E D: 15°098'S 50°120'E E: 16°1.008'S 50°11.078'E 3 - *Parc Marin Tanjona* A: 15°48'510''S 50°20'286''E B: 15°45'890S 50°19'365''E C: 15°48'510'S 50°21'650''E D: 15°45'890'' 50°21'650''E
Size	Surface totale: 100 km². PM Tampolo: 36 km². PM Masoala: 33 km². PM Tanjona: 31 km²
Status	Active.
Date established	Date de création du PN Masoala : 02 mars 1997 selon le décret 97-141 publié dans le journal officiel de Madagascar le 21 juillet 1997.
Date effective protection commenced	Date de création du PN Masoala : 02 mars 1997 selon le décret 97-141 publié dans le journal officiel de Madagascar le 21 juillet 1997.
Purpose of protection	Protection des habitats et des espèces en voie d'extinction: 1- Habitat. Récif corallien 2- Espèces. Tortue marines: *Eretmochelys imbricata, Chelonia mydas, Lepidochelys olivacea, Caretta caretta, Dermochelys coriacea.* Dugong: *Dugong dugon.*
Focus species/habitats	*Habitats:* Récif corallien, zone à phanérogames, mangroves, sable de la plage. *Espèces:* 9 espèces de mangroves, 9 espèces de phanérogames, 27 espèces de concombres de mer, 102 espèces de mollusques, 107 espèces d'algues, 164 espèces de coraux (41 genres), 367 espèces de poissons, 5 espèces de tortues marines, dugong
Zonation & restrictions	1 - le Noyau Dur (protection intégrale) 2 - la zone de droit d'usage ou Zone d'Utilisation Contrôlée « ZUC » régie par le Code de Gestion des Aire Protégée, Réglementations de Pêche et DINA (réglementations locales)
Temporal regime	Permanent.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	 1-2 : ANGAP, WCS, WWF, Gouvernement Malgache 3-4: IHSM, WWF
Sources of funding	ANGAP & Gouvernement: 50 % WCS & WWF : 50 %
Extent of community involvement	- Contrôle et surveillance (Comité de Surveillance et Contrôle par parc Marin)

	- Etablissement ou renouvellement de réglementations locales «DINA» - Bilan et proposition d'amélioration de stratégie de gestion -Validation des microprojets alternatifs aux pressions
MPA monitoring & success	• Orientation de la stratégie de gestion à partir des résultats de suivi écologiques (fermeture de la pêche aux poulpes à la période où les juvéniles ont besoin de protection, fermeture de la pêche aux concombres de mer ; arrêt de quelques pratiques de pêche comme : piétinement de coraux, utilisation des perches; recherches sur l'utilisation des poulpiers) • Concernant le taux de couverture corallienne : différence non significative entre ZUC et Noyau Dur d'où les principales sources de dégradation sont le cyclone et le blanchissement mais non pas les activités humaines
References	Rapport : «suivi écologique marin»/1998 - 2004 Rapport: "Bleaching assessment of the shallow coral reef ecosystem in Antongil Bay/Masoala Peninsula with emphasis on the three marine reserves of the Masoala National Park" / S. Jean/Avril 2005 Rapport : « CORDIO »/2006 Plan de Gestion de Conservation du PNM-ANGAP Parc National Masoala/ 2007 Adresse e-mail : pnmasoala@wanadoo.mg Website : www.wcs.org

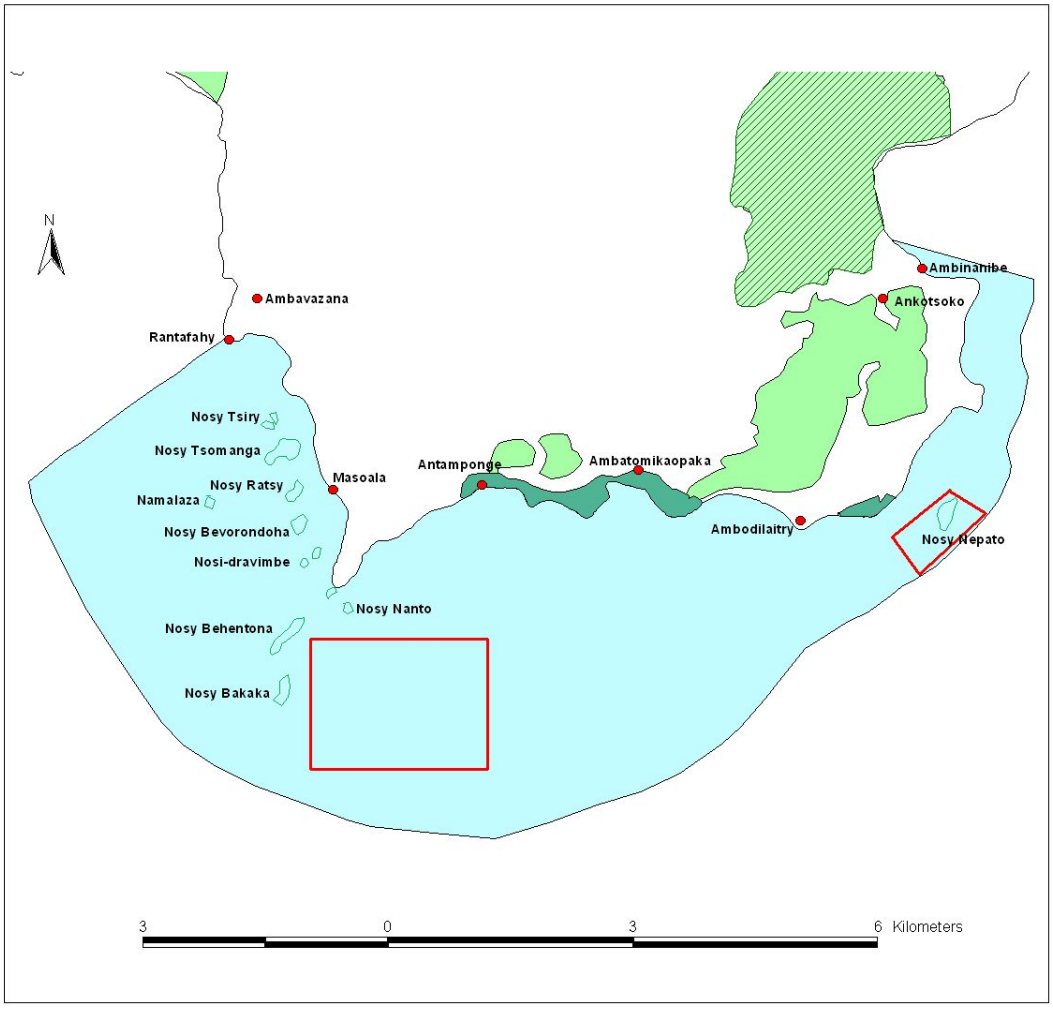
Présentation générale du parc marin Tampolo



Noyau dur
Parc marin
Fôret littorale
Noyau dur terrestre
Ruisseau
Limite de la presqu'île
Fôret de mangrove

Source: BD 500 FTM
RSE Masoala
Mai 2007

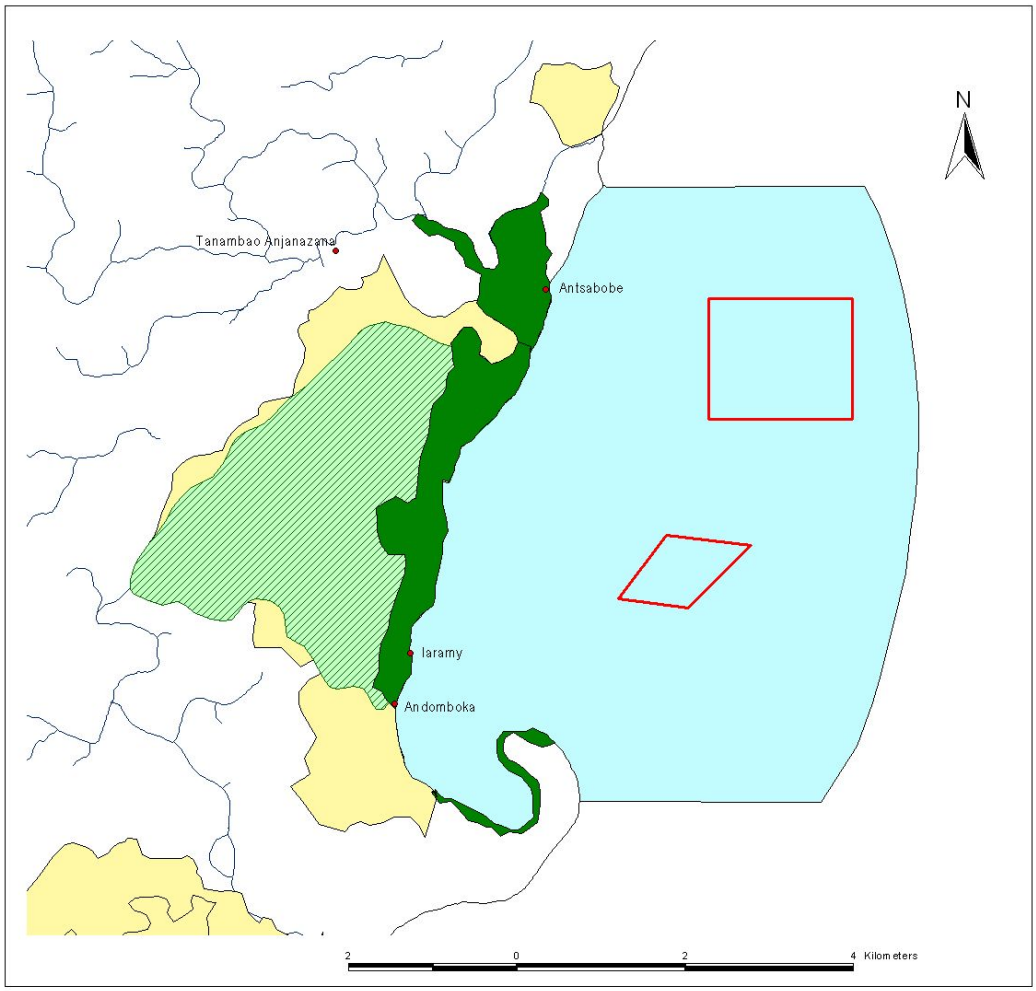
Présentation générale du parc marin Masoala



Noyau dur terrestre
Noyau dur
Village
Ilôt
Fôret de mangrove
Fôret littorale
Parc marin
Limite de la presqu'île

Source: BD 500 FTM
RSE Masoala
Mai 2007

Présentation générale du parc marin Tanjona

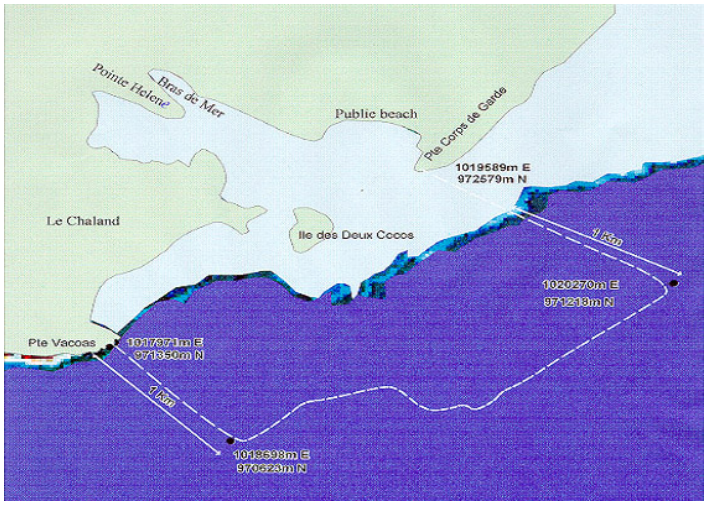


Fôret de mangrove
Noyau dur terrestre
Forêt littorale
Noyau dur
Parc marin
Limite de la presqu'île
Ruisseau

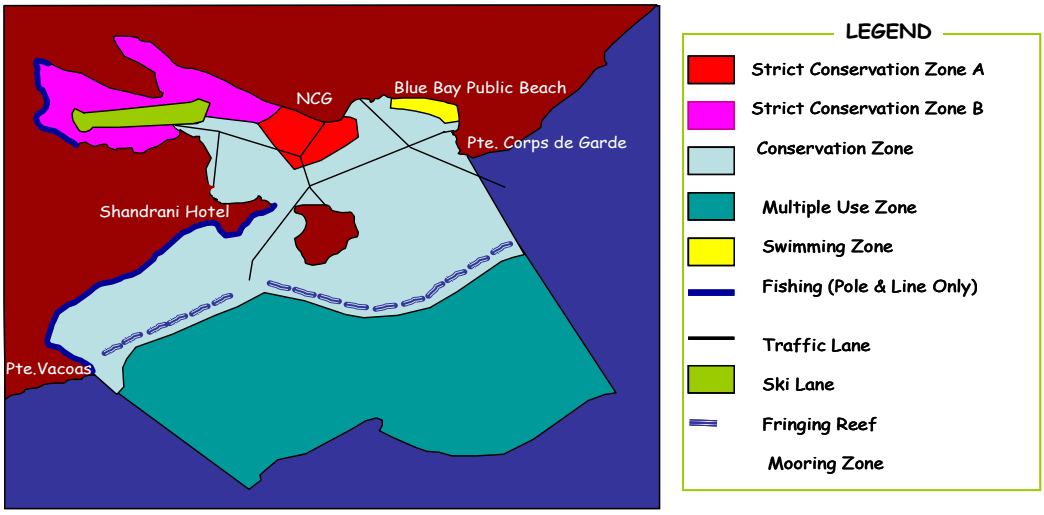
Source: BD 500 FTM
RSE Masoala
Mai 2007

MAURITIUS

Name of MPA	Blue Bay Marine Park
Location	20°26'S, 57°42'E
Size	3.5 km^2.
Status	Active.
Date established	October 1997.
Date effective protection commenced	February 2001.
Purpose of protection	Conservation of its marine biodiversity, marine ecosystems and important habitats.
Focus species/habitats	Corals, seagrasses, mangroves.
Zonation & restrictions	The Blue Bay Marine Park is demarcated into 7 zones, viz: Strict Conservation Zone A & B; Conservation Zone ; Multiple Use Zone ; Swimming Zone ; Mooring Zones ; Ski Lane; Traffic Lane *Restrictions:* Line and basket trap fishing is allowed in the Multiple Use Zone where as pole & line fishing is allowed from the shoreline in some part of the park. Undersea walking is banned.
Temporal regime	Permanent. All the GPS points with respect to the different zones have already been gazetted.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1.-4. Ministry of Agro-Industry & Fisheries (Fisheries Division)
Sources of funding	100% from the Government of Mauritius
Extent of community involvement	In the initial phase, consultative meetings were held with all the stakeholders (fishers, hoteliers, pleasure boat owners, NGOs, inhabitants, etc) and their inputs were considered. Community groups are not involved in the enforcement, however, for management purposes a Steering Committee including NGOs and other ministries has been set up.
MPA monitoring & success	Monitoring of the coral reefs is carried out annually and it is observed that the live coral percentage cover is between 85 to 90 % on the established stations
References	Annual Reports Managing MPA – A Toolkit for the WIO



Boundaries of the Blue Bay Marine Park

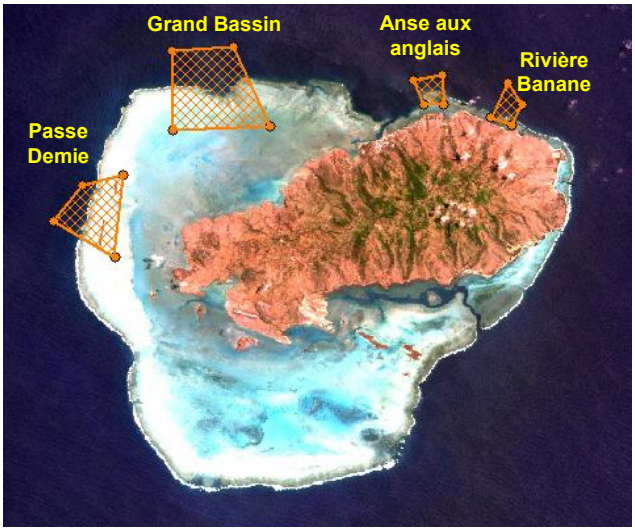


Zoning of Blue Bay Marine Park

Underwater seascape of the Blue Bay Marine Park

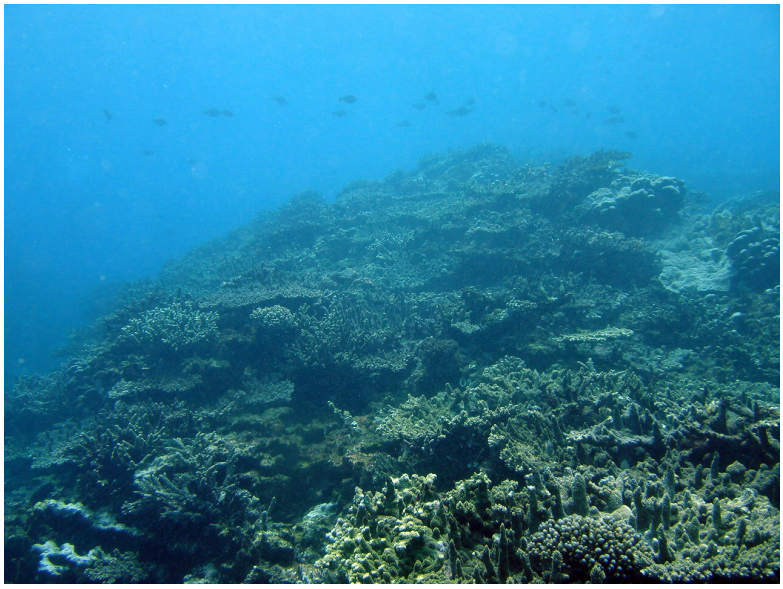
RODRIGUES

Name of MPA	Rivière Banane, Anse aux Anglais (English Bay), Grand Bassin, Passe Demie
Location	Rivière Banane: A: 19° 39.936'S 63° 28.874'E B: 19° 39.328'S 63° 28.500'E C: 19° 40.473'S 63° 28.628'E D: 19° 40.257'S 63° 28.085'E Anse aux Anglais: A: 19° 39.286'S 63° 26.040'E B: 19° 39.136'S 63° 26.821'E C: 19° 39.932'S 63° 26.343'E D: 119° 39.904'S 63° 26.858'E Grand Bassin: A: 19° 38.401'S 63° 21.372'E B: 19° 38.505'S 63° 19.777'E C: 19° 40.589'S 63° 19.827'E D: 19° 40.485'S 63° 22.340'E Passe Demie: A: 19° 42.072'S 63° 17.471'E B: 19° 43.037'S 63° 16.721'E C: 19° 41.814'S 63° 18.521'E D: 19° 43.995'S 63° 18.293'E
Size	Rivière Banane: 1.5 km^2, (perimeter 5.3 km). Anse aux Anglais: 1.5 km^2, (perimeter 5.0 km). Grand Bassin: 14.1 km^2, (perimeter 15.3 km). Passe Demie: 7.2 km^2, (perimeter 11.4 km).
Status	In development
Date established	Gazetted 9 April 2007.
Date effective protection commenced	N/A
Purpose of protection	Habitat protection/fisheries sustainability
Focus species/habitats	Coral reefs/Endemic fish and coral
Zonation & restrictions	No Take Zone
Temporal regime	Permanent
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	 1. Rodrigues Regional Assembly 2. Fisheries Protection Service/National Coastguard 3. Shoals Rodrigues 4. Shoals Rodrigues
Sources of funding	Not yet confirmed
Extent of community involvement	Consultation; possibly enforcement (rangers)
MPA monitoring & success	Biological and socio-economic monitoring
References	www.shoals-rodrigues.org



Boundaries of the four marine reserves in Rodrigues


Rivière Banane marine reserve area from the sea


Rivière Banane marine reserve underwater

SEYCHELLES

Name of MPA	Seychelles Centre for Marine Research and Technology-Marine Parks Authority: Curieuse, Silhouette, Ste Anne, Île Coco, Baie Ternay, Port Launay Marine National Parks
Location	From 4°16'E 55°17'S to 4°37'E 55°22'S
Size	61.77 km^2
Status	All active, except for Silhouette Marine Park
Dates established and areas	Sainte Anne Marine National Park (designated on 19 March 1973; 14.53 km²) Silhouette Marine National Park (designated in October, 1987; 30.45 km²) Port Launay Marine National Park (designated on 11 June 1979; 1.58 km²) Baie Ternay Marine National Park (designated on 11 June 1979; 0.80 km²) Curieuse Marine National Park (designated on 11 June 1979; 14.70 km²) Île Coco Marine National Park (designated on 19 February 1997; 0.01 km²)
Date effective protection commenced	See above
Purpose of protection	Habitat and tourism
Focus species/habitats	Coral reef, sea grass and terrestrial habitat (coastal, midland etc.)
Zonation & restrictions	No take zone, anchoring area, diving and snorkelling sites, swimming area.
Temporal regime	Permanent protection of habitats
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	SCMRT-MPA 1. Mrs. Mary Stravens (CEO); Tel: +248 225114; E-mail: stravens@scmrt-mpa.sc 2. Mr. Allen Cedras, Manager MPA; Tel: +248 517221; E-mail: a.cedras@scmrt-mpa.sc 3. Mr. Jude Bijoux, Manager, SCMRT; Tel: +248 225114; E-mail: j.bijoux@scmrt-mpa.sc 4. Mrs. Eline Moses, Education Officer; Tel: +248 225114; E-mail: e.camille@scmrt-mpa.sc
Sources of funding	Entry fees from visitors, mooring fees from boats, research fees from scientists, renting of infrastructure, and other specialized services (e.g. Installation of mooring buoys). Government subsidy.
Extent of community involvement	Directly and indirectly provides livelihood for the coastal communities (mainly in tourism trade).
MPA monitoring & success	Sea turtle monitoring (good data collection on sea turtle tagging) tortoise breeding, coral reef monitoring, beach erosion, plankton sampling, mooring and demarcation projects.
References	

Location of SCMRT Marine National Parks

Curieuse Marine National Park

A turtle crawling ashore

Name of MPA	Aldabra
Location	Latitude 9°24´S, Longitude 46°20´E
Size	282 km^2. The lagoon area is 193 km^2 and the area around the atoll 89 km^2. The reserve extends to one kilometre from the perimeter high water mark.
Status	Active
Date established	Declared a Special Reserve under Seychelles Law in 1981. A Special Reserve in Seychelles law is an area in which "the characteristic wildlife requires protection and in which all other interests and activities are subordinate". It also means that the area is "set aside to permit the free interaction of natural ecological factors without outside interference except for that which is indispensable for the existence of the reserve".
Date effective protection commenced	1981 declared a World Heritage Site 1982
Purpose of protection	Habitat protection; Unesco World Heritage Site (1982) From the Management Plan: 1. Protection of terrestrial and marine processes, biological and genetic diversity, geological features, ecological systems and Conservation of all naturally occurring species, communities and habitats; 2. Research and monitoring; 3. Restoration where possible; 4. Education.
Focus species/habitats	Coral reef, lagoon, turtles (green and hawksbill), and sea birds
Zonation & restrictions	Marine protected area falls within 1 km around the atoll and includes the large lagoon. Limited areas are available for tourism. Only subsistence fishing for Seychelles Island Foundation staff inhabiting the atoll allowed.
Temporal regime	The only temporal aspect relates to very difficult access during June to November due to rough seas brought on by south easterly winds. Virtually no tourist activities take place during these months.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	Since 1979: 1. – 4. Seychelles Island Foundation, La Ciotat Building, Mont Fleuri, PO Box 853, Victoria, Mahé, Seychelles. Tel: +248 321735; E-mail: Sif@seychelles.sc
Sources of funding	SIF manage both Aldabra and Vallée de Mai (Praslin). Tourism charges from the latter (also a World Heritage Site) contribute largely for the running of Aldabra although this is augmented by limited tourism on Aldabra itself. Aldabra Foundation.
Extent of community involvement	Not applicable as there are no permanent residents on Aldabra or nearby.
MPA monitoring & success	Fishing activities are monitored and details of all fishing trips are recorded, including weight and lengths of individual fish. Rangers accompany tourist vessels and report all their activities including misconduct. They also ensure that tourists do not enter restricted zones. A monitoring program on the coral and fish communities making up the reef system surrounding the atoll is in place. Turtles have been monitored since 1982. This is one of the longest running continuous turtle monitoring projects in the world and the success of turtle protection is now fully established.
References	www.sif.sc

Giant tortoise on Aldabra

School of Humpback snapper (*Lutjanus gibbus*) with two parrotfish in the foreground

View across part of the lagoon

Name of MPA	Cousin Island Special Reserve.
Location	Latitude 4°19'52.13"S, Longitude 55°39'46.11"E
Size	0.27 km^2 (27 ha).
Status	Active.
Date established	1968 = National Nature Reserve (terrestrial), 1975 = Special Nature Reserve (marine).
Date effective protection commenced	1975.
Purpose of protection	Species and habitat protection.
Focus species/habitats	Species = 5 endemic landbirds, 7 species of breeding seabirds, 2 species of marine turtle, 250 species of fish. Habitats = coral reefs, coastal forest, wetland, dune systems, seagrass.
Zonation & restrictions	Special Nature Reserve (No Take Zone)
Temporal regime	Seasonal: north west monsoon, October-March; south east monsoon, April-September.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1. – 4. Nature Seychelles, PO Box 1310, Roche Caiman, Victoria, Mahé Seychelles.
Sources of funding	100 % from tourist charges.
Extent of community involvement	Community involvement limited (10%) also not directly towards management and enforcement of MPA.
MPA monitoring & success	Hawksbill turtle monitoring; Seabird nesting and breeding monitoring; Recently initiated marine monitoring.
References	Francis, J., Nilsson, A., Waruinge, D. (2002) Marine Protected Areas in the Eastern African Region: How Successful Are They? *Ambio: A Journal of the Human Environment*: Vol. 31, No. 7, pp. 503–511 Shah, N.J., Souyave, J. and S. Parr (eds.). 1999. Cousin Island Special Reserve Management Plan. BirdLife Seychelles/RSPB/BirdLife International. Shah, N.J. (1998). Cousin Island Special Reserve: A case study of marine protected area management in partnership with an NGO. Partnership for Conservation Report of the Regional Workshop on Marine Protected Areas, Tourism and Communities. IUCN EARO. Shah, N.J. (2000). Cousin Island. A Sea and Island Reserve scientifically managed by an NGO. In: R.V. Salm and J.R. Clark. *Marine and Protected Areas. A Guide for Planners and Managers.* IUCN, Gland, Switzerland. Shah, N.J. (2000). Cousin Island Special Reserve. In: *Sustainable Development of Tourism: A Compilation of Good Practices*. World Tourism Organization, Switzerland. Shah, N.J. (2001). Benchmarking eco-tourism operations in MPAs. In: *Training for the Sustainable Management of Marine Protected Areas*. Centre for Marine Conservation (CMC) and Western Indian Ocean Marine Science Association (WIOMSA).

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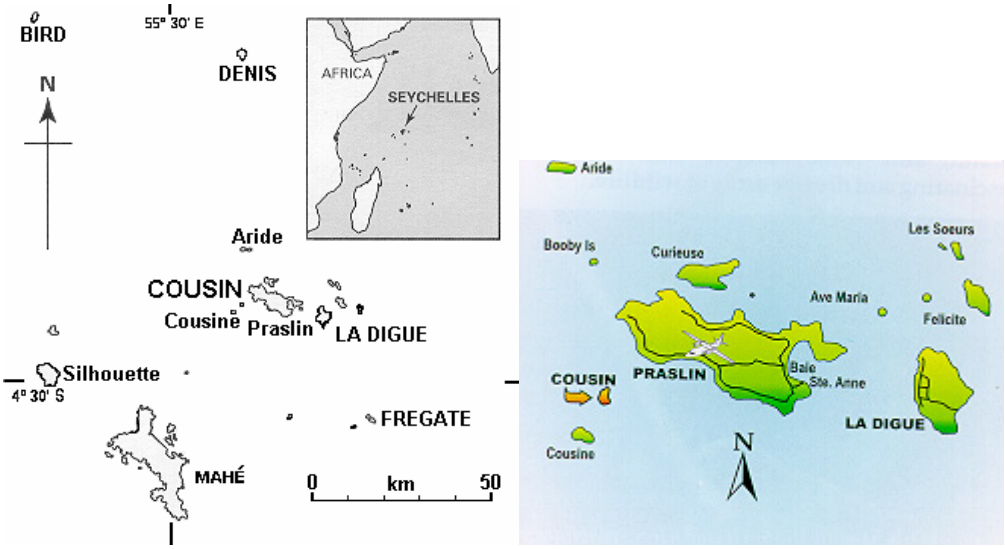


Location of Cousin Island Special Reserve

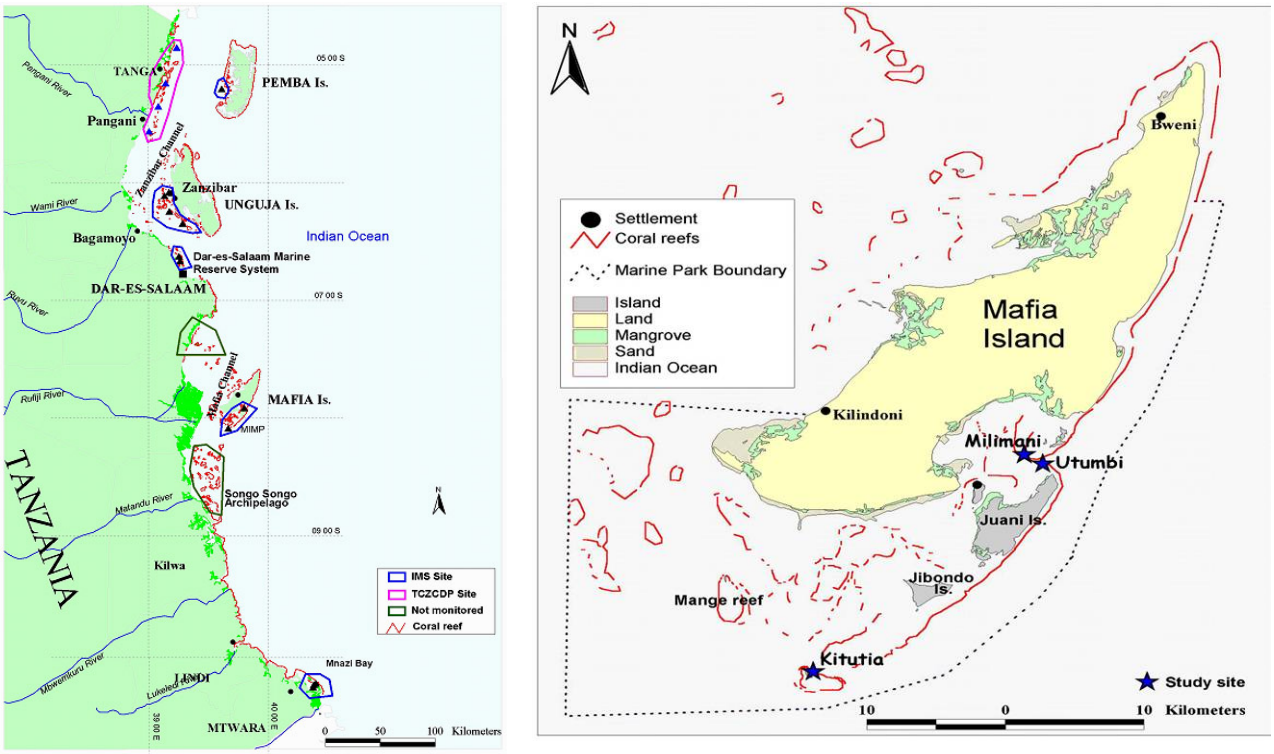
Cousin Island from the air

A school of jacks at Cousin Island

TANZANIA

Name of MPA	Mafia Island Marine Park (MIMP)
Location	07º45'07"S 39º54'01"E to 08º09'40"S 39º30'00"E. The park lies approximately 120 km south of Dar es Salaam, 20 km offshore from the eastern extent of the Rufiji Delta.
Size	822 km^2
Status	Active marine protected area.
Date established	Established 01 July 1995 under Marine Park & Reserve Act No.29 of 1994.
Date effective protection commenced	01 July 1995.
Purpose of protection	(1) To protect, conserve and restore the species and genetic diversity of living and non living marine resources and the ecosystem processes of the marine and coastal area; (2) To manage the marine and coastal area so as to promote sustainability of existing resource use; the recovery of areas and resources that have been over exploited or otherwise damaged and to rehabilitate damaged ecosystems; (3) To ensure that villages and other local resident users in the vicinity of or dependants on, a Marine Park or marine reserve are involved in all phases of the planning, development and management of that Marine Park or marine reserve, share in the benefits of the operation of the protected area and have priority in the resource use and economic opportunity afforded by the establishment of the Marine Park; (4) To stimulate the rational development of under utilized natural resources; (5) To promote community orientated education and dissemination of information concerning conservation and sustainable use of resources in the Maine Park; (6) To facilitate research and to monitor resource conditions and uses within the Marine Park; (7) To conserve and protect the historic monuments, ruins and other cultural resources that have been identified as of significance to the history of Mafia Island; (8) To facilitate the development of appropriate eco-tourism.
Focus species/habitats	*Coral reefs:* 380 species of fin fish, 48 genera of coral; *Seagrass beds:* 12 species; *Mangroves:* 8 species. *Intertidal flats:* conducive to highly productive fisheries (abundant with octopus, lobsters and sea cucumbers). *Marine algae:* 134 species. *Coastal lowland forest:* i.e. Mlola coastal forest contains relatively high biodiversity. *Endangered species:* Marine turtles (Green turtle, *Chelonia mydas*; Hawksbill turtle, *Eretmochelys imbricata*), Dugongs, *Dugong dugon*, and Whale Shark, *Rhincodon typus.* *Fruit bats:* Giant *Pteropus* to tiny banana bats e.g. *Pteropus seychellensis comorensis* (Seychelles flying fox) and *P. voeltzkowi.* *Birds:* migrating waders e.g. House Crow (*Corvus splendens*), Little Grebe (*Tachybaptis ruficolis*), Long-tailed Cormorant (*Phalacrocorax africanus*) and Pied Crow (*Corvus albus*), etc. *Wet land:* i.e. underground water habitat for different spp.
Zonation & restrictions	*Core Zone:* No resource extraction but diving & research permitted,

	Specified Use Zone: No pull net fishing, No fishing by non-residents (including no sport-fishing). *General Use Zone:* National regulations apply and for non-residents require permits.
Temporal regime	Permanent Government Institution, as per Government notice No. 200, published 06 September 1996.
Agencies involved in 1. Management: 2. Enforcement: 3. Research: 4. Education:	1. MIMP: Box 74-Mafia-Tanzania, email: mafiaisland@marineparktz.com. 2. MIMP: Box 74-Mafia-Tanzania, email: mafiaisland@marineparktz.com; Villages Enforcement Unit (VEU); Mafia District Authority. 3. MIMP: Box 74-Mafia-Tanzania, email: mafiaisland@marineparktz.com; UDSM: (University of Dar Es Salaam) Box 35050 Dar Es Salaam, Tanzania email: deanfast@udsm.co.tz; IMS: (Institute of Marine Science), Box 668 Zanzibar. email: admin@ims.udsm.ac.tz; WWF: jrubens@wwftz.org; Frontier-Tanzania: frontier@raha.com. 4. MIMP: Box 74-Mafia-Tanzania, email: mafiaisland@marineparktz.com; SEA SENSE: (Tanzania Turtle & Dugong Conservation Program) Box 105144 Dar Es Salaam, Tanzania, email: Seasense@cats-net.com; Frontier-Tanzania: frontier@raha.com; WWF: jrubens@wwftz.org; TCMP: (Tanzania Coastal Management Partnership), gluhikula@ epiq.or.tz.
Sources of funding	Government of Tanzania (62 %), WWF (20 %), NORAD (10 %), MACEMP (8%).
Extent of community involvement	Village Liaison Committee (VLC), Village Government (VG), Villages Enforcement Unit (VEU), The Advisory Committee(AC)
MPA monitoring & success	Patrols (Surveillance monitoring): i.e. activity for identify legal / illegal extraction of resources e.g. fishing areas /fishing methods. Data monitoring: for resources success sustainability Management Effectiveness (Project monitoring): evaluates success for projects running.
References	The Marine Park and Reserves Tanzania Act. 1994 (No. 29 of 1994). MIMP General Management Plan (GMP) 2000. MIMP Management reports. www.marineparktz.com



Left: The location of Mafia Island, within Tanzania. *Right:* Map of Mafia Island, indicating MIMP boundary and habitat types

Resource use in the MIMP. *Left:* Weighing octopus catches at Kitoni. *Right:* A fisherman's catch.

Left: The coral reef in the MIMP. *Right:* Pristine mangrove.

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DARWIN
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Marine
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