

## THE EFFECTIVENESS OF MANAGEMENT OF MARINE PROTECTED AREAS IN KENYA

Nyawira Muthiga<sup>1</sup>, Joseph Maina<sup>2</sup>, Tim McClanahan<sup>3</sup>

<sup>1</sup> Kenya Wildlife Service, P.O. Box 82144 Mombasa. Kenya

<sup>2</sup> Coral Reef Conservation project, P.O. Box 99470, Mombasa. Kenya

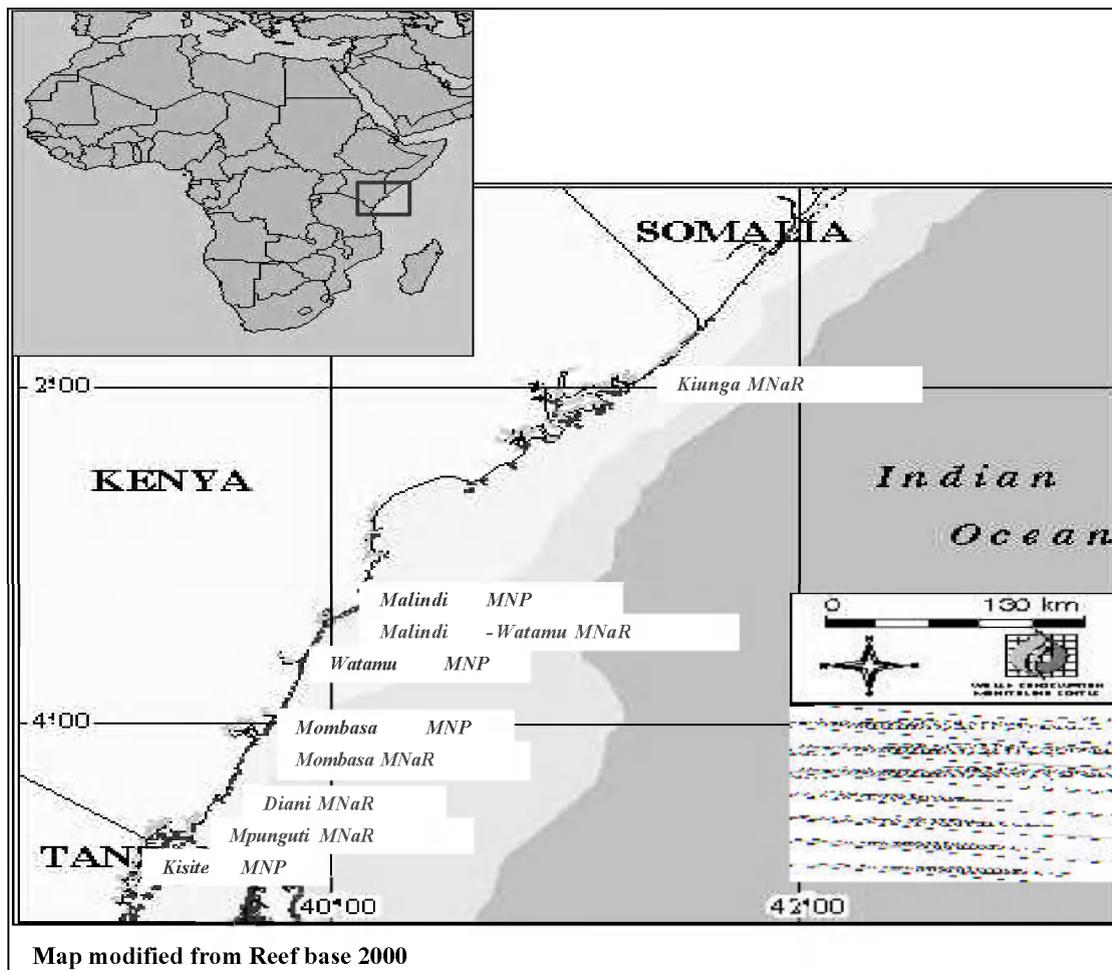
<sup>3</sup> Wildlife Conservation Society, P.O. Box 99470, Mombasa. Kenya

A report prepared for the international tropical marine environment management symposium, Manila, Philippines

### INTRODUCTION

The Kenyan coastline is approximately 500 km long, and stretches from 1° 42' S to 4° 40' S bordering Somalia in the North and Tanzania in the south (Fig. 1). It has a well-developed fringing reef system. The major oceanographic currents largely drive patterns of coastal currents. South of Malindi, the East African coastal current flows northeast throughout the year coming up from Tanzania and originally driven by the south equatorial current.

Figure 1. A Map of the Kenyan Coastline Showing the Marine Protected Areas



Map modified from Reef base 2000

North of Malindi this same East African coastal current continues to flow for most part of the year during the southeast monsoon (April-October). During the South East Monsoon (December to March), however, it is reversed, countered by the southward flowing Somali current. Around Malindi, the two currents meet and flow out to the sea.

Fringing reefs are well developed in Southern Kenya. However, to the North, where there are large areas of loose sediment and significant large water influences, levels of development are lower. Patterns of biodiversity appear to follow the patterns of reef development, with generally higher diversity in the south. Active coral growth is not continuous along the fringing reefs, but is interspersed with extensive seagrass and algal beds. Some 55 genera and 200 species have been recorded in Kenya (Spalding et al. 2001).

Coastal areas of Kenya are densely populated, and there are large-scale artisanal and commercial fisheries. Fishing using handlines, traps, spearguns, and gill and seine nets is common, with artisanal fishing concentrated in the lagoons and commercial fishing also operated from sail powered dhows. Other fisheries, including netting for aquarium fish and sport fishing in offshore waters, are increasing (Spalding et al. 2001).

Exploitation is heavy, and stocks in several localities are considered to be overexploited. A number of marine parks and reserves have been established, however, fishing is prohibited in the parks, and only traditional methods of handlines and traps are permitted in the reserves (Spalding et al. 2001)(Table 1). Protection of these areas has had clear impacts, with increases in fish abundance and diversity as well as live coral cover. Sea urchin densities are notably higher in non-protected reefs, and this may be impacting coral cover and topographic complexity.

**Table 1. A Table of Marine Protected Areas in Kenya**

Site name	Designation	Size-km <sup>2</sup>	Year established
Kiunga	MnaR, UNESCO Biosphere Reserve	600	1980
Malindi	MNP	6.3	1968
Malindi-Watamu	UNESCO Biosphere Reserve	177	1968
Watamu	MNP	32	1968
Mombasa	MNP	10	1986
Mombasa	MNaR	200	1986
Diani	MNaR	75	1993
Kisite	MNP	28	1978
Mpunguti	MNaR	11	1978

MNP: Marine National Park  
MNaR: Marine National Reserve

Over exploitation is a continuing problem on many Kenyan reefs, including illegal activities in the protected areas, although policing is increasingly effective in places. There has been local opposition to the establishment of the Diani marine Reserve due to a perceived loss of benefits, efforts are being made to address this. Increasing levels of sediment load from ex

situ changes in land use are a problem, particularly in Athi-Galana-Sabaki river, and are probably affecting reefs near Malindi.

## **MANAGEMENT ISSUES AND ACTIONS**

### ***Mission statement and goals for marine protected areas***

To protect and conserve the marine and coastal biodiversity and the related ecotones for posterity in order to enhance regeneration and ecological balance of coral reef, seagrass beds, sand beaches, to promote sustainable development, and to promote scientific research, education, recreation, and any other resource utilization.

The goals are:

- Preservation and conservation of marine biodiversity for poverty
- Provision of ecologically sustainable use of the marine resources for cultural and economic benefits
- Promotion of applied research for educational awareness programmes, for community participation, and for capacity building.

### ***Institutional arrangement for Management***

Marine protected areas comprise of ecosystems, habitats and species of fauna and flora, which are not confined to individual states. Thus, ecosystems and species that form the basis of the MPAs in Kenya are invariably shared with other countries in the region. International institutional arrangements are in form of conventions, treaties and agreements. International and regional agreements include Conventions on Biodiversity (CBD), on Climate Change (CCC), on Migratory Species (CMS) and on Trade in Endangered Species (CITES), Nairobi convention.

A wide range of institutions and agencies carries out management of natural resources in Kenya. A lot of them have divergent goals, objectives and interests which make the management quite difficult. The institutions include government sectors, Non Governmental Organizations (NGOs), developers and investors, community based organizations (CBOs), local communities and individual persons.

Kenya Wildlife Service is the mandated authority in charge of protected areas. It is a government department under the ministry of Agriculture. It includes a management and paramilitary arm responsible for terrestrial as well as marine protected areas. MPA's include marine national parks (no take zones) and marine national reserves (traditional fishing zones) usually adjacent or surrounding the National parks.

Legislation and policy instruments include the Wildlife Conservation and Management Act Cap 376, the Wildlife Policy and Protected area regulations. All MPAs have management plans produced by the KWS in collaboration with key stake holders including the local communities through a consultative and participatory process that takes into account the interests and concerns of interest groups.

At least 21 other policy instruments infringe on PAs (Fisheries Act, Forestry Act, Tourism trading and licensing Act etc). Marine species that have additional protected status include endangered species such as sea turtles and dugongs.

**Management strategies for the MPAs**

- Enforcement of MPA regulations
- Collection of revenue
- Mooring buoys
- Beach management program
- Research and monitoring
- Community initiatives
- Integrated coastal zone area management
- Awareness and education
- Management plan development and implementation

**Funding**

The main expenditure by the park service are vehicle running expenses , salaries and wages. The sources of funds include revenue from gate charges, filming, and donations. Government provides security i.e. guns and ammunition. Other sources include project funding by international organizations and governments e.g. the WCS funded annual monitoring program.

Park wardens are encouraged to solicit by writing proposals, and raise revenue by development of ecotourism facilities, and business ventures.

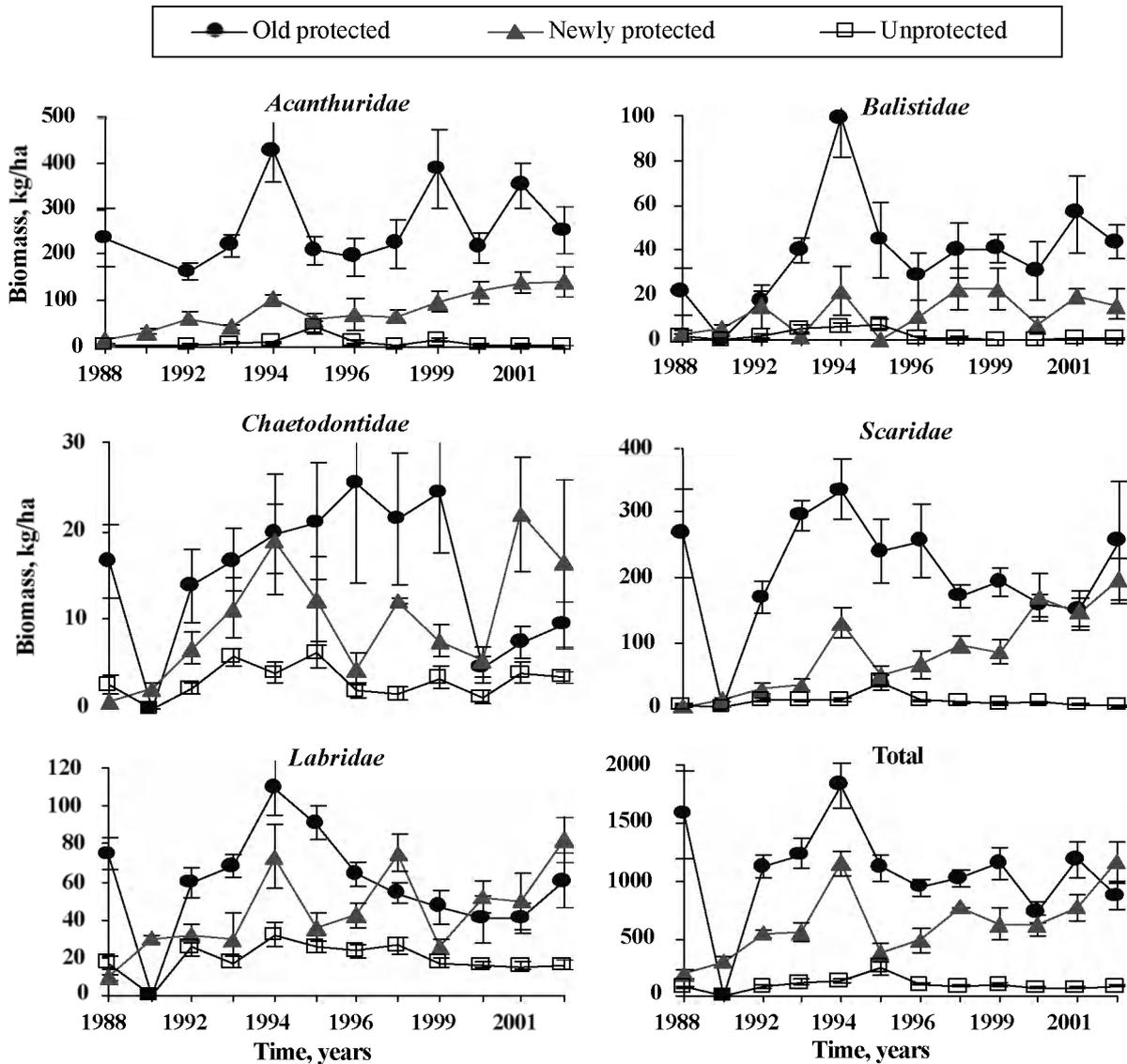
**RESEARCH AND MONITORING**

Governments seeking sustainable development in the coastal zones require both socioeconomic and ecological criteria in order to design policies. Monitoring and research is done in order to monitor changes of quantity and quality of natural resources, while pointing out the benefits they provide to the community, as well as the effectiveness of management. A long term monitoring program by the coral reef conservation project to determine the status and trends of habitats and species is in existence. The existence of four marine parks and numerous reefs experiencing intense human resource use has provided the opportunity for a number of studies that have helped increase the understanding of human impacts on Kenyan reefs (McClanahan and Obura, 1994). They have played a vital role in providing a crucial baseline data and undisturbed conditions for these longterm studies. The species that are studied include: Benthic cover i.e. hard/soft coral and algae, fishes, predation on sea urchins, sea urchins, herbivory, and gastropods. The creation of the Mombasa Marine park in 1991 resulted in full protection of the previously heavily exploited coral reef. McClanahan and Obura, 1994 in their status report predicted that Mombasa would become Kenya's premier marine park in terms of species diversity and water quality and as the largest income generator among MPA's. Water quality studies by Mwangi et al, 2001 reveals that the Mombasa marine parks waters are within EEC guide limit of <100 microbial indicators per 100ml of water, while water samples from the parks environs had microbial indicators exceeding this limit. The results of the monitoring studies indicate a very rapid response to the prohibition of consumptive activities with increases in fish and coral and reduction in many sea urchin species (Fig.2, Fig.3).

**Figure 2. A comparison of Substrate cover trends, and the number of coral taxa among the three management categories.**

**MISSING!!!**

**Figure 3. Comparison of Dominant Fish Family Biomass among the Three Management Categories**



Studies indicate that removal of finfish is having the largest impact on unprotected reefs, and has a number of tertiary effects on other faunal groups and ecological processes. A high abundance of sea urchins in unprotected reefs result from reductions in sea urchin predators, largely due to over fishing. Sea urchins are bio indicators of a retrogressive trend in the reef ecosystems, are associated with low coral cover. Their high abundance have characterized most unfished reefs.

Dominant sea urchin predators are finfishes triggerfish (Balistidae), Wrasse (Labridae), and emperor (Lethrinidae) families with snails, starfishes, and other invertebrates being of lesser importance (McClanahan and Muthiga, 1989; McClanahan, 1995b). The red lined triggerfish (*Balistapus undulatus*) has been shown to be the dominant predator in Kenyan Marine

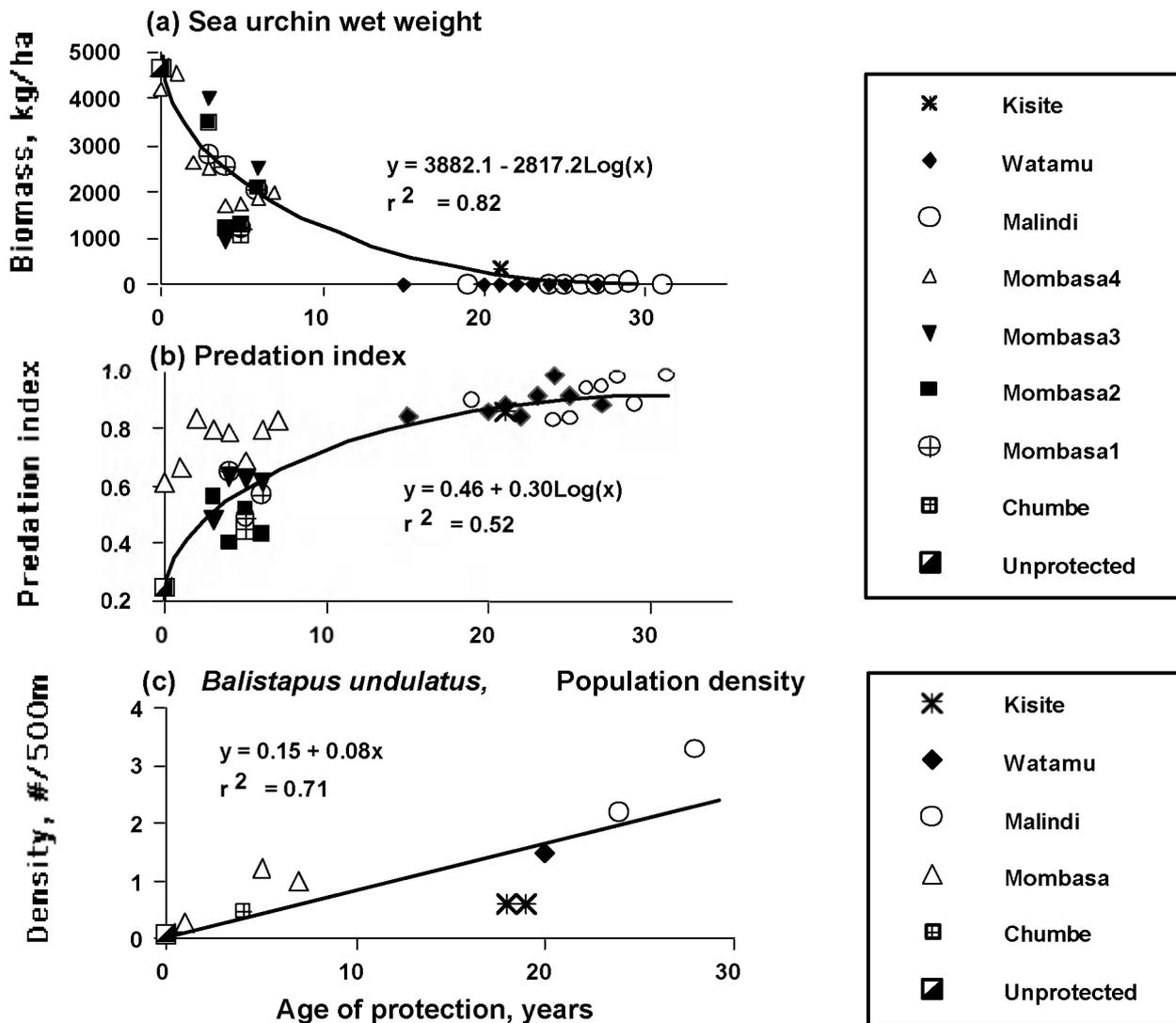
Protected areas (McClanahan, 1999). In the same study, it is shown that sea urchin wet weights decrease rapidly during the initial stages of park protection but are probably not reduced below 1000 kg/ha until after 10 years of protection (Fig. 3a).

Predation index is high in the protected reefs (Fig. 3b). A plot of the *Balistapus Undulatus* with age of protection is variable but rises in straight-line manner with no indication of leveling in population densities up to 30-year limit of the data (Fig. 3c).

Studies on the cover of the lagoon substratum indicate differences (Over time) as well as between protected and unprotected reefs. Protected reefs have a greater abundance of hard coral, calcareous algae, and coralline algae, while unprotected reefs have a greater abundance of algal turf (bare substrate), seagrass, and spft coral.

Unprotected reefs also had lower substrate diversity.

**Figure 3. The wet weight estimates of all sea urchin species, b) the predation index on tethered *Echinometra mathaei*, and Scatter plot relationship between the age of the 5 MPA's with population density estimates of balistapus undulatus during census period**



### Restoration studies

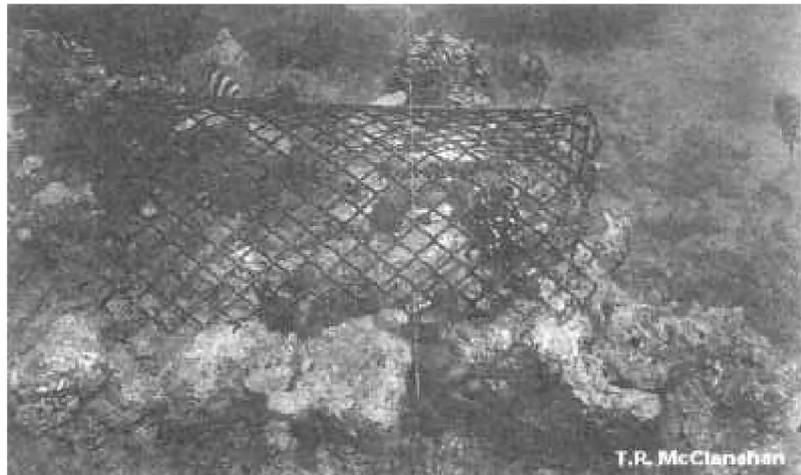
McClanahan et al, 2001 studied the ability of eurythermal coral taxa to colonize reefs that are likely to lose coral cover and species through warm water events associated with global change. Six reefs were studied in which half were in fished and half in unfished MPAs.

It was found that management of fishing was the strongest factor in determining survival, with the lowest survival occurring in unfished reefs, but management did not influence natural coral recruitment which was generally moderate (~40-60 per m<sup>2</sup>), but variable when comparing sites and fishing management. Tourist damage in these parks could not explain the observed patterns.

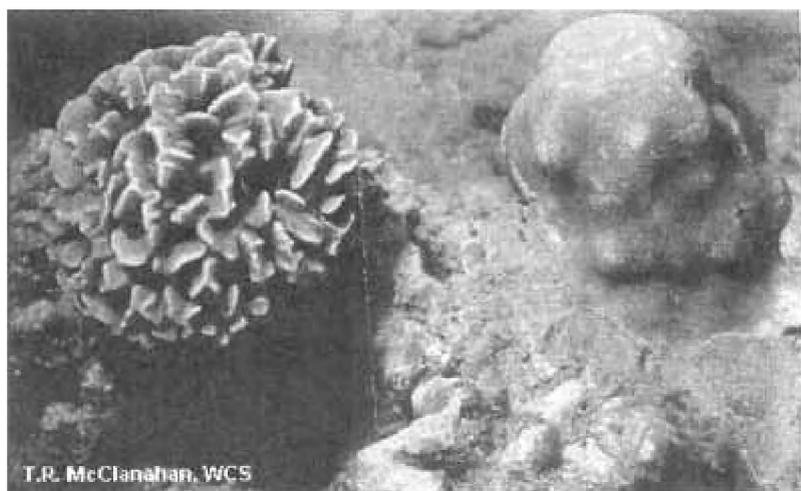
Predation seemed to inhibit the survival of the transplants especially in Malindi, where terminal male parrotfish observed preying on massive porites, and the red-lined triggerfish on *Pavona* and *Pocillopora* corals (Fig.4 b&c). Starfish crown of thorns caused the highest mortality of transplant corals in two reefs, one fished and one unfished.

**Figure 4. Photograph of a) the experimental cages b) uncaged coral transplants, and c) an example of a massive *porites* bitten by parrotfish**

**Control**



**Experiment**



## Fish predation



None the less, this study indicated a great deal of site specific differences in mortality and recovery and the diversity of coral species, their tolerance to warm water and predators, and the complex choices of made it difficult to predict recovery patterns of coral under current patterns of global change.

A similar study by Annick cross, university of Newcastle looked at the effects of beach seining on the coral transplants. She reported that corals transplanted into gear restricted fishing site had the highest survival, and that branching corals were more susceptible to breakages as a result of beach seining. (Annick cros, unpublished thesis, 2002).

N.A. Muthiga and T.R. McClanahan, 1997 looked at the effects of tourists on transplants, where a visual census of coral damage were carried out in 377 quadrats in the different damage categories, at the most frequented and less frequented areas. They report that All shallow sites regardless of the number of visitors had greater physical damage which suggests that natural factors such as waves and currents may be more important than trampling.

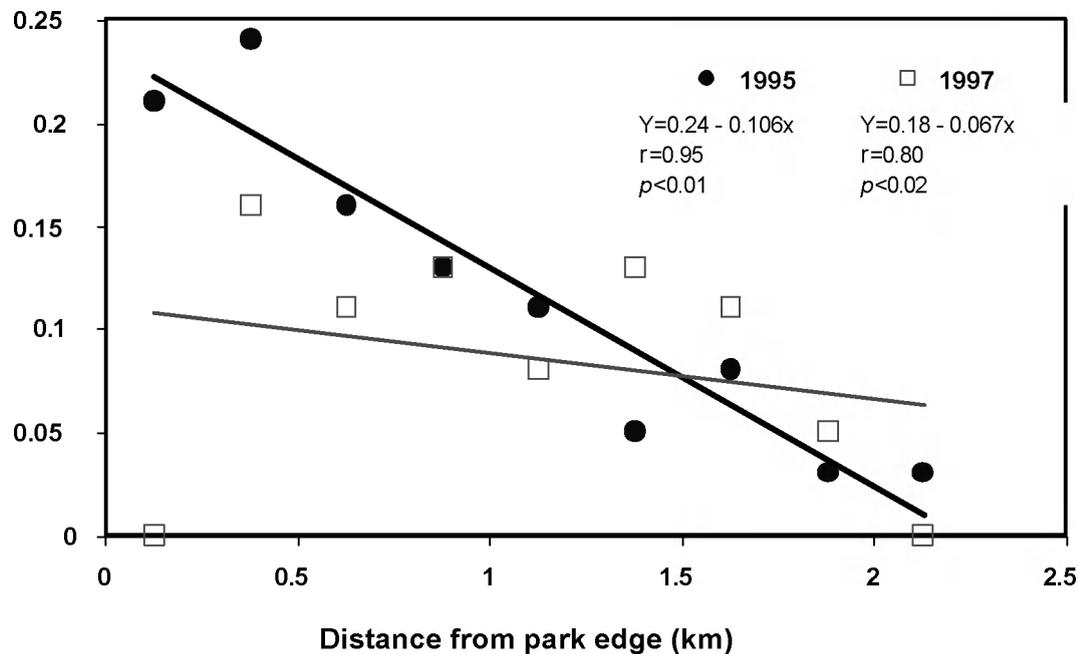
### ***Spillover and fisheries***

The role of marine protected areas in enhancing fisheries, through the emigration or spillover of exploitable fishes, have been studied in all Kenya's MPAs.

In Malindi and Watamu Marine National Parks, Kaunda-Arrara and Rose, using traps placed at different distances from the center of the park found evidence, but this was dependent on species and reef type i.e. patch vs fringing.

In Mombasa MNP, McClanahan and Mangi 2001 assessed catch in traps placed at different distances from park edge( Fig. 5). They found evidence of higher spillover from boundaries with better fisheries management, and In Kisite MNP, Watson 1996 in a tagging study found no evidence and poor movement in an isolated reef.

**Figure 5. Density of Traps as a Function of the Distance From the Park's Southern Boundary Two Sampling Periods**

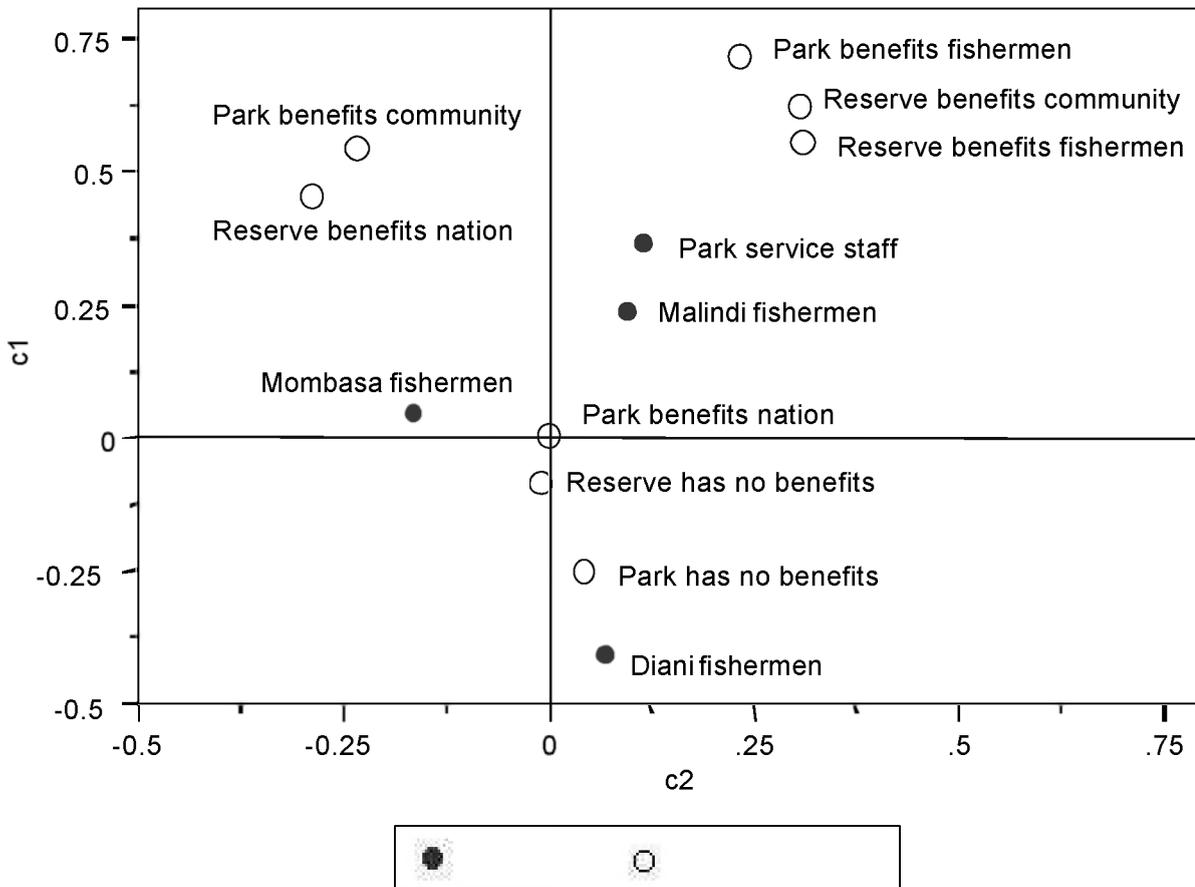


Fish landing data from the Mombasa marine reserve, an area adjacent to Mombasa Marine park, and from areas with no form of formal management were studied over seven year period. In Diani, an area that experiences intermittent seining, an initiative by the Fisheries department, NGO's, and the fisher elders to stop use of beach seining resulted in an increase in CPUE (McClanahan, unpublished data).

Finally, T. R. McClanahan, J. Davies and J. Maina studied the attitudes of people living and using resources adjacent to protected areas. This is a central issue for the success or failure of protected areas. Given the low level of management success of MPAs there is increasing need to determine the factors that influence the attitudes of stakeholders (McClanahan et.al., 2003 In preparation).

The overall perceived benefits was highest for the park service staff and decreased among fishermen from Malindi, Mombasa to Diani. The highest perceived benefit was for the parks to the nation, which was equally high for park service personnel as the Malindi, and Mombasa fishermen but Diani fishermen saw no benefit to any type of closed areas except for small benefit of the reserves to fishermen. The second highest perceived benefit was reserves to the nation and again this was equally high among the park service personnel, Malindi and Mombasa fishermen with no benefit perceived by the Diani fishermen. Fishermen saw the community and fishermen benefiting less from parks than park personnel and the responses among respondents towards reserves were more variable. Malindi fishermen had equally high perception of the benefits of reserves as park personnel but Mombasa and Diani fishermen did not see large benefits from reserves (Fig. 6).

Figure 6. A Two-Dimension Presentation of the Benefits and the Respondent Types



Individuals with a secondary education had a more positive perception of the value of gear-restricted areas to fishermen and their communities than less educated individuals but did not have significantly more positive perception of the value of fishery closure zones. Fishermen exploiting the oldest MPA held significantly more positive attitudes towards the designations than fishermen living adjacent to the newest MPA, although only a slight majority (54%) agreed that they and their communities benefited from the designation.

## CONCLUSIONS AND RECOMMENDATIONS

- Monitoring has shown that protection from resource use significantly changes the ecology of coral reefs
- Adaptive management experiments showed that ecological restoration needs to be done in conjunction with resource-use restrictions
- Small and patchy restoration is preferable to large-scale methods as restoration changes fish foraging and not recruitment patterns
- Small-scale experimentation is often required before large-scale management is implemented
- Gathering information and communicating it to key people is critical for catalyzing needed management actions
- Partnerships between management, users and investigators are critical for management success