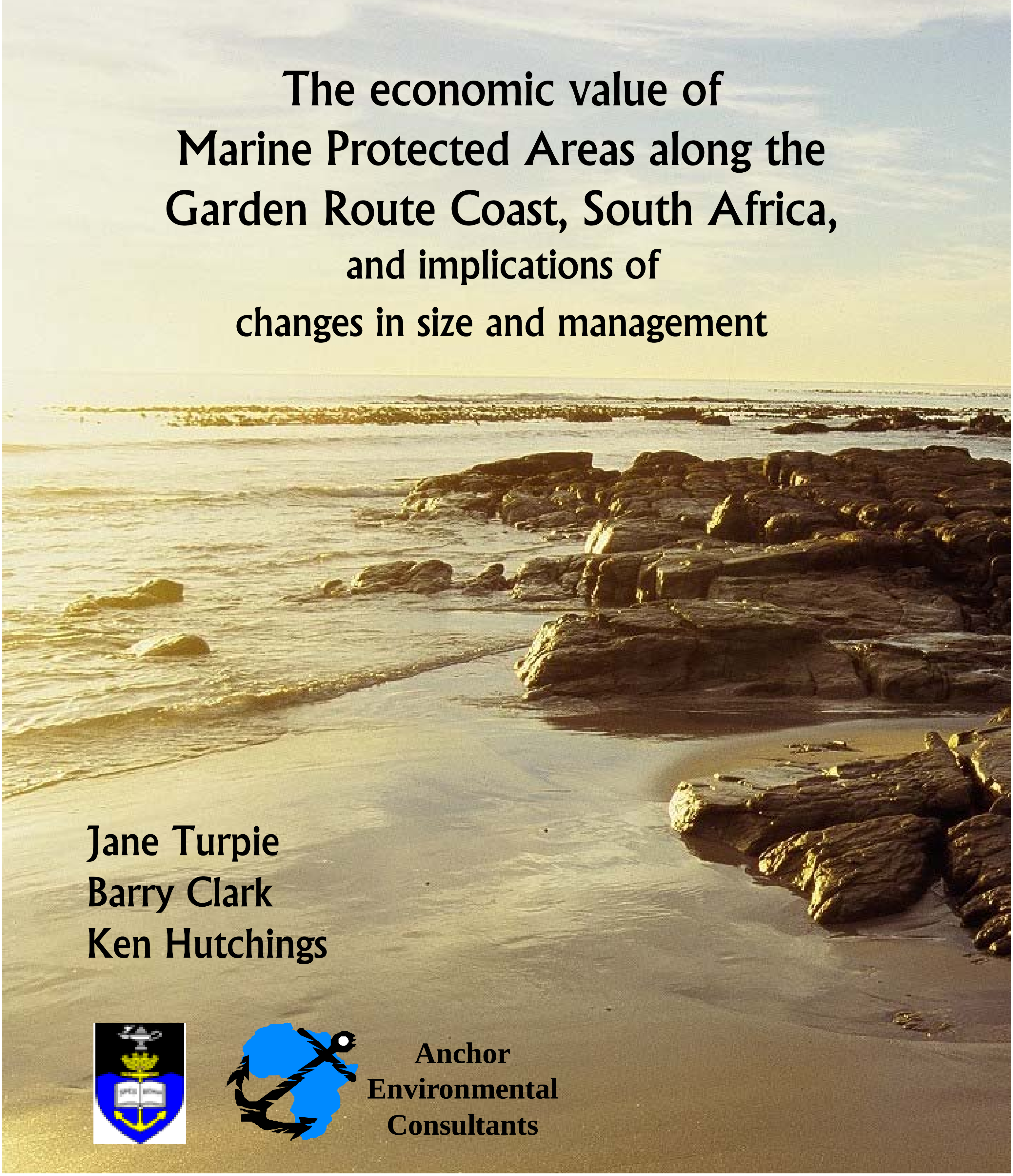

The economic value of Marine Protected Areas along the Garden Route Coast, South Africa, and implications of changes in size and management

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PREFACE AND ACKNOWLEDGEMENTS

This study was undertaken as part of a larger study on the conservation planning for marine biodiversity of the south Cape coast. It was conducted as a student project by the students of the 2006 Conservation Biology MSc programme at the University of Cape Town. The following students participated in the study:

Fahiema Daniels, Lisa Nupen, Helen Thomas, Matt Bird, Patrick Boundja, John Burnside, Helen Gordon, Helen Hill, Julia Jenkins, Lindy MacGregor, Mwema Musangu, Dimby Raharinjanahary, Pippa Schultz and Jeremy Shelton.

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EXECUTIVE SUMMARY

Introduction

Marine ecosystems of the Agulhas bioregion are threatened by exploitation, habitat alteration, disturbance and pollution. This problem is being addressed by the Cape Action for People and the Environment (CAPE) programme, through the implementation of sound marine conservation planning. This work has highlighted the shortcomings of the existing marine protected area (MPA) system in meeting biodiversity conservation targets and has identified a need for the strengthening of the MPA system in this region. Increasing conservation often meets with resistance and will require economic justification. The advantages of MPAs are increasingly understood, and include recreational benefits and their function as source areas for surrounding fisheries. However, the benefits of MPAs have seldom been quantified, even internationally, an neither have their opportunity costs. Understanding the costs and benefits of MPAs on the Garden Route coast is also particularly pertinent in the light of the controversial area of recreational angling, with public opinion ranging from banning this activity to allowing fishing in MPAs such as Tsitsikamma.

The aim of this project was to provide preliminary estimates of the costs and benefits associated with the MPAs on the Garden Route coast (Goukamma, Robberg and Tsitsikamma), and to estimate how these costs and benefits might change under different scenarios of MPA size and management intensity.

Study area and overall approach

The Garden Route coast is situated along the Western and Eastern Cape coasts and includes three MPAs. The Goukamma MPA in the west is 18km long and covers an area of 40km^2. Robberg MPA is 11km long, with an area of 20.4km^2. Tsitsikamma MPA is the world's oldest MPA, established in 1964. It is 80km long, covering 318km^2. All three MPAs are attached to terrestrial protected areas. Recreational shore angling is allowed throughout Goukamma and Robberg, but no angling has been allowed in Tsitsikamma since 2001 before which it was permitted in a restricted area. There are proposals to expand Goukamma westwards and outwards, to close half of Robberg to angling, and to open part of Tsitsikamma to recreational angling.

This project works within a Total Economic Value (TEV) framework. TEV comprises direct use value, indirect use value and non-use value. Direct use value may be consumptive (angling) or non-consumptive (e.g. diving). Indirect use value is where an ecosystem provides inputs into an economic activity elsewhere (fish exports in the case of MPAs). Non-use value comprises the option value of retaining an ecosystem for future use, and existence value which is the wellbeing derived from knowing that something exists, expressed in terms of public willingness to pay. In addition to these values we examine the management and opportunity costs associated with MPAs.

The study was based on empirical data collection through surveys, as well as models constructed using available data. A survey of visitors was carried out at the three MPAs, and a general public survey was conducted along the Garden Route. A total of 150 visitor groups and 381 members of the general public were interviewed. It should be noted that this is a preliminary study, and these sample sizes need to be boosted.

Recreational use value

Goukamma NR, Robberg NR and Tsitsikamma NP attracted a total of some 1140, 29 000 and 204 000 visitors during the 2005-6 financial year, respectively, attracting total revenues in the region of R10.65 million. Off site expenditure that was attributed to visiting these reserves was an additional R24.5 million which mostly accrues as revenues to the trade sector. Using a zonal Travel Cost Method, we estimated that the consumer surplus for Tsitsikamma NP alone was in the order of a further R10.1 million annually. This is the additional amount that visitors would have been willing to pay over and above what they actually had to pay. Only part of all this value is attributed to the MPA. Between 14 and 38% of the enjoyment of these nature reserves is derived from marine activities, and the MPA contributed about 28%, 11% and 19% of the decision to visit the nature reserves in the case

of Goukamma, Robberg and Tsitsikamma, respectively. Based on the latter, the total expenditure attributed to the MPAs is estimated to be R6.7 million, excluding consumers' surplus.
Apart from Robberg, were most visitors were neutral, the majority of visitors to Goukamma and Tsitsikamma were resistant to a proposed change in the angling regulations (banning in the case of Goukamma and allowing angling in the case of Tsitsikama). Goukamma visitors tended to be in favour of while Tsitsikamma vistors were opposed to angling in MPAs generally, which is to be expected, since visitors go to places that suit them best. The general public opinion was slightly skewed against angling in MPAs (53%), but 40% were in favour. More than half of anglers in favour of fishing in MPAs were in favour of a catch-and-release only policy, and a significant proportion of respondents that were against angling felt that a catch-and-release only policy would be acceptable.

Changing the regulations at the three MPAs would significantly reduce the recreational value among the current visitor pool, with a loss of up to R4.7 million in Tsitsikamma. However, results from the general public survey suggest that these losses would be almost exactly counterbalanced by new visitors attracted to the areas. It should also be borne in mind, however, that whereas there are alternative sites for anglers, there are no alternative sites for those who wish to visit areas devoid of angling or consumptive use activities. Thus relaxing protection in MPAs may ultimately lead to a loss of recreational value.

Value of fish exports

Using published linefishery catch effort from roving creel and access point surveys, and density data from research mark-recapture and diving surveys along South Africa's Garden Route coast (Cape St Francis to Cape St Blaize), the catch attributable to the presence of Tsitsikamma National Park's, Robberg Nature Reserve's and Goukamma Nature Reserve's Marine Protected Areas (MPA) was valued. This was based on the estimated value per fish to the recreational shore (R140), recreational boat (R76) and commercial linefishery (R11). These values were multiplied by the estimated export of adult fish from MPAs and the proportion of recruits estimated to come from spawner biomass protected within the three MPAs. The resultant economic value of linefish exports from MPAs along the Garden Route coast was valued at R33 million per year.

Existence value

The existence value of the MPAs was determined using the Contingent Valuation Method which elicits peoples' willingness to pay to retain or improve an environmental amenity or to prevent its loss. Respondents were predominantly from the Western and Eastern Cape, with 38% from the Garden Route area. Quantitative estimates restricted to these respondents, since the sample sizes from other areas was too small. The survey did not capture a representative group in terms of income or race, and thus responses were calculated and extrapolated by income group. In choosing between four protection scenarios, 54% of respondents preferred maximal protection which involve banning all fishing in MPAs and increasing their extent. The remainder were equally divided between the status quo and relaxing the fishing ban in Tsitsikamma. Respondents were almost unanimous in voting the zero protection scenario as the worst option. The overall willingness to pay (as a once-off payment) to prevent the loss of MPAs, which equates to the existence value of the current system, was R238 million. Note that this is a preliminary estimate based on a small sample size. Taking all users' opinions into account, there would be an overall gain in value of R34 m by increasing protection, and a loss of welfare of R31 m if protection was to be relaxed through opening more areas to angling.

Management costs

Management costs of Goukamma, Robberg and Tsitsikamma MPAs are in the order of R300 000, R200 000 and R3.3 million, respectively. Management costs per unit area were similar (R7500 – 10 300 per km^2) and did not reveal economies of scale. However, actual management costs are not the same as ideal management costs, and these costs are low compared the global average.

Opportunity costs

The opportunity cost of an existing MPA is the value that would be gained from fishing if it were to be deproclaimed. A simple spreadsheet model was set up to estimate this value. The model was based on the Tsitsikamma MPA for which the most detailed information was available. The model simulated responses in the abundance of red roman *Chrysoblepharus laticeps*, a major target of the commercial line and recreation boat angling fisheries, and of galjoen *Dichistius capensis*, an important shore angling species, in order estimate the value of these fisheries if a stretch of MPA was opened to fishing, and the change in value of these fisheries over time. Firstly we examined the time period over which benefits from the fishery accrued, following the opening of a 1 km stretch of coastline within the MPA. CPUE for the commercial and two recreational fisheries were simulated differently in the model, with commercial CPUE being dependent on abundance of fish (i.e. declined with declining abundance on the fishing grounds) while recreational CPUE being independent of abundance but limited to two fish per person per day (the current legal bag limit). It was necessary to run the model in time steps of days (rather than yearly time steps used for the previous model) due to the rapid rate at which fish stocks in the MPA were depleted. Two simulations were run for each species, in the first fishing effort was limited to only 10 commercial linefishers and 10 recreational boat anglers per day (the roman fishery) and 10 shore anglers per day (the galjoen fishery), while in the second fishing effort was increased to 20 commercial linefishers and 20 recreational boat anglers per day (the roman fishery) and 20 shore anglers per day (the galjoen fishery). In the case of the roman fishery the population in the MPA crashed within 33 days with an applied effort level of 10 commercial line fishers and 10 recreation boat anglers fishing per day, and in only 9 days under an applied effort level of 20 commercial line fishers and 20 recreational boat anglers fishing per day. Such an applied level of effort can only be considered very light relative to what might be expected if a portion of an MPA such as Tsitsikamma which has been closed for more than 40 years is suddenly opened to fishing! As such, time taken to reduce the population to a similar level to that in adjacent exploited areas in these simulations can only be considered conservative! It is likely that other species in the MPA targeted by commercial linefishers and recreational boat anglers will follow the same path as the roman, with the less desirable or sought after species taking only marginally longer than this before their abundance levels decline to levels corresponding to those outside the MPA. The maximum economic benefit accrued from the roman caught in the MPA up until abundance declines to the level corresponding to those outside the MPA is estimated to be in the order of R4 million per km.

A second model was developed to estimate the opportunity cost of the establishment of a new MPA area is the loss of fishing value from that stretch of coast. The current value of fishing along the coast was estimated as roughly R 28 000/km/year, but value was assumed to be decaying at a rate of 1.4% per annum. It was assumed that fishing effort from the area where the MPA is proclaimed shifts into the surrounding areas, with the result that overall CPUE in those areas first declines. This rate of decline was increased by 25% after proclamation of the MPA to account for the projected increase in fishing effort and decline in CPUE in areas adjacent to the MPA. Model estimations of impacts of MPA proclamation on catches to a simulated linefishery were run under varying stock recovery scenarios in the MPA (20-60% after 10 years), and various estimates of stock export rate from the MPA (0.5-2%). After some point, the exports from the MPA raise the CPUE in those areas, and catches eventually exceed initial levels after 8-18 years. The overall gains in catches exceed the losses after some 9-32 years.

Synthesis and conclusion

This study has found that MPAs along the Garden Route coast provide substantial value over and above the value that these coastal areas would otherwise generate. Just in terms of the tangible values, the additional recreational value attributed to managing these areas as MPAs is in the order of R9 million per annum, when taking consumer surplus into account, and is far greater than the management costs of these systems. The total economic value of the MPAs includes the export of fish which add value to recreational and commercial fisheries in surrounding areas, a value that we estimated to be in the order of R33 million per annum. The non-use value of the MPAs, when estimated as an annual value, is also substantially greater than the recreational use value alone. Acknowledging that one has to also consider the opportunity costs of conservation, we estimated that these could be as much as R421 million for the current MPA system. This is a substantial cost, which therefore requires that the overall costs and benefits are compared in order to determine if increasing protection incurs an overall gain or loss in welfare.

Using the findings reported in the preceding chapter, we estimated the present value of each of these types of value over a 20 year period, using a discount rate of 6%. We also estimated the change in these values for each of the following scenarios:

1. The current status quo
2. Zero protection
3. Reduced protection: Opening 5km of Tsitsikamma coastline to angling
4. Maximum protection: Closing MPAs to fishing and extending the Goukamma MPA seawards (by 2.8 km) and westwards (by 10 km)

The first important conclusion is that the costs of MPAs are outweighed by the benefits. This is in spite of the fact that the costs were not conservatively estimated, while the benefits were. The second important conclusion is that there is an increase in overall net present value with an increase in the level of protection (Figure 1).

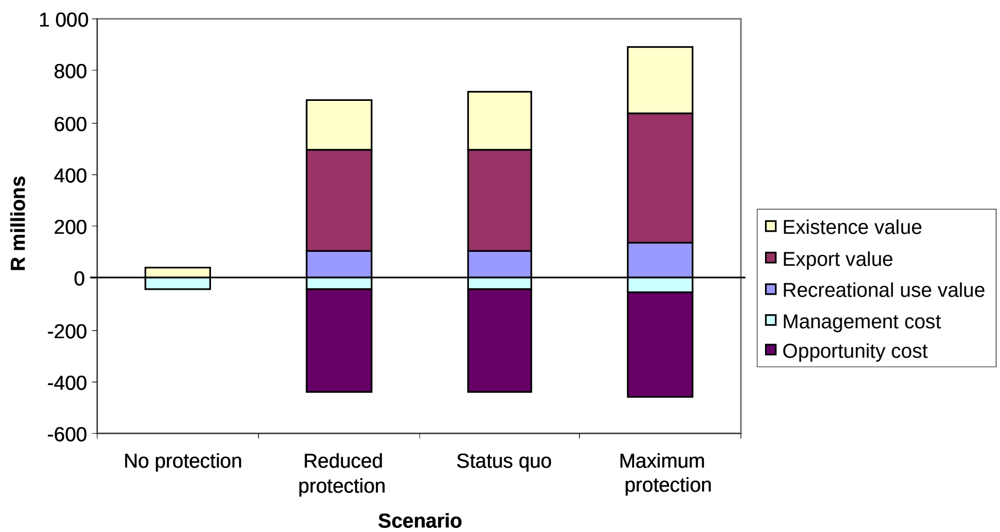

Figure 1. Present value of costs and benefits of MPAs under different protection scenarios. Values are calculated over 20 years at a discount rate of 6%.

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1 INTRODUCTION

Uncontrolled exploitation and development, human disturbance, and pollution threaten the integrity of marine ecosystems in the Agulhas Bioregion through changes in community structure (loss or reduction in biomass of top predators and keystone species, incidental mortality of non-target species), alteration of benthic environments, and changes in the gene pool (through selection against traits such as large size and fast growth). The Cape Action for People the Environment (CAPE) is a GEF funded initiative designed to address some of these problems, through the implementation of sound marine as well as terrestrial conservation planning. Objectives of the marine component include:

- Establishing and maintaining a network of marine protected areas in the CFR that provides for biodiversity conservation, environmental education and research, and that contributes to sustaining fishing activities
- Building awareness, training and educating stakeholders on the importance of biodiversity conservation, sustainable resource use and sustainable development

Fine scale planning exercises have recently been completed for the Agulhas Marine Bioregion (Clark & Lombard 2007) and have highlighted the fact that there are a number of important shortfalls in respect of the ability of the existing Marine Protected Area (MPA) network to provide for conservation of habitat and maintenance of species populations in this region. Clark & Lombard (2007) also identified a number of priority areas for potential expansion of existing MPAs and establishment of future MPAs which would assist in meeting generally accepted habitat and population conservation targets.

While it would be desirable from a conservation perspective to implement recommendations prepared by Clark & Lombard (2007) there are a number of unresolved questions regarding the costs and benefits of expanding the existing MPA network in the Agulhas Bioregion and indeed the country as a whole. The conservation and fishery benefits of MPAs are becoming increasingly well-known. In addition to conserving biodiversity and ecosystem functions, MPAs have been advocated as an important tool in fishery management (Clark 1996, Roberts 1997, Gell & Roberts 2003). Evidence suggests that MPAs allow fish stocks to recover (Attwood & Bennett 1993) and improve the fishing yields in adjacent areas by the export of fish larvae, pre-recruits and adults (Turpie 1996, Mosqueira *et al.* 2000, Gotz 2005, King 2005, Roberts *et al.* 2000). However, for conservation planning to be successful it also has to make economic sense. The economic costs and benefits of marine protected areas, though understood (Dixon 1993), have seldom been quantified anywhere in the world. The costs such as displacement of fishing effort from these protected areas and possible changes in visitor numbers and expenditure have need to be compared with the economic benefits such as recreational benefits and the replenishment of fish stocks in adjacent areas. Without quantifying these costs and benefits, the costs of MPAs are generally perceived to be higher than the benefits, with the result that there is a strong disincentive for the establishment of new MPAs in this country and elsewhere.

This project aims to provide preliminary estimates of the costs and benefits associated with the MPAs of the Garden Route coast. This area includes South Africa's oldest MPA, the Tsitsikamma National Park, as well as Goukamma and Robberg MPAs. These MPAs vary considerably in size and offer varying levels of protection to marine resources within their boundaries, and thus also provide an opportunity to examine the influence of these characteristics on the economic value derived from MPAs.

Understanding costs and benefits of MPAs is not just an all-or-nothing matter regarding whether MPAs carry a net cost or benefit. The questions surrounding the design of an MPA system include how much of the coast should be protected, and what the intensity of that protection should be. In particular, one of the most controversial issues in the South African MPA system is whether angling should be allowed in some MPAs. Along the garden route, there is currently pressure to open parts of the Tsitsikamma MPA to fishing, and there are also proposals to increase the size of the Goukamma MPA. Thus an attempt was also made in this study to assess the implications of a change in the size or degree of protection offered by these MPAs on total economic value generated.

2 STUDY AREA AND OVERALL APPROACH

2.1 Study area

The Marine Protected Areas in this study are located along the Garden Route coast of South Africa and all three border a terrestrial nature reserve or National Park. Goukamma and Robberg Nature Reserves are in the Western Cape Province, and Tsitsikamma National Park is in the Eastern Cape (Figure 6.1).

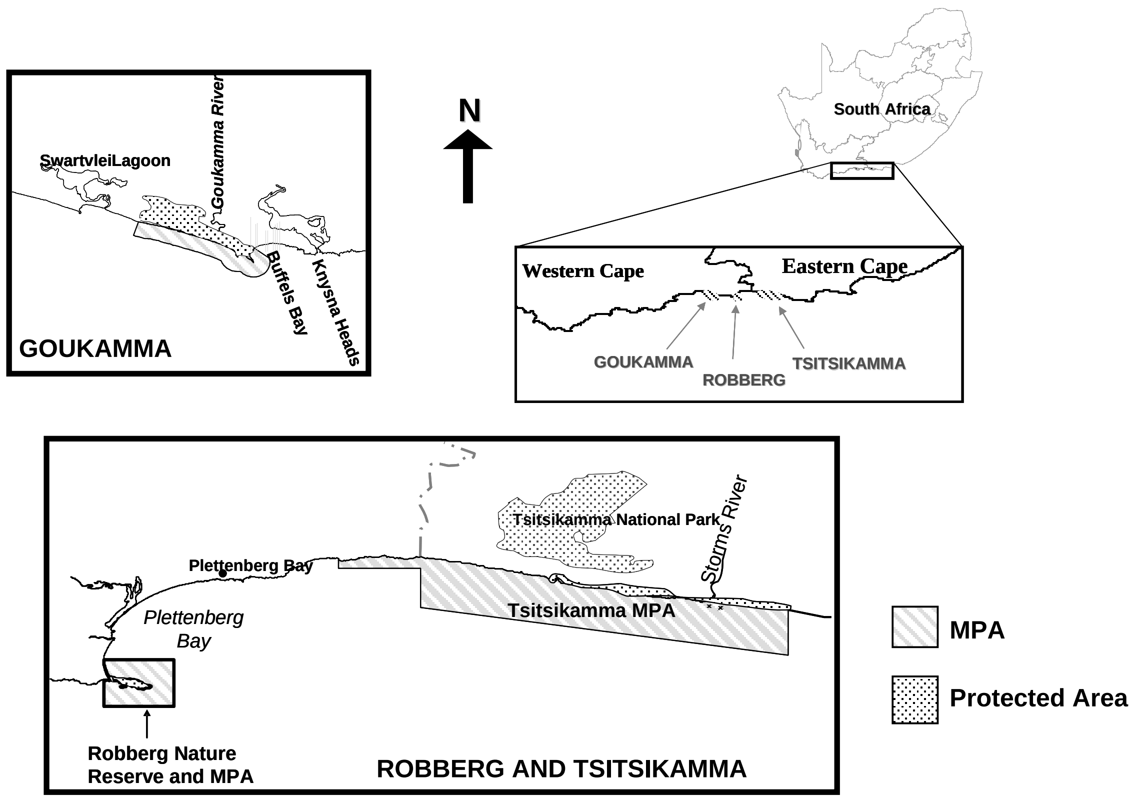

Figure 6.1. The locations of Goukamma and Robberg NRs, Tsitsikamma NP and the MPAs associated with each

2.1.1 Goukamma MPA

The Goukamma MPA abuts the Goukamma Nature Reserve, which has been protected since 1974. The Goukamma MPA is a medium sized MPA that has been protected from boat-based linefishing since 1990 (Götz 2005). It covers the stretch of coast between Gerrickes Point (34°02`S, 22°45`E) and Buffels Bay (34°04`S, 23°00`E). The length of the Goukamma MPA shoreline is about 18 km, and it extends 1.8km out to sea, making a total area of approximately 40 km^2. It includes rocky sections of coast as well as sandy beaches and an estuary formed by the Goukamma River. Significant reefs (of aeolianite or sandstone origin) are found at the eastern end of the MPA, as well as along the MPA border. Recreational shore angling is allowed in the MPA. Whereas visitors to the nature reserve pay an entrance fee, free access to the MPA along the beach is possible from either end.

There is a proposal to increase the extent of the Goukamma MPA. The proposed extent of this modification is shown in Figure 6.2.

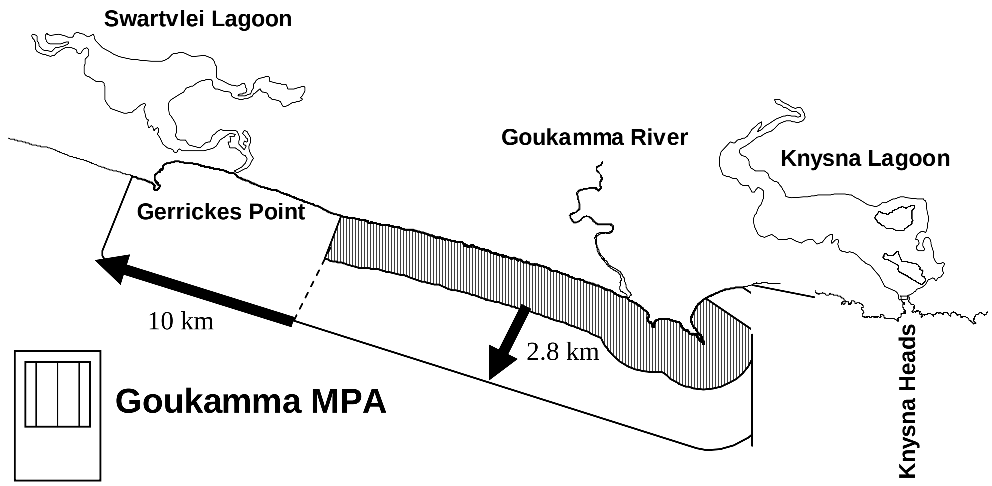

Figure 6.2. The position and dimensions of the Goukamma MPA at present. The arrows show the distance and direction of the proposed extension (Adapted from Götz 2005).

2.1.2 Robberg MPA

MPA at Robberg covers 11km of coastline and extends 1.8 km out to sea, having a total protected area of 20.4km^2 (King 2005). It is positioned at the southern end of Plettenberg Bay on the Robberg Peninsula, between the 34°04'.916S and 34°07'.633S and the longitudes 023°22'.300E and 023°25'.967E. The coastline is rocky, except for a bridge of sand that links the mainland to a rocky outcrop known locally as 'the island'. The Robberg MPA abuts Robberg Nature Reserve and is accessed through a controlled gate. Shore fishing allowed, but not bait collecting (King 2005).

There has been a proposal to halve the area available to anglers in this MPA.

2.1.3 Tsitsikamma MPA

The Tsitsikamma MPA is South Africa's oldest and largest MPA and forms part of the Tsitsikamma National Park. The MPA encompasses approximately 70 km of coastline and extends 5.6km offshore, covering a total area of 318km^2. It extends from Natures Valley (34°59'S, 23°34'E) in the west to Oubos-strand (34°04'S, 24°12'E) in the east (Cowley 2005). The shoreline consists mostly of steep rocky cliffs, with occasional sandy beaches occurring at sheltered positions on the coast. There are a series of parallel reefs (of sandstone and aeolianite origin) separated by sand-filled valleys (Buxton and Smale 1984). The MPA has been closed to fishing since 1964, except for a 3km stretch in the vicinity of Natures Valley where shore angling is permitted (Sauer *et al.* 1997).

There was a period when recreational shore angling was allowed in part of the MPA, but this was stopped in 2001. This decision created conflict with the local angling community who are lobbying to reinstate recreational angling, and there is a proposal to open a 5km section for angling.

2.2 Valuation framework

The economic value of the MPAs was studied within the framework of Total Economic Value, which includes direct use, indirect use and non-use values, as follows.

Direct use values are generated through the consumptive or non-consumptive use of natural resources. In an MPA, direct use values are generated through consumptive (fishing) and non-consumptive (e.g. diving, whale-watching) recreational activities.

Indirect use values are values generated by outputs from ecosystems that form inputs into production by other sectors of the economy, or that contribute to net economic outputs elsewhere in the economy by saving on costs. In the case of MPAs, these outputs are primarily the export of fish to areas where they are exploited for recreational and commercial use.

Non-use values include the value of having the option to use the ecosystem and its components in future (option value), as well as the value of simply knowing that the resources within the ecosystem are protected (existence value). Although far less tangible than the use values, non-use values are reflected in society's willingness to pay to conserve these resources, and with appropriate market mechanisms, can be captured through transfers and converted to income.

Direct and indirect use values are manifested directly or indirectly in tangible income and employment. Existence values inherently are not manifested in income and employment, and they are often highest in wealthier areas.

In addition to the benefits described above, we also consider the management and opportunity costs associated with maintaining MPAs.

2.3 General approach

This study was based on primary data collected in surveys, information gathered from the protected areas and the literature, and models.

Two surveys were carried out: a survey of visitors to each of the protected areas (the visitor survey), and a survey of the general public outside of the protected areas (the general survey). The visitor survey differed slightly among the parks, because of the different types of activities allowed (no angling within Tsitsikamma National Park). The surveys were carried out by 14 enumerators on 26 June to 2 July 2006, on both week and weekend days. A total of 76 visitor groups were interviewed at Tsitsikamma and 37 visitor groups were interviewed at each of Goukamma and Robberg Nature Reserves. A total of 150 groups representing 568 visitors were sampled within the three sites (Table 6.1).

Table 6.1. Sample size by no of groups and no of people within groups

Site Name	No. of groups	No. of visitors represented
Tsitsikamma NP	76	288
Goukamma NR	37	147
Robberg NR	37	133
TOTAL	**150**	**568**

A total of 381 respondents were interviewed in the general survey, at Storm's River Bridge, Plettenberg Bay, George, Knysna and Victoria Bay. In addition, diving operators were interviewed in order to estimate the total revenue derived from diving activities in MPAs.

Details of how the surveys were used to estimate recreational use value and existence value of the parks are provided in the following sections. In addition to survey data, some of the other values of the parks were estimated using a desktop approach, based on available data.

3 TOURISM AND RECREATIONAL USE VALUE

3.1 Introduction

Marine protected areas offer recreational opportunities as one of their primary benefits. In the case of protected areas generally, recreational use value is measurable in terms of the overall expenditure generated by the MPA, and its impacts on the economy. Because the three MPAs in this study are all linked to terrestrial protected areas, it is necessary to isolate the expenditure attributed to the MPA from the expenditure associated with visiting the combined attraction. Visitors themselves probably do not consciously make the distinction.

Along the Garden Route coast, recreational activities in MPAs include both non-consumptive activities such as coastal walking, whale watching and scuba diving, and consumptive use activities, namely angling. Two of the three MPAs under study (Robberg and Goukamma), allow angling, and there is pressure from some groups to open Tsitsikamma to angling. This is a controversial issue since many believe there is no place for angling in MPAs.

The aim of this study was to estimate the recreational use value of each of the three MPAs and to estimate how these values might change under different angling regulations.

3.2 Methods

3.2.1 Overall approach

Data pertaining to the recreational use value and the potential impact of changes in fishing regulations were obtained by means of two surveys: a visitor survey carried out at each of the three MPAs, and a survey of the general public carried out along the Garden Route. A total of 37, 37 and 76 visitor groups were surveyed at Goukamma, Robberg and Tsitsikamma, respectively, representing a total of 147, 133 and 288 visitors, respectively. A total of 381 respondents were interviewed in the general public survey. The characteristics of the latter group are described in more detail in Chapter 5.

3.2.2 Recreational use value

The recreational value of protected areas can be considered as the amount that visitors are willing to pay to use them. This can be broken down into what visitors spend within the protected areas (on-site costs), what they spend on travelling to them (off-site costs) and the amount that they would have been willing to pay over and above their on- and off-site costs in order to use the area (consumers' surplus, Figure 6.3).

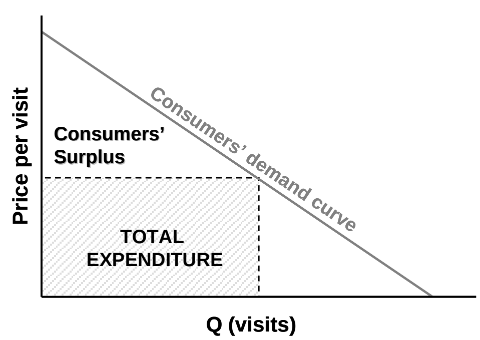

Figure 6.3. Hypothetical consumers' demand curve showing the total recreational value of a site.

On-site expenditure is the turnover generated in the park, as entrance fees and by businesses within the park. Off-site expenditure includes the money spent on transport, accommodation, food and other sundries incurred by a specific visit to that site. Consumer's surplus is particularly relevant in the case of protected areas that do not charge entrance fees, or where the entrance fees are low.

3.2.3 Estimation of on-site and off-site costs

Total on-site entrance and accommodation costs were taken as the annual revenue for each of the protected areas. The most recent visitor records available for the three MPAs were obtained. This included 2003 visitor data for Goukamma Nature Reserve and 2005 visitor data for Tsitsikamma National Park and Robberg Nature Reserve. Note that visitor data for Goukamma Nature Reserve are only for visitors using the entrance gate (mainly the overnight visitors) whereas it is possible to access the MPA area without using the entrance gate.

Other on-site costs and all off site costs were estimated by means of a questionnaire survey. Visitors to the protected areas were asked to provide details on their group's spending within the park and their total budget for their trip away. In order to estimate the off-site costs attributable to the park, respondents were asked the degree to which visiting the park was the reason for their trip as a percentage, and this was used to adjust the total off-site costs (Turpie & Joubert, 2001). The total off-site costs were calculated based on the ratio of on- to adjusted off-site costs of the respondents, applied to the total on-site costs.

3.2.4 Estimation of consumers' surplus

The amount that visitors were willing to pay for enjoying a site, over and above its actual price was estimated using a zonal Travel Cost Method (Hof & King 1992). This method determines visitor spending according to distance travelled and derives a demand curve to predict the consumer surplus attributable to the park.

Visitors were asked about the origin of their journey (country, province, town) and the number of people in their group. Origin zones were defined on the basis of average travel cost to the sites. The visitation rate per inhabitant per zone was regressed against the average travel cost per person per zone resulting in a semi-log curve of the form:

$$Ln(Q) = a + b(TC)$$

where Q is the zonal visitation rate per person and TC is the average zonal travel cost per person. The regression curve was used to produce a consumers' travel-cost demand curve to predict the change in visitation rate as a function of increased travel costs and thus derive the consumer surplus using the equation:

$$CS = \frac{-e^{a+b(TC)}}{b}.$$

3.2.5 Total recreational value attributable to MPAs

The percentage enjoyment that visitors derived from marine-related characteristics of the site was estimated. The questionnaire asked interviewees to identify the characteristics or attributes of the site that motivated them to visit that site rather and to apportion their total enjoyment amongst these marine and non-marine attributes. The average proportion of enjoyment derived from marine attributes was calculated for each site.

Visitors were asked if they were aware that MPAs existed and, if so, whether the MPA's presence had influenced their decision to visit the sites. Visitors were asked to indicate whether they were influenced ‘strongly’, ‘somewhat’ or ‘not at all’ and these responses were assigned weightings of 0.9, 0.5 and 0 respectively. This was used to isolate the value of the MPAs to visitors from the value of the terrestrial plus marine protected area as a whole.

3.2.6 Impacts of changes in angling regulations on recreational use value

3.2.6.1 Change in enjoyment of activities in the reserves

Respondents in each of the study sites were asked how a change in angling regulations would affect their enjoyment of the activities that they participated in. The proportion of visitors (%) that reported a very negative, slightly negative, no effect, slightly positive or very positive effect on these activities, was calculated and compared for the main activities in each reserve.

3.2.6.2 Change in visitation and revenue

Respondents were asked how a change in angling regulations would affect the amount of time that they spent visiting the site. If they stated that they would spend more or less time at the site, then they were asked to estimate the percentage change. The proportions of visitors falling in each group and the average estimated percentage change in visitor rate were used to adjust the revenue data for each of the parks, and from that to estimate the change in their overall recreational value.

Since changes in MPA policy would be expected to attract new visitors as well as affect the visitation rates of existing visitors, data were also drawn from the general public survey. Interviewees that had heard of the Tsitsikamma National Park, but had never visited, and reported a positive change in their use of the park, were considered to be potential new visitors that would be gained under the alternative scenario.

3.2.6.3 Visitors and public WTP to prevent angling

Both visitors to the Tsitsikamma National Park and the general public outside the park were asked what they would be willing to pay over and above the entrance fee in order to prevent recreational shore angling from being permitted within the National Park. Only interviewees that had heard of the Tsitsikamma National Park were included in the calculations.

3.2.6.4 Reaction to consumptive vs non-consumptive angling in MPAs

Visitors to each of the sites were asked whether they would be in favour of or against angling in the MPA, and then they were asked if they would be in favour of or against catch-and-release angling in the MPA.

3.3 Results

3.3.1 Visitor characteristics

Visitors to the three protected areas were dominated by whites, with only a small proportion of groups representing other race groups (Figure 6.4).

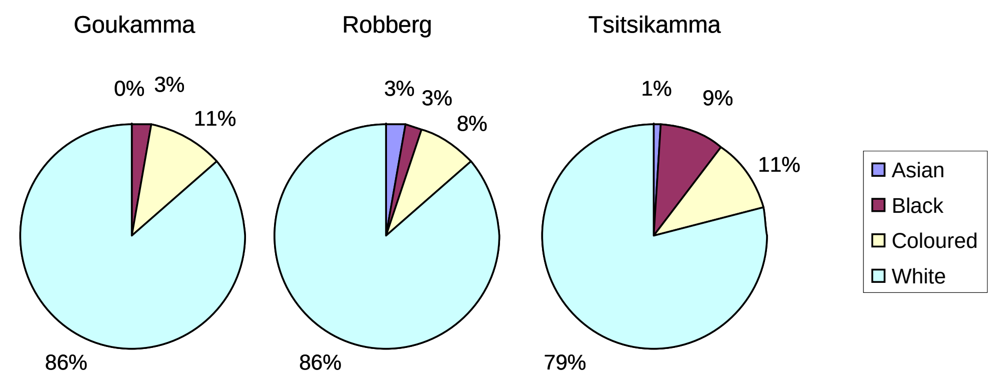

Figure 6.4. Racial composition of visitors sampled at each site

At all sites, most of the visitors were from South Africa, with the majority coming from the Western Cape followed by the Eastern Cape. Detailed provincial breakdowns of visitor origins are presented in Figure 6.5.

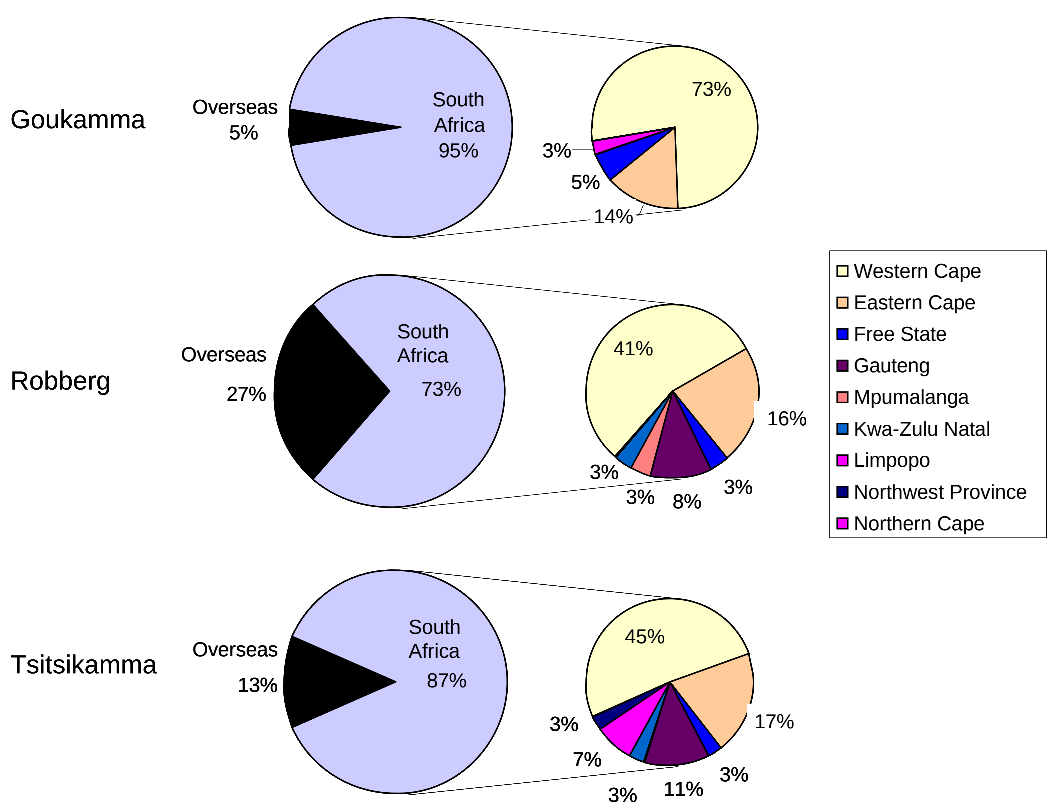

Figure 6.5. Origins of visitor groups sampled in the three protected areas

Visitor income brackets show that for Tsitsikamma NP, the largest proportion of visitors that responded had gross monthly household incomes between R24 - 48 000 and at Robberg NR the most frequently cited monthly income bracket was greater than R48 000. By contrast, most interviewees at Goukamma NR earned between R12 000-24 000 (Figure 6.6).

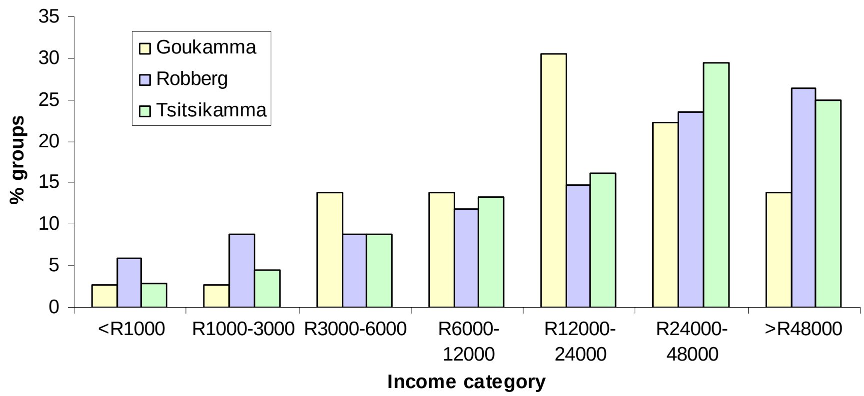

Figure 6.6. Percentage of groups in each income category (including international visitors)

The majority of visitors to all three sites had visited at least once previously (Figure 6.7). Visitors to Goukamma were more likely to be returning visitors than those to the other two reserves. Activities were varied at all sites, although activity profiles differed somewhat from site to site (Figure 6.8).

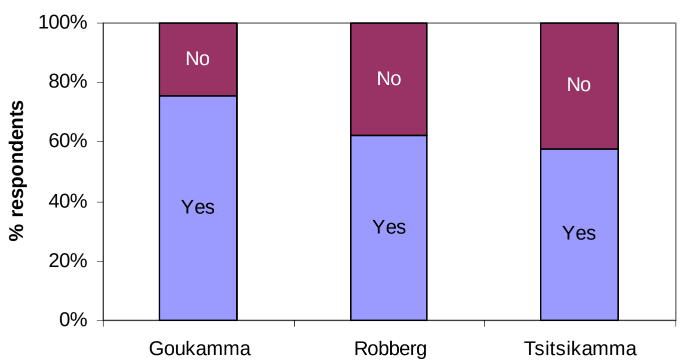

Figure 6.7. Percentage of respondents that reported having visited the site previously

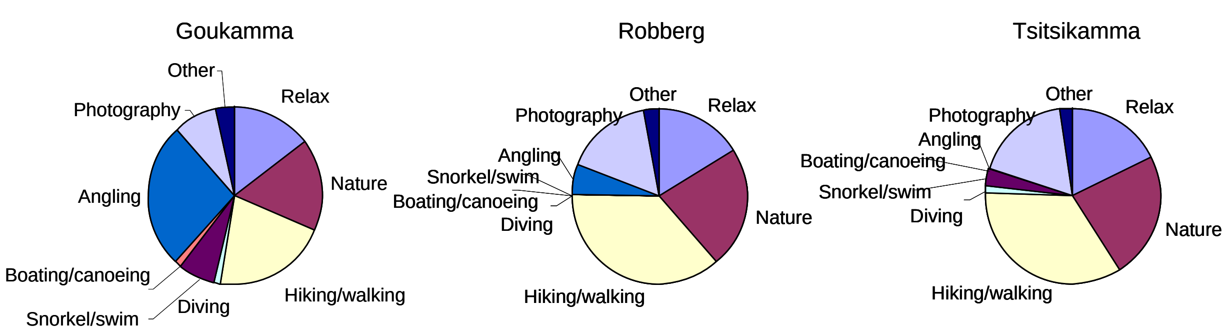

Figure 6.8. Activity profile of visitors to the three protected areas

Anglers make up 39% of visitors to Goukamma, but the majority of visiting groups contain anglers. A smaller proportion of visitors to Robberg were anglers (Table 6.7).

Table 6.2. Proportion of anglers among visitors to Goukamma and Robberg

	Goukamma	Robberg
% anglers in sample	39%	14%
% groups with anglers	78%	27%

Goukamma attracts more avid anglers than Robberg (Figure 6.9). This would be expected since it is a more remote destination, whereas Robberg is an easy outing within Plettenberg Bay. Anglers at Goukamma and Robberg spend an average of 12.4 and 34.3 days per year, respectively, fishing at that site. Nevertheless, catch per unit effort was similar at the two sites (Table 6.3).

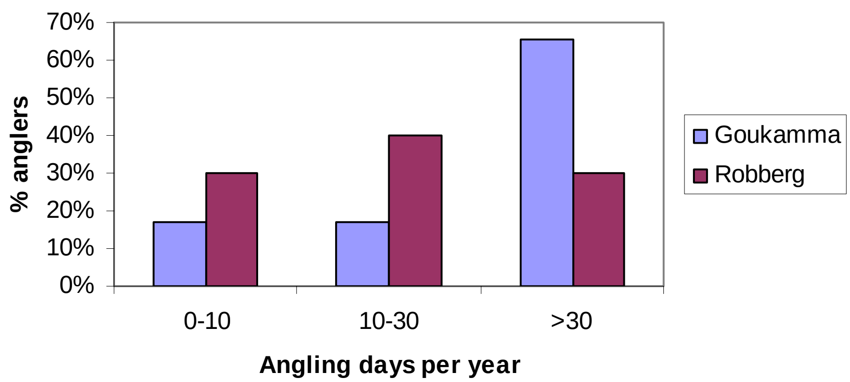

Figure 6.9. Avidity of anglers visiting Goukamma and Robberg.

Table 6.3. Fishing effort and catches for angler groups surveyed at Goukamma and Robberg

	Goukamma	Robberg
N (groups)	29	7
Average Angling hours so far	5.45	3.00
Average number of fish caught	1.00	0.50
CPUE (fish per angler hour)	0.18	0.17

Over two-thirds of anglers to both MPAs claimed they had chosen to come to this site over other angling areas that were closer or more easily accessible to them. Anglers at Goukamma had travelled an average of 175km from their next best fishing spot, while the comparable figure for Robberg was 1.7km. The most popular alternatives for Goukamma included a number of sites from Wilderness to Plettenberg Bay, while for Robberg it was Robberg Beach. Fishers chose the sites for a number of reasons besides the quality of fishing itself (Figure 6.10). Note that all of these figures are based on small sample sizes, especially for Robberg.

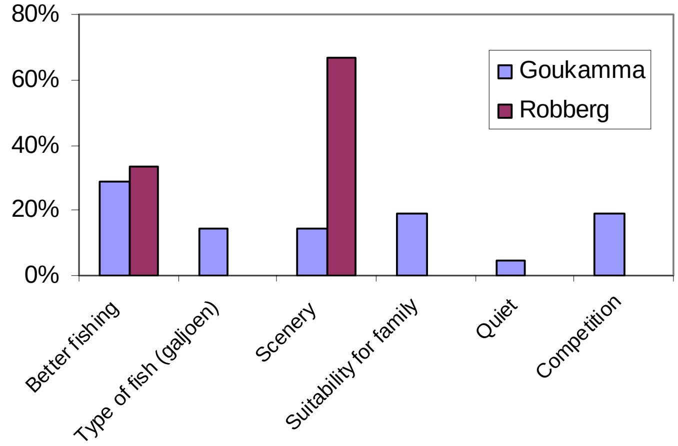

Figure 6.10. Reasons given for choosing to fish at Goukamma and Robberg.

3.3.2 Visitor numbers and expenditure

Visitor numbers to the three MPAs are orders of magnitude different. Whereas there were little over 1100 paying visitors to Goukamma in 2005/6, Robberg received about 28 000 visitors, and Tsitsikamma received over 160 000 visitors. It should be noted that it is possible to gain access to Goukamma NR without paying a conservation fee. Visitor numbers to Tsitsikamma have decreased in recent years, with the latter being the lowest in 10 years (Figure 6.11). Visitor numbers over this period were over 200 000 in 2002/3.

Revenues for 2002/3 and 2005/6 are given for each of the sites in Table 6.4. Note that annual gate takings were considerably lower in the last financial year than in 2002-3 for Tsitsikamma, and slightly lower for Robberg. It is likely that this is partly due to decreased visitor numbers, but in the case of Tsitsikamma, it is also partly due to the introduction of the wild card. The average revenue per visitor (not adjusted for inflation) in the last financial year was only 75% of that in 2002/3. Thus the revenues for the latest financial year have been adjusted upwards by a factor of 1.33 to account for the Wild Card effect (i.e. part of the revenue going directly to head office), and the estimated "true" income from Tsitsikamma in 2005/6 is about R9.737 million. Since Goukamma (Cape Nature) is also a Wild Card participant, its revenues were similarly adjusted.

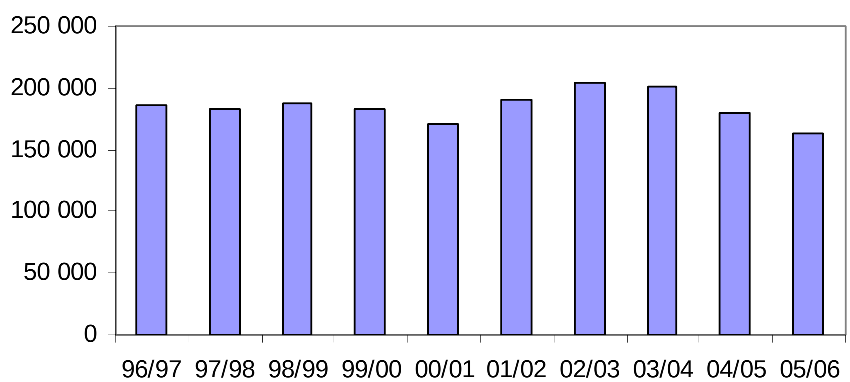

Figure 6.11. Annual visitor numbers at Tsitsikamma National Park (per financial year)

Table 6.4. Annual revenues generated by each reserve in 2002-3 and 2005-6 and visitor numbers in 2005-6.

Site Name	Annual revenue (2002-3)	Annual revenue (2005-6)	"True" revenue (2005-6)	Annual visitors (2005-6)
Goukamma NR	321 443	348 992	462 594	1 143
Robberg NR	591 172	446 334	446 334	28 970
Tsitsikamma NP	12 201 000	7 346 000	9 737 234	204 000

After adjusting trip expenditure in South Africa by the percentage reason for the trip attributed to visiting the reserve, the off-site costs for the reserves were estimated to be 2 to 6 times that of on-site expenditure (Table 6.5). These proportions were used to derive the actual off-site costs and total expenditure attributable to each nature reserve (Table 6.5).

Table 6.5. Estimated on-site and off-site costs

	On-site cost (R)	Average % of SA costs attributed to reserve	Off-site costs (R)	Total expenditure
Goukamma NR	462 594	69.2	2 429 264	2 891 858
Robberg NR	446 334	37.1	2 671 908	3 118 242
Tsitsikamma NP	9 737 234	47.1	19 384 994	29 122 228

3.3.3 Consumer surplus

Consumer surplus could only be estimated for Tsitsikamma NP, as sample sizes at Robberg and Goukamma were too small. Average travel costs and visitor numbers were calculated for each zone (Table 6.6), and the visitation rate was significantly negatively correlated with average travel cost per person (Figure 6.11).

Table 6.6. Average expenditure, population and visits from each of the zones used in the Zonal Travel Cost Method for Scenarios One and Two at Tsitsikamma NP.

Zone	Average expenditure per person per zone (R)	Population from each zone	Sampled visitors from each zone	Estimated no of visitors from each zone
1	383	222 621	11	6 208
2	637	5 738 475	104	58 698
3	791	35 735 680	93	52 490
4	796	17 233 803	55	31 042
5	1 850	623 773 976	25	14 110

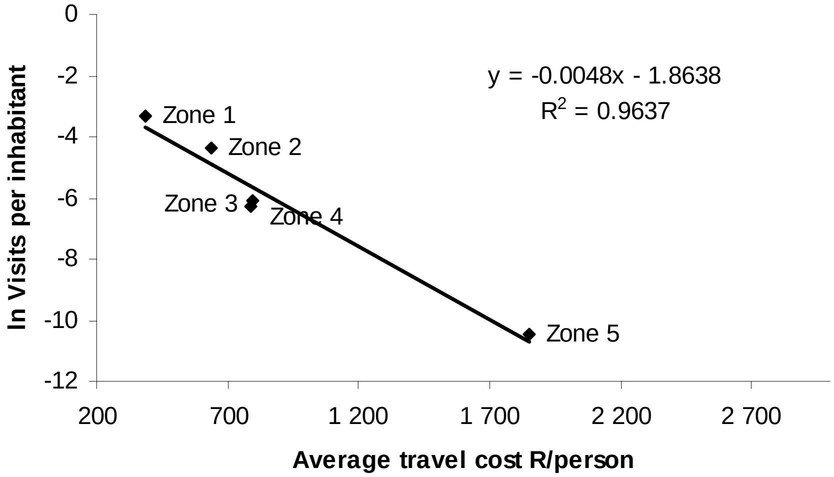

Figure 6.12. Semi-log regression of travel cost against visits per zone at Tsitsikamma NP

The travel cost model (Figure 6.11) was then used to estimate the demand curve for visits to Tsitikamma, by varying a hypothetical increase in entrance costs (Figure 6.13). The demand curve indicates how visitation rate would change with a change in the cost of visiting the park.

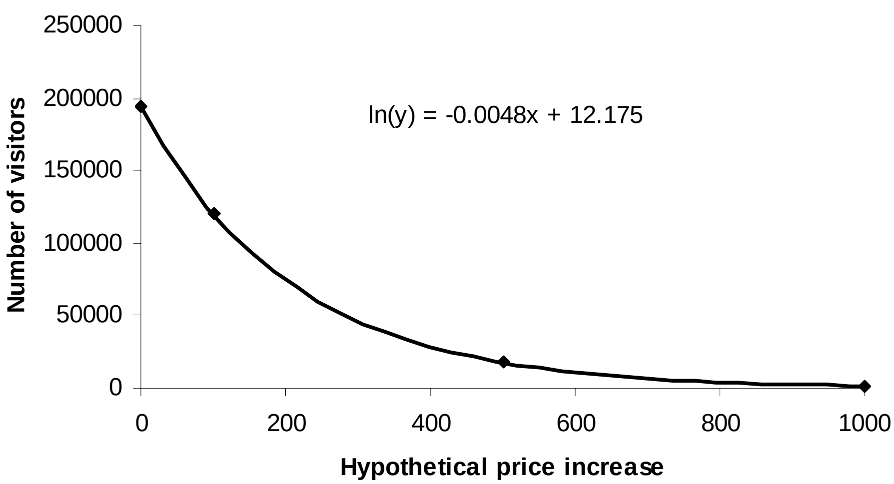

Figure 6.13. Demand curve derived for Tsitsikamma NP using the Travel Cost Method

The demand curve was then used to derive the consumer surplus for Tsitsikamma NP, interpreted as the value of benefits visitors received that they were not paying for. This was estimated as R10 109 000 per annum.

3.3.4 Total recreational value attributable to MPAs

Not all respondents knew about the presence of the MPA prior to their visit and it was assumed that the MPA did not contribute to their decision to visit the nature reserve. Of those that did know of the MPA, the majority of respondents maintained that the MPA did not factor in their decision to visit the area (Figure 6.14).

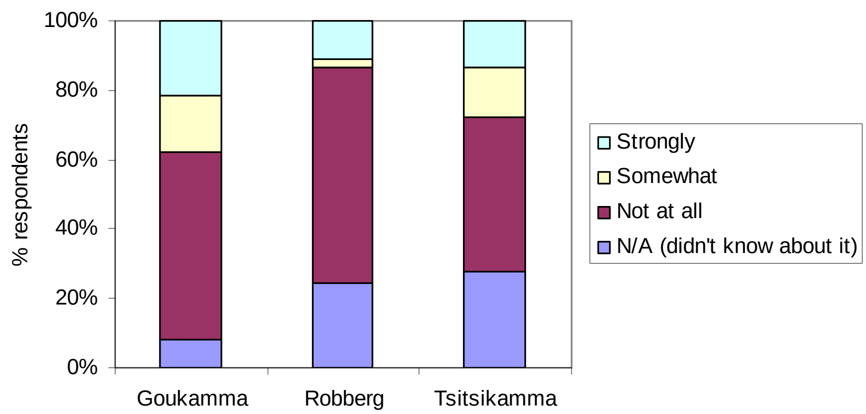

Figure 6.14. The extent to which the presence of the MPA influenced respondents' decisions to visit the site.

Once in the park, respondents described how different attractions contributed to their enjoyment. Scenery is the main attraction in all three parks. Fishing is highly important in Goukamma, while forest is of major importance at Tsitsikamma. Purely marine attractions accounted for 38%, 20% and 14% of visitor enjoyment at Goukamma, Robberg and Tsitsikamma, respectively. This does not include the contribution of scenery, which includes the sea, or remoteness, which is influence by lack of commercial fishing or restricted angling.

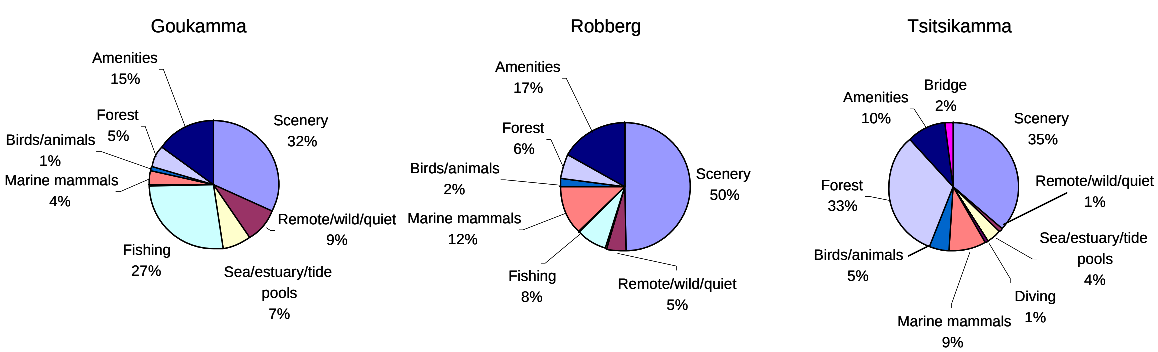

Figure 6.15. The extent to which the different attractions contribute to visitor enjoyment at each site.

The above findings were used to estimate the proportion of value of the nature reserves that were attributable to the MPAs. The resulting estimates range from R485 000 for Robberg to R4.8 million for Tsitsikamma (Table 6.7), excluding consumers' surplus. With consumers' surplus, the value of Tsitsikamma is in the order of R6.5 million.

Table 6.7. Estimated recreational value of the MPAs (not including consumers' surplus)

	Average % enjoyment	% contribution to decision*	MPA Value (R)
Goukamma NR	38%	28%	797 215
Robberg NR	20%	11%	345 535
Tsitsikamma NP	14%	19%	5 556 214

*weighted as follows: 'Strongly' = 0.9; 'Somewhat' = 0.5; 'Not at all' = 0

3.3.5 Research and educational value

The total number of publications and documents focusing on marine aspects were 122, 5 and 12 for Tsitsikamma, Goukamma and Robberg respectively (Table 9).

Table 6.8. Research conducted on marine aspects of the three sites

	Books	Scientific Papers	PhD	MSc	Reports
Tsitsikamma NP	5	92	3	13	9
Goukamma NR	0	3	1	0	1
Robberg NR	1	4	1	4	2

A total number of 851 and 1576 learners visited Tsitsikamma NP and Robberg NR for guided educational tours. Educational data was not available for Goukamma NR. No monetary value could be placed on the educational value as no entrance fees were charged for students.

3.3.6 Potential impacts of changes in angling regulations

3.3.6.1 Impact on the visitor experience

Most visitors surveyed at Goukamma (92%) knew that fishing was allowed there, but only 64% of respondents at Robberg were aware of this. At Tsitsikamma, only 53% the respondents knew that fishing was not allowed in that MPA. Among visitors to Tsitsikamma that did know that the area was closed to fishing, only 11% claimed that this was a draw card in coming to the area.

When asked how changing the regulations would affect their activities, the majority of respondents felt that most of their activities would not be affected (Figure 6.16). Some respondents reported negative or very negative effects, but few felt there would be positive impacts. Apart from angling, activities at Robberg were the least negatively affected, and at Tsitsikamma the most. Interestingly, not all anglers felt that the effects would be very negative.

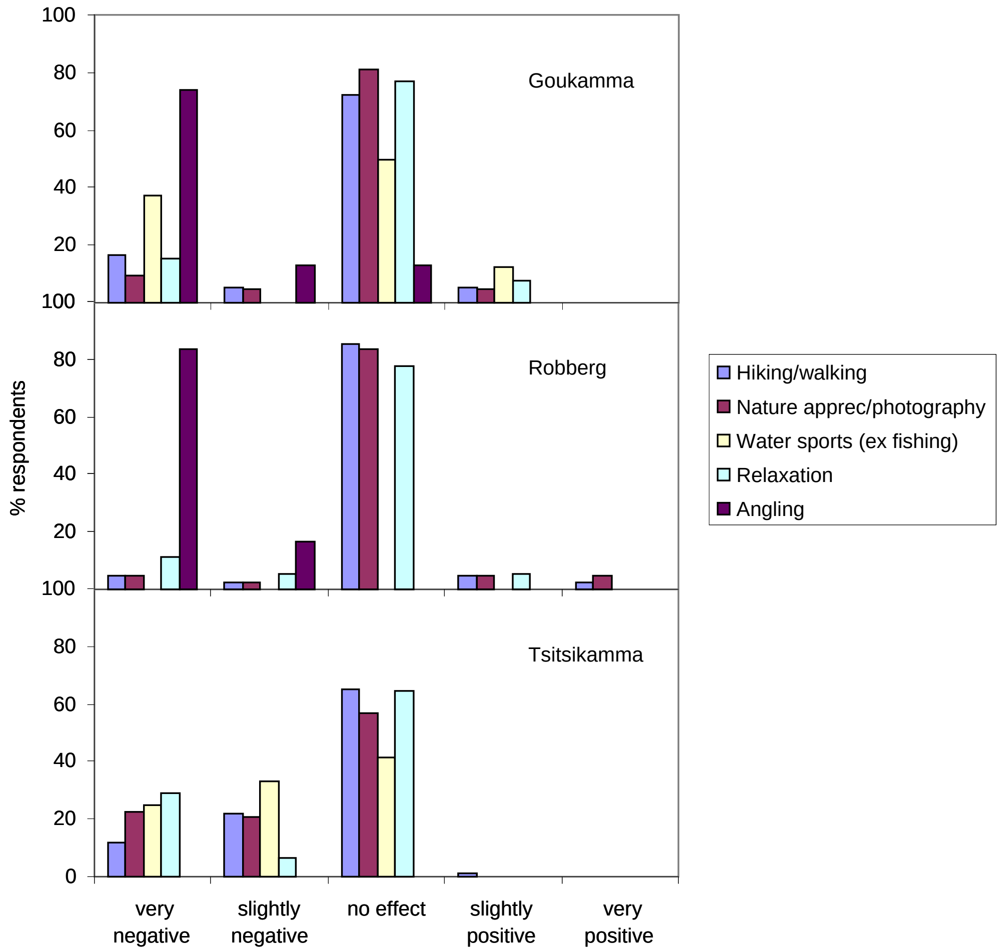

Figure 6.16. How respondents felt their activities would be affected by a change in fishing regulations.

Visitors to each of the MPAs were asked how their overall enjoyment of the site would be affected by a change in regulations – a fishing ban in the case of Goukamma and Robberg, and allowing fishing in two 5km sections in Tsitsikamma. The reactions were conservative both in Goukamma and Tsitsikamma, with visitors preferring the current status quo or being unaffected (Figure 6.17). At Robberg, most respondents would not be affected by a fishing ban. At Tsitsikamma, only 18% of respondents claimed that they would come there to fish if it were opened.

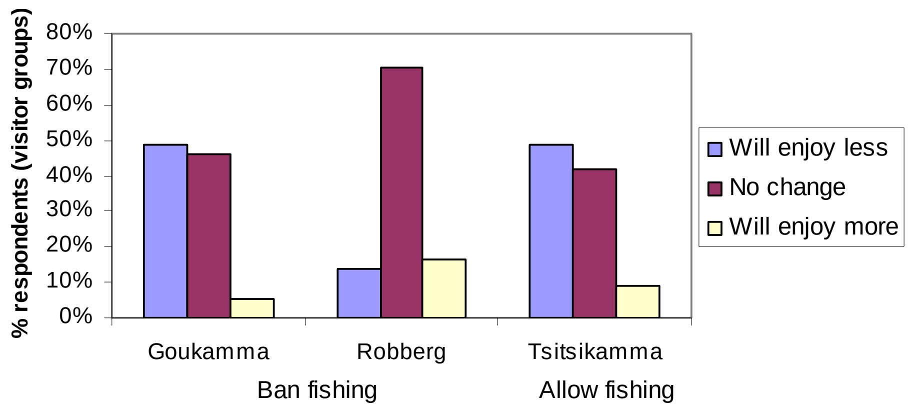

Figure 6.17. How current visitors would appreciate a change in fishing regulations at the three MPAs.

3.3.6.2 Opinion on fishing in MPAs

The majority of visitors to Goukamma were in favour angling in MPAs, visitors to Robberg were roughly equally divided, with slightly more against, while visitors to Tsitsikamma were overwhelmingly against angling in MPAs generally (Figure 6.18). Many people that were in favour of angling added that it should be controlled. Because visitors tend to go to places that suit them best it is important to compare this with the general public opinion. In the survey of the general public, almost just over half (53%) of South African respondents were against allowing recreational shore angling in MPAs in general, while about 40% were in favour (Figure 6.18). However, of the respondents in favour, 21% stipulated that they would only be in favour if shore angling was highly regulated. Opinions regarding the MPA they were at were almost identical to the pattern shown in Figure 6.18. Similarly, 53% of South African respondents in the general public survey were against allowing angling in the Tsitsikamma MPA, specifically.

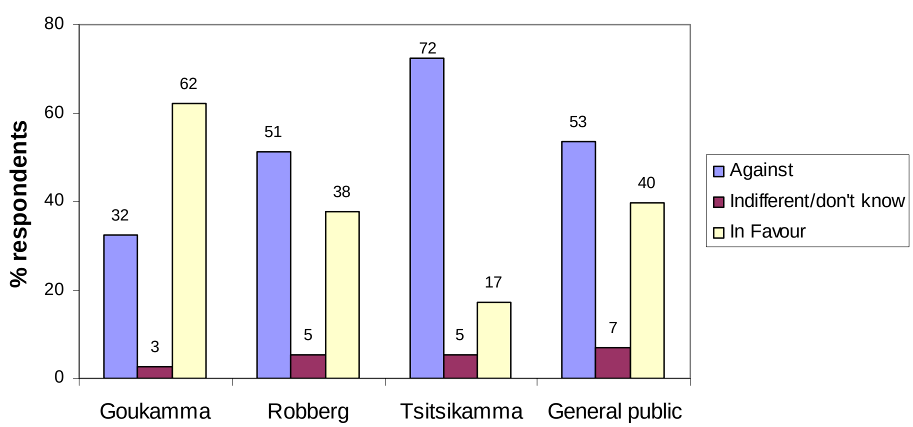

Figure 6.18. Percentage of respondents interviewed at the different MPAs that were against or in favour of **allowing angling in marine protected areas generally**.

In the general public survey, 26% of respondents were anglers. However, the anglers' opinion on fishing in Tsitsikamma was not significantly different from that of non-anglers ($t = 4.3$, $df = 2$, NS) (Figure 6.19).

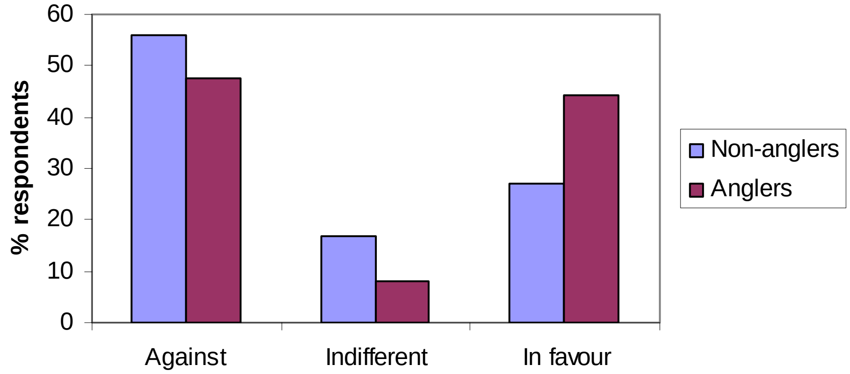

Figure 6.19. Percentage of anglers and non-anglers in the general public survey in favour, against or indifferent, to allow recreational shore angling in Tsitsikamma MPA.

Visitors in favour of fishing in MPAs felt that fishing would be of high quality in the MPAs, and that recreational angling would not have a significant impact. They felt that it harmed no-one and gave people pleasure. Some also offered that it would boost revenues from entrance fees. Among those in favour of fishing at in MPAs, 29%, 36% and 21% at Goukamma, Robberg and Tsitsikamma, respectively, said they would be willing to pay an additional fee to fish, and the average willingness to pay amongst those respondents was R27 in Goukamma and Robberg, and R56 in Tsitsikamma.

Among respondents that were in favour of angling, the majority were also in favour of a catch-and-release only policy, although a significant proportion were against this policy in Goukamma. Average willingness to pay for angling under a catch and release policy was R15, R6 and R34 for the three reserves, respectively. This is just over half of the willingness to pay for regular angling.

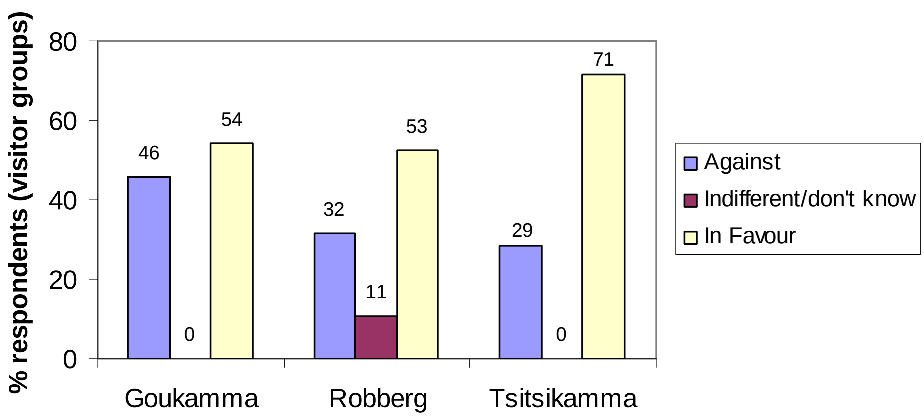

Figure 6.20. Percentage of visitors in favour of fishing in MPAs that were against or in favour of a catch-and-release only policy.

Visitors who were against angling in MPAs were mainly concerned that the whole point of having MPAs is for the protection of biodiversity and fish stocks, and so allowing angling would defeat the object. They also felt that protecting fish resources would favour the presence of dolphins and other marine life, enhancing the tourism experience. Another very common concern was about fishing-associated pollution, especially fish hooks and line left lying around. Some were concerned about changing the atmosphere of the MPA.

More than half of respondents against fishing (55%, 61% and 71%) were willing to pay higher entrance fees in order to prevent fishing in the MPA, with those respondents willing to pay up to R42, R53 and R54 more in the three MPAs, respectively. However, many of the respondents that were against angling in MPAs reacted favourably towards a catch-and release policy (Figure 6.21).

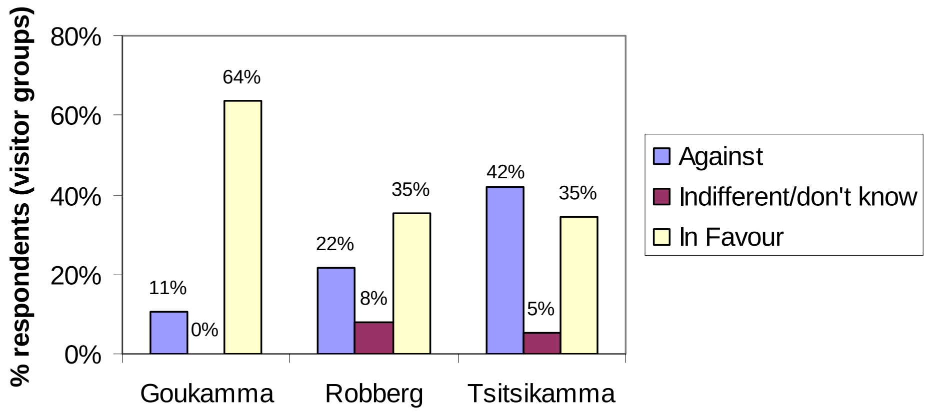

Figure 6.21. Percentage of respondents against fishing in MPAs that were against or in favour of **a catch-and-release only policy**.

3.3.6.3 Expected change in value

Whereas very few visitors at Robberg or Tsitsikamma said they would stop coming under a change of regulations, some 40% of visitors to Goukamma said they would no longer visit the MPA. Robberg would be least affected in terms of the behaviour of its visitors at present, with over 90% of visits expected to continue. Visitation by the current visitor pool to Goukamma would be reduced to 58% of present, whereas that of Tsitsikamma would be reduced to about 84% of present. These translate to a loss of value of R1.2 million, R300 000 and R4.7 million per annum for Goukamma, Robberg and Tsitsikamma, respectively (Table 6.9).

Table 6.9. Proportion of visitors' that would come less or more as a result of change in fishing regulations, and their estimated proportional change in visitation rate, the estimated overall effect of this on visitor numbers and on the value of the MPA. Note that this does not include non-users that would start coming as a result of the change (see below).

	Goukamma	% more or less	Robberg	% more or less	Tsitsikamma	% more or less
Would stop coming	40%		4%		7%	
Would come less	14%	63%	11%	45%	22%	48%
Would have no effect	40%		85%		66%	
Would come more	6%	50%	0%		5%	40%
Overall effect (% of present visitation rate)	57.5%		90.2%		83.8%	
Net loss of value (R per year)*	**R1 229 040**		**R306 050**		**R4 710 255**	

* not including consumers' surplus

Estimating the amount of new visits due to other members of the public being attracted to the areas as a result of the change in regulations is more difficult. In the general public survey, it was found that a large proportion of the public had heard of the three MPAs, and a high percentage had also visited each of the sites. This is to be expected to some extent because the survey was carried out along the Garden Route.

Table 6.10. Proportion of respondents in the general public survey that had heard of and been to the three protected areas, and that knew there was an MPA there.

	% that had heard of it	% that had visited	% that knew of the MPA
Tsitsikamma NP	94	57	57
Robberg NR	67	45	46
Goukamma NR	61	23	25

The majority of respondents in the general public survey felt that a change in regulations would not affect their propensity to visit the sites. There was no significant difference in responses between those that had not been and those that had been to the sites. What is of particular relevance is the balance between those that would be discouraged from visiting or encouraged to visit. In the case of Tsitsikamma, the responses suggest that the loss of value described above due to opening the area to fishing would be counterbalanced by a gain in value from those that would find it more attractive. In the case of Goukamma and Robberg, which were considered together, it appears that the loss of value could be outweighed by a gain in value from people that would find these reserves more attractive, resulting in a net increase in value.

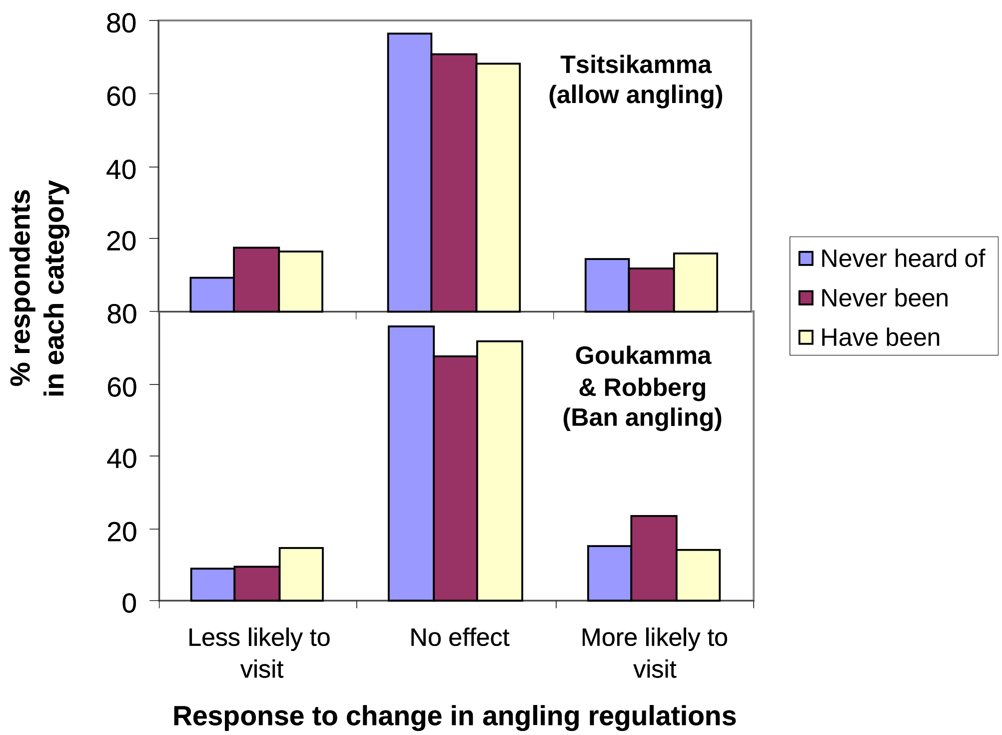

Figure 6.22. General public response to changes in angling regulations at the three MPAs

3.4 Discussion

This study estimated the annual expenditure incurred by visitors to three coastal reserves, and attempted to estimate how much of that expenditure could be attributed to the MPA. The revenues generated by the three MPAs were markedly different, with Tsitsikamma earning far higher revenues than the two smaller MPAs. This is probably due to its park status, much larger size, greater number of activities, higher accommodation costs and tiered pricing system. However, Tsitsikamma is also famous for the Otter and Dolphin Trails, neither of which are included in the revenue figures used. It must be borne in mind that they would contribute considerably to the value of both the park and the MPA.

The estimation of total expenditure on visiting the reserves required estimating off- expenditure on the basis of a visitor survey. The resultant estimates of expenditure on visiting the reserves are probably reasonable in terms of their order of magnitude, but it should be noted that the accuracy of these estimates is compromised by several factors. Firstly, visitor numbers to these reserves fluctuate annually, as could be seen in the Tsitsikamma visitor statistics. The estimates used here were based on the most recent visitor numbers and revenues, and are therefore conservative in that visitor numbers were lower than previous years. Another complicating factor was the impact of the wild cards on revenue data. Whereas revenues previously formed an accurate record of the fees paid to visit a particular park, they no longer do so under the Wild Card system, as wild card holders have paid up front to visit a suite of parks, and do not pay entrance fees at the gate. We used a simple ratio of average on-site expenditure before and after the introduction of the wild card to estimate the overall expenditure due to the park. A third factor affecting the accuracy of our estimates was the relatively low sample size of visitors used to estimate the off-site costs. This was particularly the case for the two smaller parks. In addition, the survey was conducted during mid-winter school holidays, and patterns might be different at other times of year. Nevertheless, we are confident that our estimates are in the right order of magnitude.

Consumers' surplus is notoriously difficult to estimate, especially in situations where people are visiting multiple sites on a single trip. This is indeed the case for the majority of visitors to the three MPAs. This was corrected for in the travel cost analysis by adjusting expenditure estimates by the stated percentage reason for the trip that was attributed to visiting the reserve in question. Due to small sample sizes for the smaller MPAs, it was only possible to apply the travel cost method for Tsitsikamma. The consumer surplus estimated is theoretically the additional amount that visitors would have been willing to pay for their experience there, and can theoretically be captured. Including consumers' surplus in the overall estimate of recreational value gives a truer reflection of the value of the resource to users than just using actual expenditure.

Estimating the proportion of value that could be attributed to the MPA was a challenging task, in that it is even difficult for the visitors themselves to have a good idea of this. We thus used two alternative methods of estimating the percentage contribution that the MPA made to the recreational experience. Natural features are inextricably linked and it is therefore very difficult for visitors to distinguish the relative enjoyment values associated with each characteristic. In addition, the survey was carried out at a time of year when visitors attributed far less enjoyment value to marine-related characteristics, resulting in an underestimate of MPA value. There is also a major caveat in result obtained, in that the value obtained is essentially the value that the marine resources contributed to the experience. This is the way that valuation of protected areas is conventionally handled. However, in theory, the value of the MPA is the amount of this value that would be lost if there was a change in management (ie. loss of MPA status). This value would probably be much smaller than the value that we have estimated. For some attributes, such as the presence of whales and dolphins, there may be no direct link to the MPA. However, if visitors perceive the attribute to be linked to the MPA then the assumption is taken to be valid. For other attributes, such as 'scenic beauty', the link is more tenuous as views of the ocean are generally not affected by the degree of protection.

Putting a monetary value to scientific and educational value is probably not possible, since one cannot establish how these activity affect future decisions. However, it is worthwhile considering these values. Our results suggest that the research value of Tsitsikamma MPA is considerably higher than Robberg or Goukamma, since its size, age and near-pristine state make it an excellent focus for research.

The crux of the matter that was investigated in this study was how changing fishing regulations might impact on recreational use value of the parks. This is a pertinent question because, on the one hand, there is a strong sentiment that MPAs should be no-take zones and should always act as sanctuaries and source areas, but on the other hand, there is pressure from the public to open areas to fishing in the Tsitsikamma MPA. In investigating this aspect it was important to take the opinion of the general public into account, as well as that of the current users. The opinions of the users were obviously biased in favour of the current management policy of the MPA that they were visiting. This is because people tend to go to the places that suit them best. For those who felt otherwise, clearly other attractions of these sites over-rode the annoyance of not being able to fish or having to put up with others' fishing, as the case may be. The anti-fishing sentiment was very strong among visitors at Tsitsikamma. The general public, however, are more or less equally divided, with a greater proportion being against the idea of fishing in MPAs. However, as shown in Chapter 5 (existence value), a much higher proportion of the public people prefer the strictest protection. If the regulations were changed, then there would be significant losses in terms of reduction in use by the current users at all three sites. However, it is reasonable to expect that this would be counterbalanced by increased use by people that currently do not visit the parks, and data from the general public survey support this. Nevertheless, it is interesting to note that there could be an increase in value of the MPAs in which fishing is banned. In general it should be borne in mind that whereas there are always alternative sites for fishing outside of MPAs, there are no alternative non-fishing zones for users that enjoy visiting no-take protected areas. Thus ultimately there would be a net loss of welfare if the amount of no-take MPAs was reduced.

4 VALUE OF FISH EXPORTS

4.1 Introduction

This study focuses on the Garden Route coast (Cape St Francis to Cape St Blaize) of the Western Cape. Theory suggests that MPAs improve the fishing yields in adjacent areas by the export of fish larvae, pre-recruits and adults (Attwood & Bennett 1995, Mosqueira *et al*. 2000, Gotz 2005, King 2005) and ideally the increase in fishing should be sufficient to off-set the loss of fishing in the MPA (Roberts *et al*. 2000). Thus an MPA can cause economic impact by the loss of a fishing area but also by enhancing catches in exploited areas. The main objective of this study is to put an economic value on export of fish from the Tsitsikamma National Park (TNP), the Robberg Nature Reserve (RNR) and the Goukamma Nature Reserve (GNR) MPAs to the adjacent exploited Garden Route coast. These MPAs have been shown to have a higher catch-per-unit-effort (CPUE) within them than in adjacent areas (Brouwer 1997, Sauer *et al.* 1997, Gotz 2005, King 2005, Smith *et al.* in prep) with the CPUE decreasing with decreasing proximity to the MPA.

The main objective was achieved by:

1. Estimating an average economic value per fish to the shore angling, recreational and commercial boat linefishery.
2. Quantifying for two species representative of the shore (galjoen *D. capensis*) and boat based (red roman *Crysoblephus laticeps*) linefishery the export of fish adults from the three MPA's and estimating the contribution to recruitment in adjacent areas by spawner biomass protected within the MPA's.
3. Determining and valuing the catch surplus for all resident reef fish species in the exploited areas adjacent to MPAs by extrapolation based on the proportion of these two species in the catch composition.

4.2 Methods

4.2.1 Calculation of Fish value

Approximately 200 species are landed in the linefisheries although only a dozen account for more than 90 % of the catch (Mann 2000). For the purposes of this study all fish were assumed to have the same value and the average value of a fish to a recreational shore-angler and ski-boat linefisher was calculated as the entire amount of money spent on fishing in a year (this includes travel, accommodation, tackle, rod, reel and bait) divided by the total number of fish caught in a year. For recreational linefishing, the value of a fish was therefore estimated as the willingness to pay value.

The value to a commercial boat linefisher was calculated differently because the fish is worth what it can be sold for. The value of total daily catch was divided by the total catch. This excludes the operating expenses of the commercial fisher and as such is an overestimate of the actual value of a fish to a commercial linefisher. However, as the estimated value was so much lower than that for recreational fishers and the commercial fisher's expenses do represent a contribution to the economy in the broader sense, this inflated value was used for the purposes of this study. The average expenditure values for linefishers between Witsand and East London were taken from McGragh *et al.* (1997). Linefisheries catch information was taken from Brouwer (1997) from the regions between the Kei Mouth and Stil Bay. Both the studies cover the Garden Route area, are therefore representative of the linefish industry in the area.

4.2.2 Export of fish from MPAs

Nomadic and migratory fish species that are wide ranging are unlikely to derive much more than temporary benefit from MPAs (unless the sites of spawning aggregations are protected). The values estimated in this study were therefore based only on resident reef dwelling species (mostly sparids). Estimation of the annual emigration rates of adult, resident fish from the Garden Route MPAs was done by estimating the total population size within the three MPAs (calculated from density estimates) and the proportion thereof estimated to disperse beyond the MPA borders based on information on movement patterns.

There is limited data available from mark recapture studies on the movement patterns of many South African reef and surf zone fish species. Quantitative data on the actual density of surf-zone and reef fish species within MPAs, however, is scarcer. For the calculations made in this study, two fish species considered representative of shore angling (galjoen *Dichistius capensis*) and boat based (red roman *Crysoblephus laticeps*) fishing sectors for which information on their movement patterns and density within MPAs was available, were selected.

The galjoen is a heavily exploited shore angling species, and has been one of the most intensively studied fish in South Africa. Long-term mark and recapture studies conducted at two sites within the De Hoop National Park MPA indicate that around 5 % of the population move out of the MPA annually (Attwood and Bennett, 1993; Attwood, 2003). It was assumed that the same proportion of other shore angling species populations emigrated from the garden route MPAs annually. The TNP MPA is the only Garden Route MPA that offers protection to shore angling species (the other two MPAs being open to shore angling).

The density of galjoen within the TNP MPA was estimated from the catch per unit effort (CPUE) values recorded by research angling within the TNP and the relationship between CPUE and density calculated for the two sites within the De Hoop MPA. A linear relationship between galjoen CPUE (fish angler-1hour-1) and density (fish km coastline-1) was assumed. Although it is clear that catchability differs between areas and that the relationship clearly is not linear, the assumption was considered to provide sufficiently accurate estimates for the estimation of economic value. Galjoen CPUE and density values were extracted from Attwood (2003). The total galjoen population within the TNP MPA was calculated as the product of density and the coastline distance.

Red roman are an important component of both the recreational and commercial boat fishing sectors along the Cape coast (Brouwer 1997). Mark recapture data indicate that this species is highly resident, with 74 % of recaptures being made within 1 km of the release site, 95 % of recaptures occurring within a radius of 13 km and maximum displacement of 39 km (Griffiths & Wilke 2002). More recent telemetry studies also suggest that although some red roman move up to 4 km, most red roman inhabit small home ranges of about 50m2 (Kerwath in prep. in Gotz, 2005). Given the limited movement of most tagged red roman, an export rate of 0.5% of the total populations was used.

Density estimates (fish .m-2) of red roman within the TNP MPA were extracted from Buxton (1987) based on underwater visual census (UVC) data. Although these data were collected 20 years ago it is likely that the population was by that stage close to carrying capacity within the TNP MPA and has remained fairly stable since then. This appears to be a valid assumption, as density estimates also based on UVC data of red roman in the GNR MPA by Gotz (2005) were very similar. The density of red roman within the RNR MPA was assumed to be an average of these two values. The reef area considered as suitable habitat for red roman within the TNP MPA was conservatively estimated at 13 % (based on Figure 4 in Buxton 1987), and the total population was estimated as the product of this value and the density estimate. Thirty percent of the area protected within GNR and RNR MPAs was considered suitable red roman habitat and total populations calculated using the same method.

4.2.3 Estimated contribution of larvae and pre-recruits by spawner biomass within MPAs

There is a lack of information on fecundity for nearly all South African surf zone and reef fish, whilst information the survival and dispersal rates of eggs and larvae (which are certain to be highly variable depending on prevailing environmental conditions) is also non existent. What is known is that MPAs protect dense populations of large individuals and that fecundity is exponentially related to body size for nearly all fish species. It follows that the populations within the garden route MPA's must contribute a substantial proportion of the pre-recruits to exploited areas where spawner biomass of nearly all linefish species has been drastically reduced. This proportion for galjoen and red roman was estimated based on the difference between the estimated spawner-biomass-per-recruit ratio as a percentage of the pristine ($SBPR\%SBPR_{F=0}$) for the exploited area (extracted from Mann 2000) and the SBPR ratio for the MPAs (assumed to be 1, i.e. pristine).

The economic value of larvae, pre-recruits and adult red roman and galjoen exported from the three MPAs was calculated by multiplying the estimates by the value per fish for each fishing sector. For the boat based recreational and commercial sectors, the value of red roman export from MPAs was calculated as the relative proportion of the total red roman catch made by each sector from data presented in Brouwer (1997). The total value of linefish exports for all resident surfzone and reef species was crudely estimated by extrapolation of the values obtained for galjoen and red roman based on their proportions in the catch composition (data extracted from Brouwer 1997). This method assumed that movement patterns and stock status of all species in exploited areas are identical (or at least similar), and as such estimates should be considered preliminary.

4.3 Results

4.3.1 Fish Value

A single "generic" fish was calculated to be worth more to a recreational shore angler (R140) than it was to a recreational boat angler (R76) and the least to a commercial linefisher (R11).

4.3.2 Shore fishery

Calculations revealed a modest export of just less than 1000 galjoen adults from the TNP MPA annually (Table 6.11). The best estimate $SBPR\%SBPR_{F=0}$ for galjoen in exploited areas is 16 %, assuming the remainder of the estimated total annual catch of 8129 fish for the southern Cape was spawned by adult biomass within the TNP, the contribution is a further 6015 fish annually. Expanding the total monetary value of galjoen export to include all resident reef fish species in shore angler's catches based on the percentage contribution of galjoen (3.5 %), gives a total estimate of nearly R28 million from the TNP MPA to the recreational shore fishery annually.

Table 6.11. Estimates of linefish export from the Tsitsikamma National Park MPA to the recreational shore fishery along the garden route coast.

Parameter	Estimate
Galjoen density ($No.km^{-1}$)	242
Total population	19 367
Export (5% per year)	968
Value (R)	135 520
MPA spawner contribution (number per year)	6 015
Value (R)	842 056
Total galjoen value (Rper year)	977 576
All species contribution to shore fishery (Rper year)	27 930 741

4.3.3 Boat based recreational and commercial line fisheries

Export of adult red roman from the three MPAs was estimated at 8 857 fish, valued at R64 500 to the commercial linefishery and substantially more to the recreational boat fishery (R226 326) (Table 6.12). Including the likely contribution by spawner biomass within the MPAs with the exploited area SBPR%SBPRF=0 of 20 %, elevates the value to over R500 000. Given the relative contribution of red roman to the recreational reef fish catch (17%) and the commercial catch (5%) the total value contributed by the MPA's is over R5 million (Table 6.12).

The combined economic value of linefish exports from MPA's along the Garden Route coast to the recreational shore, recreational boat and commercial boat fisheries is estimated at R33 million per year.

Table 6.12. Estimates of linefish export from the Tsitsikamma National Park MPA(TNP), Robberg Nature Reserve MPA (RNR) and the Goukamma Nature Reserve MPA (GNR) to the boat based linefisheries along the garden route coast.

Parameter	TNP	RNR	GNR	Total
Roman density (No. m^{-2})	0.0254	0.0286	0.027	
Total population (number)	1344473	276952	150012	1 771 437
Export (0.5% per year)	6722	1385	750	8 857
Value comm. linefishers(R)	48952	10084	5462	64 498
Value rec. linefishers (R)	171775	35384	19166	226 326
Reserve spawner contribution	6323	1302	706	8 331
Value comm. linefishers(R)	46044	9485	5137	60 666
Value rec. linefishers (R)	161570	33282	18028	212 880
Total Roman value (R)	428342	88235	47793	564 371
All species value comm. (R)	1921323	395779	214375	2531 477
All species value rec. (R)	1986633	409232	221662	2617 527
TOTAL (R)	3907956	805011	436037	5149 004

Comm.. = commercial
Rec. = recreational

4.4 Discussion

Although the theoretical basis for the hypotheses that MPAs enhance fishery production under appropriate conditions is sound and simple models can demonstrate this, quantitative evidence from the field is rare (Crowder *et al.* 2000). This study attempted to put an economic value on an as of yet unproven or quantified export of fish from MPAs and as such the estimates should be treated with caution. Numerous crude assumptions and extrapolations were incorporated in estimating both adult emigration from reserves and the contribution of eggs, larvae and pre-recruits. All resident reef or surf zone fish in this study were considered the same as red roman or galjoen and extrapolations based on limited information regarding movement and density for these two species, when substantial life history and fishery differences are known. Furthermore, the value of all fish estimated to emigrate from the MPAs was presented, in reality only a small proportion of these fish are caught (a proportion will die by natural causes and a proportion will simply never be available to the fisheries due to settling within natural refuges) and consequently a lower economic value will be realized. Of particular concern is that the majority of the value attributed to MPAs was assumed to be derived from propagules spawned by adults within the MPAs. Although the theory supporting this assumption is sound with the stocks of nearly all resident reef species are known to be overexploited in open areas (Griffiths 2000); the very high fecundity of marine fishes, natural variability and poor knowledge of larvae survival and distribution and uncertainty surrounding stock-recruitment relationships, means that this will probably never be quantified for open marine systems.

Although crude, the estimates of economic value presented in the study are based on the best available information. The estimates of emigration from MPAs used were conservative and the contribution of spawning products, although unproven, is extremely probable. The total estimated annual contribution of R33 million from the three MPAs on the garden route coast to the linefisheries in the region is certainly inaccurate, but is probably within an order of magnitude of the real value. The true monetary value of fishery enhancements by MPAs could be best quantified by long-term monitoring of CPUE both within and in areas adjacent to, before and after, the proclamation of a new MPA.

5 OPTION AND EXISTENCE VALUE

5.1 Introduction

The non-use values of MPAs include their option and existence value. Option value is derived from the benefits that arise from the future use of MPAs and it expressed in terms of the willingness to pay to retain the option to have those benefits. This is easily demonstrated by the phenomenon of bio-prospecting, where companies invest considerable amounts on the off-chance that they may organisms that have medical or commercial use. Existence value can be described as the utility derived from people's knowledge of the existence of MPAs, and also their knowledge that others and future generations may benefit from their existence, even though they may never actively visit or utilise them themselves (Turpie 2003). Option and existence value are difficult to separate in reality. These intangible, non-market values have traditionally been difficult to quantify, however it is possible to elicit existence value by means of stated-preference survey methods (Turpie 2003). An example of this is the Contingent Valuation Method, which attempts to quantify people's willingness to pay (WTP) for a non-market good (Bengochea-Morancho *et al*. 2005). Contingent valuation is a controversial method, because it is potentially subject to numerous biases. However, these biases can be reduced through careful design, and guidelines have been developed in this regard (Arrow *et al.* 2003). This study aimed to estimate the non-use value of the Garden Route MPAs as a measure of the welfare that they generate at present, and also attempts to estimate how that welfare might change with a change in protection strategy.

5.2 Methods

The existence value of the three MPAs was determined using contingent valuation, a survey based method. This formed the main thrust of the general public survey.

5.2.1 Gauging respondents' level of knowledge and interest

Respondents were asked to describe their level of interest in nature, and were then asked to allocate the government's budget for nature conservation, as a percentage, to each listed biome, (bushveld/savanna, fynbos, coastal/marine, forest, rivers and wetlands, grasslands or karoo) based on the biome's importance to them.

For each of the three parks in question, respondents were asked whether or not they had heard of them. If so, it was recorded whether or not they had visited the park, and if they knew there was a MPA associated with it.

5.2.2 Contingent valuation

The valuation aspect involved probing to find out what MPAs meant to the respondent, and then quantifying their preferences for the degree of protection of the marine environment within the Garden Route coastal region, as described below. Preferences were then translated into monetary value by ascertaining respondents' willingness to pay to obtain or prevent different hypothetical scenarios.

Respondents were first asked to rate the importance to them of each of a list of different types of benefits provided by MPAs, on a scale of 0 to 10. The following statement about MPAs was then made to the respondent. It highlighted both the benefits and downfalls of allowing recreational shore angling within MPAs, and thereby attempted to minimize information bias.

> *"The Marine Protected Areas in South Africa together protect 6% of the coastline. This is not considered sufficient for adequate protection of threatened fish species and stocks (numbers). Some marine protected areas allow recreational shore angling, subsistence fishing and other uses. Although this may impact on resources in MPAs, recreational angling can also benefit the local economy by increased fishing-based tourism."*

The respondents were asked whether or not they thought recreational shore angling should be allowed in MPAs in general.

Respondents were then told:

> *"Given what you know about MPAs and also that there is limited funding available for their creation or maintenance, consider the following hypothetical scenarios along the Garden Route (Cape St Francis to Mossel Bay):"*

Using an accompanying figure, the following scenarios were described:

- **A. Status quo**: This represents our current scenario, in other words two MPAs, 10 and 5km shoreline length respectively, both allowing recreational shore angling. The third MPA, 80km of shoreline length, does not allow fishing of any kind. The regions in between the MPAs allow fishing. This scenario secures 60% of species and stocks.
- **B. No protection**: In this scenario there are no MPAs. In other words, fishing may occur along the entire Garden Route coastline. This is the minimum protection scenario where 20% of species and stocks are secured.
- **C: Max protection**: In this scenario, the 10 and 5km MPA shorelines are increased to 20 and 7km respectively. In addition to this, no fishing is allowed in any of the protected areas. In other words this represents a maximum protection scenario whereby 75% of species and stocks are secured.
- **D. Status quo + angling in Tsitsikamma**: This scenario is the same as our current scenario, except that in the MPA incorporating 80km of shoreline (TNP), recreational angling is now allowed along a 5km stretch of the shoreline. By doing this, 50% of stocks and species are secured.

Respondents were then asked to identify the scenarios they liked the most and the least.

In reference to the respondent's most preferred scenario, the following question was posed:

> *"Assuming implementation (or maintenance) of this scenario would require additional public funding, would you be willing to pay a once-off contribution to a fund to achieve this?"*

If the respondent's answer was positive, they were asked what the most was they would be willing to contribute (in Rands). If not, they were asked for a reason. The same sequence of questions was posed in reference to their least preferred scenario, except that in this case it was a once-off contribution to a fund to prevent this scenario. WTP values given in order to prevent scenario B, in other words in order to prevent MPAs from being de-proclaimed, were used to calculate the public's existence value of MPAs along the Garden Route. Similarly, the values given in order to ensure scenario C was implemented, reflected the public's WTP in order to increase the area and degree of protection of MPAs along the Garden Route.

5.2.3 Socio-economic data

South African respondents were asked to indicate their monthly household income bracket before tax (in Rands). Foreign respondents indicated their annual household income in US dollars. The age, sex and race of each respondent were noted by the enumerator. The country of origin, province and town of each respondent was also recorded.

5.2.4 Data Analysis

The raw survey data were entered into a single spreadsheet and screened for errors before further analysis. WTP outliers were excluded from analyses if the respondent's value given did not correlate to his/her income bracket. Conflicting responses, or WTP values given as "unsure", were also excluded from analyses.

Quantitative analysis was restricted to respondents from the Eastern and Western Cape. WTP data were log-transformed before statistical analyses. Data were subdivided according to income groups before a mean WTP for each group was obtained. This mean was extrapolated to the households of the Eastern and Western Cape. At the time of surveying, one US$ was equivalent to R7.11.

5.3 Results

5.3.1 Respondent characteristics

In total, 397 members of the public were surveyed. Of these, 381 surveys were fully completed and used in the analyses. South Africans made up 93% of the respondents (Figure 6.23) and 83% came from the Western and Eastern Cape. South African locals were defined as people whose home town was within a 100 km radius of where the interview took place. South African tourists were defined as people who lived outside this radius. Respondents represented a full range of income groups (Figure 6.24), but was not representative of the South African earning population in terms of race groups (Figure 6.25).

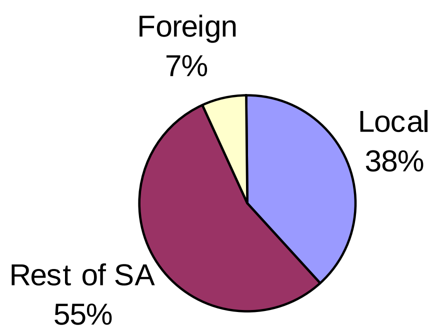

Figure 6.23. Percentage breakdown of origin of respondents.

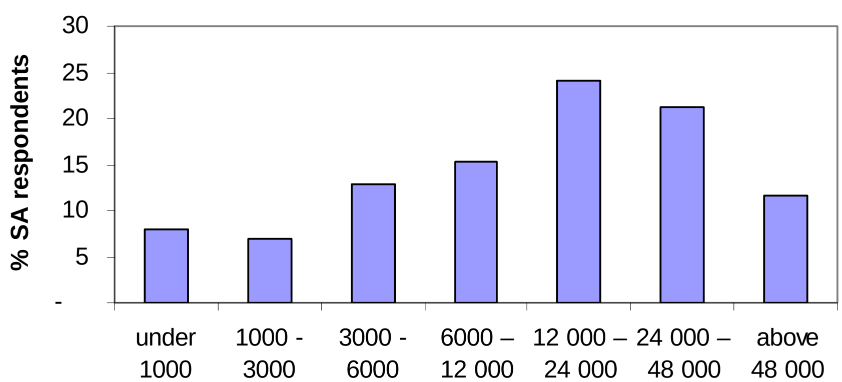

Figure 6.24. Monthly gross household income of the South African respondents.

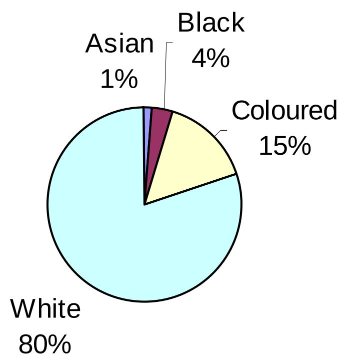

Figure 6.25. Race composition of South Africans in the general public survey (n = 354)

5.3.2 Interest in nature and conservation

The majority (71%) of respondents rated their interest in nature as very interested or passionate. On average the public allocated 23% of the government's conservation budget to the coastal/marine biome (Figure 6.26).

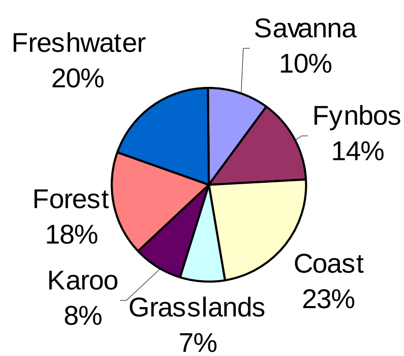

Figure 6.26. Average percentage distribution of government budget per biome (n = 381).

Respondents were generally fairly familiar with the three MPAs along the Garden Route, with at least a quarter of respondents knowing of the Goukamma MPA, and over half of respondents being familiar with the Tsitsikamma MPA (Table 6.13).

Table 6.13. Proportion of respondents in the general public survey that had heard of and been to the three protected areas, and that knew there was an MPA there.

	% that had heard of it	% that had visited	% that knew of the MPA
Tsitsikamma NP	94	57	57
Robberg NR	67	45	46
Goukamma NR	61	23	25

Nevertheless, respondents had difficulty distinguishing which were the more important functions of MPAs, scoring all of them highly. There was no significant difference between scores for the different functions (N = 162, Z = -1.333, NS).

5.3.3 Reaction to alternative protection scenarios

53% of respondents said they were against fishing in MPAs generally while 40% were in favour. Similarly, 54% of respondents chose the maximum protection scenario (with no consumptive use) as their most preferred scenario. Most of the remaining respondents were equally divided between scenarios A (the status quo) and D (the status quo plus angling in Tsitsikamma). Nevertheless, nearly all respondents (93%) picked scenario B (no protection) as their least preferred scenario (Figure 5).

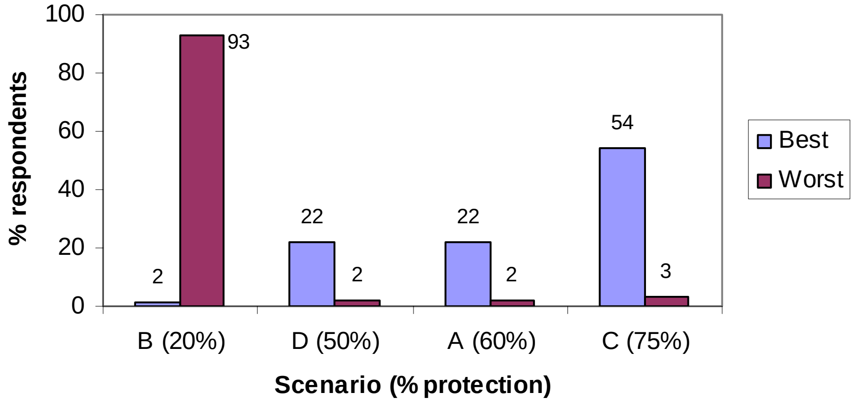

Figure 6.27. Percentage of respondents that chose each of the scenarios as their best and their worst scenario. Percentages provide rough indications of species/stock protected.

Respondents were asked to score each of the scenarios in terms of how much satisfaction it gave them. There was no significant difference in scores between the different race groups. The maximum protection scenario obtained the highest overall score.

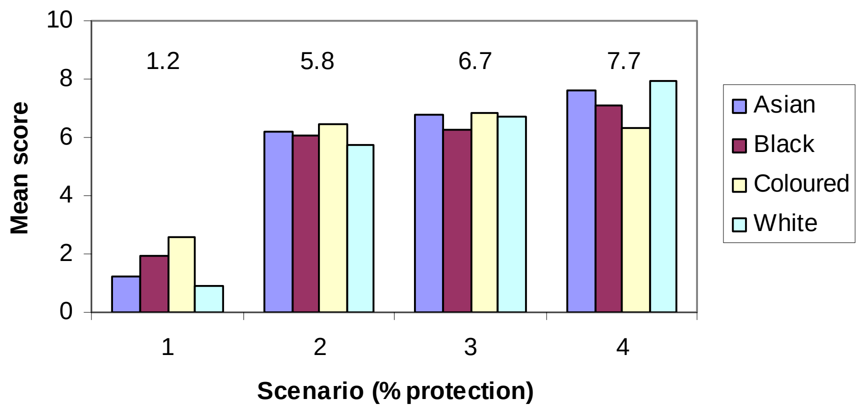

Figure 6.28. Average score for each of the scenarios by race group. Overall average score is given above.

5.3.4 Existence value of Garden Route MPAs

Respondents were asked what they would be willing to pay as a once-off payment to prevent the worst scenario from coming about. In 93% of cases, this meant paying to prevent the deproclamation of all the MPAs. The amount that people are willing to pay to prevent this happening represents the value of the MPAs under the current status quo. Because of the bias towards white respondents, the survey did not obtain enough data for Asian and Black respondents or for coloured respondents from non-coastal respondents. Black and Asian groups were too small to provide statistically reliable results. Thus willingness to pay data were extrapolated on the basis of income group. Extrapolated to income-earning households in the Eastern and Western Cape households, these preliminary results suggest that the existence value of these MPAs could be at least as high as R238 million (Table 6.14).

Table 6.14. Geometric mean willingness to pay to prevent Scenario B (no protection) and minimum estimate of total willingness to pay, extrapolated to Eastern Cape and Western Cape households earning over R3000p.m..

Monthly income category	EC + WC households	n	% WTP to prevent B	Ave WTP (R)	Total WTP (R millions)
under 1000	1 067 296	22	50	142	76.0
1000 - 3000	353 668	17	82	165	48.0
3000 - 6000	281 270	37	65	205	37.4
6000 – 12 000	206 223	38	61	205	25.6
12 000 – 24 000	112 831	68	71	364	29.0
24 000 – 48 000	34 792	50	66	492	11.3
above 48 000	20 450	25	52	995	10.6
TOTAL					**237.8**

Based on the above, and the mean utility scores for each scenario it was possible to estimate the change in value that would result under each of the different scenarios. Under no protection, there would be a loss in value amounting to some R196 million. If fishing was allowed in Tsitsikamma, the net loss of non-use value could be expected to be in the order of R31 million. However, under maximum protection, the net benefit to society could worth as much as R34 million. Note again, however, that these are preliminary estimates, based on small sample sizes.

Table 6.15. Conservative estimates of the value of alternative scenarios, based on the estimate for the status quo and the mean utility of the alternative scenarios.

Scenario	B (20%) No protection	D (50%) Status quo + allow fishing in Tsitsikamma	A (60%) Status quo	C (75%) Maximum protection
Estimated value (R millions)	41.4	206.6	237.8	272.0
Change in value (R millions)	-196.4	-31.2	0.0	34.2

Extrapolating the willingness to pay of the proportion of respondents who favoured scenario C (maximum protection) suggests that the benefits of developing this scenario could be even higher than suggested above, in the order of R99 million. This would be expected to be higher than the above estimate because it does not account for the cost to people that are against this scenario. Nevertheless, the fact that these two estimates are in the same order of magnitude strengthens confidence in the above estimates.

5.4 Discussion

This study suggests that the existence value of MPAs along the Garden Route could be in the order of R238 million. Based on this estimate and the overall response to alternative protection scenarios, it is clear that stepping up the level of protection will increase the overall non-use benefits to society, whereas relaxing the level of protection will lead to a net loss of value. These are estimates of net change. Of course there will be members of society that derive benefits from lower levels of protection and vice versa, and these are taken into account in the above conclusion.

The strongest result of this study is the directional change n value with changing levels of protection. The estimate of the actual current value and the changes in value are still preliminary, in that they are based on a small sample size, and we have only been able to extrapolate to the populations of the Western and Eastern Cape provinces. The estimates could be improved with a larger sample size and broader geographical coverage.

Another factor to bear in mind in interpretation of the actual values is that contingent valuation studies are subject to a number of biases. Attempts were made to minimise these biases as far as possible in the sample design. Information bias may have resulted in an exaggerated WTP, as respondents were not given a balanced representation of the benefits and costs of MPAs in the questionnaire text. This was also the case for the scenario options. Respondents were highly influenced by the levels of stock/species protection given for each scenario. However, as no corresponding costs for the scenarios were shown, this would have constituted information bias. Evidence of this is shown by the number of respondents (39%) who, although in favour of recreational shore-angling in MPAs in general, went on to select the highest protection scenario as their most preferred once the levels of protection were presented to them. Respondents may have overstated their willingness to pay as a result of embedding bias, through having this issue brought to the forefront of their minds without paying sufficient attention to their other budgetary priorities, and through "yea-saying" bias, which arises when respondents feel the need to please the interviewer. The open ended format of the willingness to pay questions may also have made the survey more prone to strategic bias, where respondents overstate their willingness to pay in order to try and influence an outcome. Very high amounts in relation to income category were removed from the database to avoid this effect. On the other hand, average willingness to pay would have also been reduced by protest responses (Meyerhoff and Liebe 2006), where people expressed a zero willingness to pay, for example because they believed their tax contribution should include conservation payments. Issues with the format and content of the questionnaire such as the payment vehicle, may have resulted in inaccurate WTP answers.

Willingness to pay to prevent the loss of MPAs was found to be positively correlated with both income and the stated level of interest in nature. It is important to realise that income affects peoples' ability to pay, whereas interest in nature is often positively correlated with income because it is a luxury pursuit. Nevertheless, it is worth noting that increasing public interest through awareness raising might also increase the non-use benefits of biodiversity protection.

While this study has explicitly investigated existence value, it is in fact difficult in practise to separate existence from option value. People's expressed willingness to pay no doubt contains some degree of option value in that they may to some extent want to retain the option of visiting these areas in future. However, option value also includes the potential benefits from activities such as bio-prospecting.

In conclusion, the South African public places a high existence value on MPAs along the Garden route coastline, and this value increases with increased protection. This reflects the importance that the public places on MPAs, particularly if they are aware of their protective role for marine biodiversity and ecosystem function.

6 MANAGEMENT AND OPPORTUNITY COSTS

6.1 Introduction

Costs associated with a particular MPA can be considered equivalent to the costs of managing the area plus any opportunity costs associated with excluding fishing activity in that area. Management costs can be easily calculated but opportunity cost is more complex and requires some explanation. Thus this task involved developing a conceptual model of opportunity cost for MPAs, before going on to estimate what these costs might be. The way the model is applied to the different MPAs and the assumptions involved is described in the methods section. It must be noted that since this type of thinking is relatively novel, this data relies more on logic than on hard data, and was entirely a desktop exercise.

6.2 Methods and assumptions

6.2.1 Management costs

Management costs were obtained from the managers of Goukamma NR, Robberg NR and Tsitsikamma NP, and were calculated in terms of costs per km^2. Tsitsikamma was the only MPA for which costs were budgeted separately from terrestrial protected area. Costs of expanding these MPAs (where costs were increased in proportion with the change in size) as well as creation of a new MPA were calculated on the basis of unit area costs. Any additional costs incurred by a change in management status (e.g. from partial take to no-take) were not calculated and for the purposes of this study assumed to be zero.

6.2.2 Opportunity costs

6.2.2.1 Defining the opportunity costs of MPAs

Opportunity cost is generally defined as the cost of something in terms of an opportunity forgone (or the net benefit that could be derived from that opportunity), or the most valuable forgone alternative. In the case of a no-take MPA, one might consider the opportunity costs of its proclamation as being equivalent to the loss in revenue derived from fishing activities that would otherwise have taken place in that area. This is not strictly correct, though, as in most cases proclamation of an MPA does not result in the cessation of all fishing activity from that area, but rather a displacement of this fishing effort to an alternative (most likely) adjacent area.

This, in all likelihood, would result in an initial reduction in catch-per-unit-effort (CPUE) in the area(s) adjacent to a newly proclaimed MPA due to increased fishing effort (and hence increased competition for a limited pool of resources), and potentially increased costs associated with longer travelling distances (assuming fishers base themselves in close proximity to the resources they target or fish resources close to where they reside). Such a reduction in CPUE would definitely result in a reduction in revenue or benefits from a commercial or subsistence fishery (due to a reduction in catches and possible increase in costs) where a close relationship between CPUE and revenue is evident. However, this is not necessarily the case with a recreational fishery, where effort and catch are often decoupled (i.e. fishing effort is not necessarily related to or affected by changes in catch rate; Crowder *et al.* 2000, Attwood 2002). Even in the case of a commercial or subsistence fishery, any potential loss in revenue experienced by a fishery in an area incorporating an MPA is likely to be offset, and even overtaken, by benefits derived from the export of adult fish and progeny from the MPA in the medium to long term. This is true for both the net and cumulative benefits derived from the fishery. Effects of MPA establishment on fishing effort and CPUE are summarised in Figure 6.1.

Opportunity costs associated with an existing MPA (as opposed to proclamation of a new one) can be considered as being the net benefit of the next best alternative to having the MPA – that being the sum of the benefits of allowing fishing in that area. Benefits of this may be high (especially in the case of an MPA that has been in existence for some time) but are likely to be short lived. All types of fishing effort in the MPA are likely to escalate rapidly after it is initially opened owing to the promise of high catches (high CPUE), but CPUE in the MPA is likely to decline rapidly to levels corresponding to those in the adjacent areas in a very short space of time. Both net and cumulative benefits accruing to the fishery will become negative in the medium to longer term (Figure 6.2).

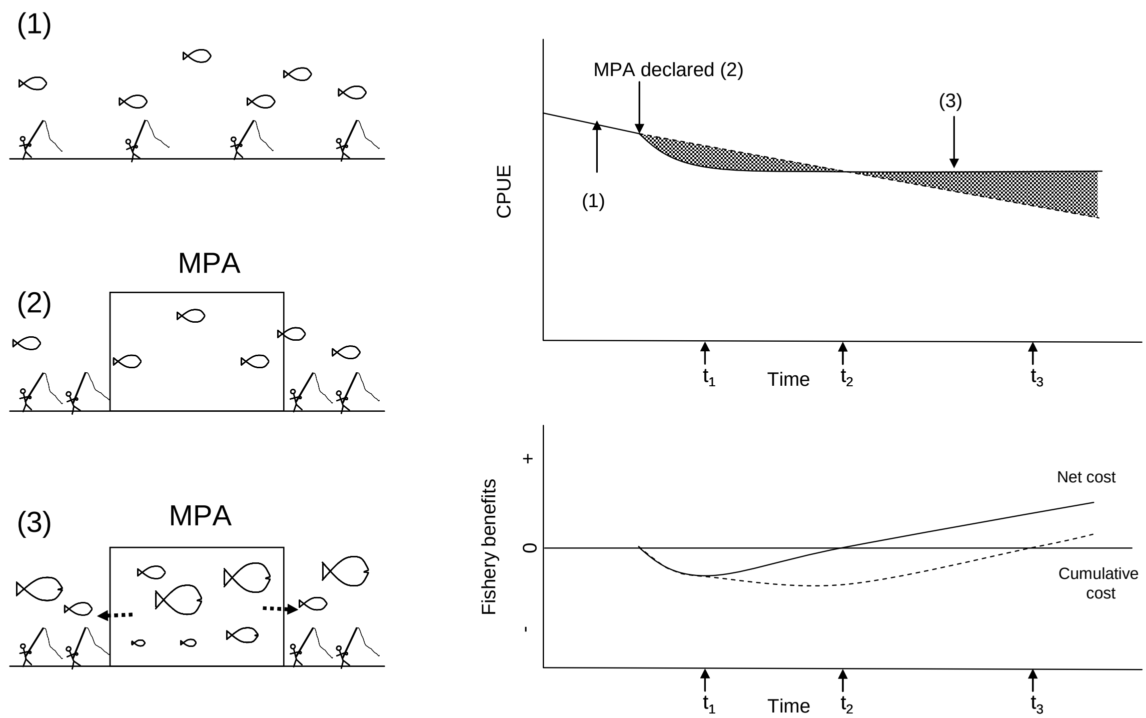

Figure 6.1. Effects of MPA establishment on fishing effort, CPUE (top right, currently assumed to be in a state of decline) and net and cumulative opportunity cost (bottom right). Solid lines on the top graph indicate actual CPUE (which declines initially after the MPA is declared but later stabilises due to export of fish from the MPA) and dashed lines hypothetical CPUE (existing trend extrapolated). Solid lines on the bottom graph indicate net cost to the fishery while dotted lines indicate cumulative costs. Cumulative cost of declaring the MPA in terms of CPUE (right) is the sum of the stippled area minus the shaded area. At time t_1 net cost of MPA proclamation is a maximum, but declines to zero by time t_2 and then becomes positive (i.e. a benefit), while cumulative cost peak at time t_2, remains negative until time t_3 at which time they als0 become positive. Figures on the left are graphical representations of the situation at times 1, 2 and 3.

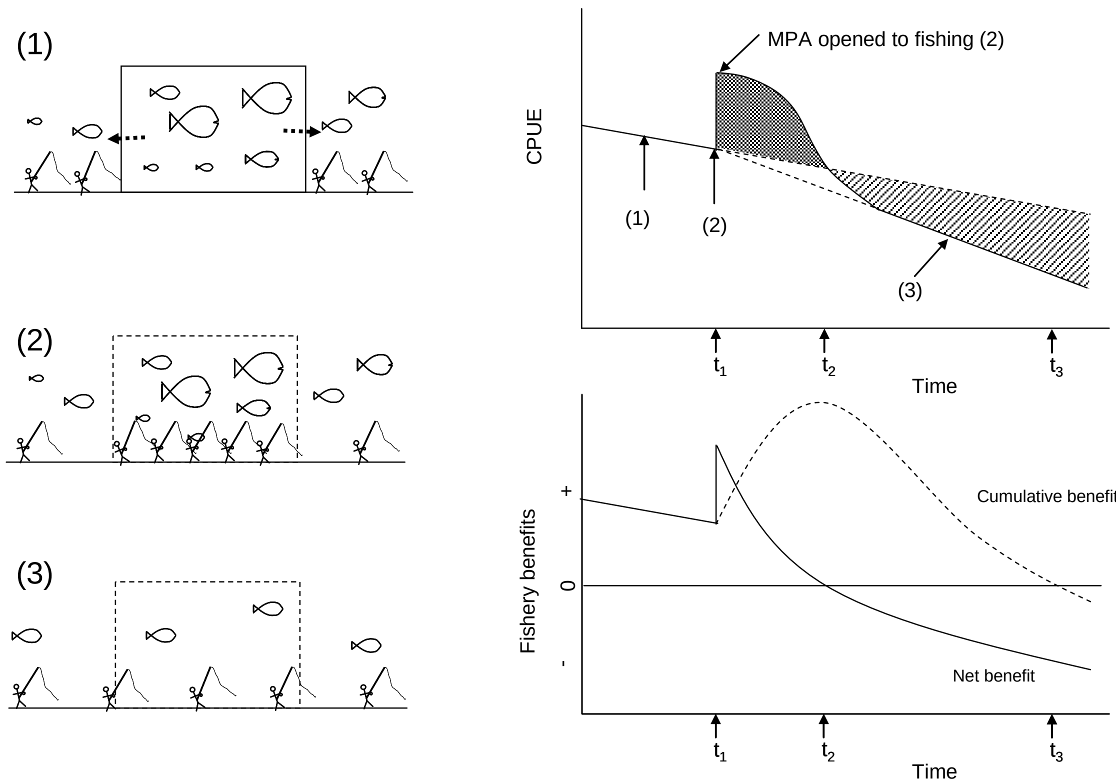

Figure 6.2. Effects of de-proclaiming an MPA on fishing effort, CPUE (top right, currently in a state of decline) and opportunity cost to commercial and subsistence fishing (bottom right). In the top graph solid lines indicate actual CPUE and dashed lines hypothetical CPUE (e.g. while the MPS is closed) while on the bottom graph solid lines show net fishery benefits and dashed lines cumulative benefit. Net opportunity cost is at a maximum at time t_1 immediately after the MPA is opened to fishing, but declines rapidly after this as the surplus fish stock held in the MPA is mined, reaching zero at time t_2 where CPUE reaches the projected level had the MPA not been de-proclaimed. Cumulative CPUE peaks at time t_2 and only declines to zero at time t_3 when the benefits of being allowed to fish in the MPA (the stippled area) are eroded away as exports from the MPA are no longer available to support catches in surrounding areas (the hatched area).

In summary therefore, the net opportunity costs of proclaiming a new or maintaining an existing no-take MPA are positive (i.e. a cost) in the short term, but decline to zero at some point (i.e. no net benefit), and become increasingly negative thereafter. Cumulative opportunity costs follow a similar trajectory also becoming negative in the medium to long term. What is required now is to calculate the relative magnitude of these benefit and costs of changing the protection status and/or size of the three MPAs considered in this study (Tsitsikamma, Goukamma and Robberg) and the time scales over which they will accrue. Note that opportunity costs applying to the three MPAs considered in this study will vary owing to the fact that only the Tsitsikamma MPA has been declared a no-take area, with shore angling being permissible in Goukamma (other forms of fishing including boat based fishing and bait collecting have been banned), and both shore- and boat based being permissible in Robberg MPA (only harvesting of invertebrates having been banned at present). It is assumed that for the purposes of this study that management costs do not vary with protection status. This may no be strictly true as managers have indicated that it is generally easier (and hence cheaper) to maintain a complete ban on fishing effort in a particular area rather than a partial ban (e.g. no bait collecting) which requires managers to monitor carefully the activities of all fishers in a particular area. The extra costs of this are probably marginal through and will not significantly affect overall costs.

6.2.2.2 Opportunity costs of an existing MPA

A simple spreadsheet model was set up to estimate the magnitude of the fishery benefits that might be realised by opening up a hypothetical existing MPA to fishing and also the time period over which these benefits might accrue. This model examined benefits accruing to both commercial and recreational linefishers as well as recreational shore anglers. Rather than attempting to simulate all benefits accruing from all species targeted by these fisheries (a difficult if not impossible task considering the paucity of data for many of the species targeted by the respective fisheries), the red roman *Chrysoblephus laticeps* was chosen to simulate benefits accruing to the commercial and recreational boat-based linefisheries while the galjoen *Dichistius capensis* was chosen to simulate benefits accruing to the shore angling fishery. The model was based on the Tsitsikamma National Park MPA for which the most detailed information was available, and was based on modelling the impact of opening a single kilometre of coastline. A number of additional parameters had to be estimated or calculated for this model:

1. **Population size of red roman** *Chrysoblephus laticeps* in the Tsitsikamma MPA. This was based on work by Buxton & Smale (1989) which included density estimates of roman in the MPA derived from underwater visual surveys. Mean estimate from the counts was 0.25 roman m^{-2}, which, when multiplied by the total reef area in the MPA (401 km^2) (estimated from Buxton & Smale 1989), yielded a total population of 3 055 620 individuals.
1. **Population size of galjoen** *Dichistius capensis* in the Tsitsikamma MPA. Galjoen are typically confined to surf zone areas and as such cannot effectively be surveyed using underwater counts. Shore angler CPUE data for galjoen are available for the Tsitsikamma MPA as well as for a number of other localities where populations estimates have also been derived from mark recapture surveys. Attwood (2003) provides such estimates for two sites in the De Hoop MPA, Koppie Allen (CPUE = 1.19 fish.angler-hour-1, fish abundance = 1 829 fish.km-1 of shoreline) and Lekkerwater (CPUE = 1.49 fish.angler-hour-1, fish abundance = 4 924 fish.km-1 of shoreline). Using CPUE data for galjoen for Tsitsikamma MPA (0.12 fish.angler-hour-1, from Cowley 2005), and CPUE and abundance data from De Hoop it is possible to derive an estimate of galjoen abundance in Tsitsikamma MPA, which equates to 605 fish.km-1 of shoreline.
2. **Abundance of red roman in exploited areas**. Buxton & Smale (1989) provide data on the abundance of roman from a site near Port Elizabeth (Noordhoek) from underwater visual surveys. There estimate of roman abundance in this area was 0.0064 individuals.m-2. Using the same proportion of reef cover per unit of shoreline as for Tsitsikamma we can derive an estimate of roman abundance from this area, which equates to 4736 individuals.m-1 of shoreline.
3. **Abundance of galjoen in exploited areas**. In a similar manner to that used for deriving galjoen abundance estimates for the Tsitsikamma MPA, a mean abundance estimate for galjoen outside of the Tsitsikamma MPA was derived from mean shore angler CPUE for galjoen at three exploited sites (Plettenberg Bay, Port Elizabeth and ‘southern Cape” – unpublished data from Colin Attwood, MCM), and CPUE and abundance estimates for De Hoop MPA. Mean abundance for exploited areas outside of the Tsitsikamma MPA was estimated at 50 individuals.km-1 of shoreline.
4. **CPUE** for red roman for the commercial, and roman and galjoen for recreational linefishers. CPUE for roman (as for any other species) will vary with abundance as well as other factors. Focussing only on the abundance issue, we derived a relationship between CPUE and abundance from experimental handline fishing undertaken in and adjacent to the Goukamma MPA by Götz (2005), Buxton and Smale (1989), and Brouwer (1997). The relationship between roman abundance (no. fish.km-1 of shoreline) was best described by the equations: $y = 0.0061x + 6E-15$. Recreational boat anglers and shore anglers are bound by bag limits of only two red roman and two galjoen per person per day, a condition that does not apply to commercial linefishermen. As such it was easier to use this as a rule in defining daily catch per person, rather than trying to derive a relationship between abundance and CPUE for these fishers.
5. The **economic gain** per fish caught. Economic gain from recreational fishing was measured in terms of expenditure on fishing. Dividing total expenditure per annum by the average shore anglers by the total annual catch yielded an estimate of R140.50 per fish for a recreational shore angler and R75.59 per fish for a recreational boat angler (McGrath *et al.* 1997, Brouwer

1997). In the case of commercial fishers, economic value was estimated in terms of gross income, as R10.75 per fish on average (McGrath *et al.* 1997, Brouwer 1997). Considering that CPUE in the MPA will far exceed that for an exploited area (for which these values were calculated), we can confidently say that these values are maximal estimates. We assume that the total expenditure and revenues approximate the direct plus indirect value added to the economy (i.e. there is minimal leakage).

Two simulations were run for each of the two species modelled. In the first, fishing effort was limited to only 10 commercial line fishers and 10 creational boat anglers per day (the roman fishery) and 10 shore anglers per day (the galjoen fishery), while in the second fishing effort was increased to 20 commercial line fishers and 20 recreational boat anglers per day (the roman fishery) and 20 shore anglers per day (the galjoen fishery).

6.2.2.3 Estimation of opportunity costs of expanding the MPA system

A spreadsheet model was set up to estimate the change in commercial linefishery value over time following the proclamation of an MPA. We modelled the impact of proclaiming 20% of a hypothetical section of the Garden Route coast as an MPA. A starting value of the commercial linefish landings from this section of coastline were taken as R 27 986/km/year (calculated from Brouwer 1997). A number of parameters had to be estimated or calculated for the model:

1. **CPUE for the commercial linefishery** was taken from Brouwer (1997) who estimated mean CPUE for the area from Kei River to Stilbaai to be 1 399.3 kg/km/year. Appling an average sale price of R10.70/kg for linefish to this value provides an estimated gross income of R27 986/km/year for this fishery.
2. Estimated **rate of decline in CPUE** without an MPA was taken from Bennett (1991) who provided data on shore angling catches for False Bay in the period 1938-1985 when there were very few MPAs in existence in the country. This is considered to be a reasonable approximation of the rate of decline in catches for the linefishery in the Garden route area as there is a large overlap between principal species targeted by these two fisheries (yellowtail, geelbek, red stumpnose, roman, kob, etc.). Similarly detailed data are not available for the boat based linefishery in the study area but work by Attwood & Farquhar (1999) and Griffiths (2000) indicate that trends are likely to be similar. Trend in CPUE over time were estimated using the equation $y = -3.68x + 265$, with CPUE declining at a rate of approximately 1.4% per annum.
3. Increase in fishing effort and hence the increase in the rate of decline of CPUE (and fishery benefits) in the area adjacent to a newly proclaimed MPA due to **displacement of fishing activity from the MPA**. The internationally accepted target of including 20% of coastal habitats within MPAs has been endorsed by the agency responsible for fisheries management in South Africa (Marine and Coastal Management, MCM). If this were to become a reality and we were to assume there was no net decrease in fishing effort this would result in a 25% increase in fishing effort on the remaining sections of coastline. Applying the same logic would yield a 25% increase in the current rate of decline of CPUE (and fishery benefits) in these areas.
4. **Recovery rates of fish stocks** within a newly-declared MPA were estimated from Attwood (2002). Attwood (2002) used a spatially structured, individual based model to study effects of MPA establishment on galjoen *Dichistius capensis* throughout its home range which extends from Port Shepstone to Lamberts Bay. Galjoen is an important shore angling species but is not readily caught by commercial linefishers. However, this is the only species in South Africa for which detailed estimates of recovery within an MPA are available. Attwood (2002) found that recovery of galjoen populations within an MPA depended primarily on the state of the stock at the time at which the MPA was proclaimed, the size of the MPA, the length of time over which protection was applied, and the larval dispersal rate applied for the species. The estimated recovery estimates after a period of 10 years for six MPAs between Port Elizabeth and Cape Town. These estimates range between 3.1 (a lightly exploited area) and 168.3% (a heavily exploited area), with an average of 38.5%. Populations within MPAs in existence for longer than 10 years typically did not show much recovery beyond this point. We used a value of 40% as an estimate of stock recovery in MPAs for our simulations but tested sensitivity of the model using values of 20 and 60% as well. If we consider angler CPUE in

and outside MPAs as a measure of fish abundance in these areas it rapidly becomes clear that estimates used in this study are highly conservative. For example, Cowley *et al*.(2005) reports results of experimental angling in the Tsitsikamma MPA (conducted for research purposes – total 13 188 angler hours) as being in the order of 0.99 fish per angler hour compared with estimates from Brouwer (1997) for the whole southern Cape region of 0.39 fish/angler-hour – i.e. catches in the MPA are in the order of 250% higher. Note that experimental angling in the MPA is conducted by a small team of highly skilled anglers and is likely to be somewhat inflated relative to estimates from Brouwer (1997) who surveyed members of the public with varying levels of skill. Experimental line fishing conducted by Götz (2005) shows a similar picture for the Goukamma MPA.

5. **Contribution to fishery production** due to exports from MPAs. Few attempts have been made to quantify export of fishery products from an MPA due to the difficulties involved with this (see Chapter 4). Work by Attwood and Bennett (1994) and others (e.g. Gowan & Fausch 1996, Beentjies & Francis 1999, Attwood 2002) has shown that fish display a range of movement patterns from those that are highly resident with home ranges of only a few hundred meters or less in extent to those that are nomadic and display no site fidelity at all to those that are highly migratory and display some site fidelity (e.g. for a spawning area) but spend only a small portion of their lives at such a site. Most MPAs, owing to their small size are only likely to contribute significantly towards stock maintenance for those species that are resident in a relatively small area (<10 km) for significant portions of their life cycles, and hence are the only ones that warrant consideration here. Many of the fish species targeted by the South African linefishery occupy small (e.g. galjoen, blacktail, baardman, red roman, dageraad, bronze bream) or modest home ranges (e.g. dusky kob) (Mann 2000, Attwood pers. comm.), and hence can potentially benefit from MPAs. If the home range of an individual fish overlaps with the boundary of an MPA it then becomes available to the fishery in the adjacent area and hence can be considered an export product of that MPA. As density within the MPA builds up after proclamation this is likely to happen with increasing frequency. In addition to this many highly resident species (such as the galjoen) also display polymorphic dispersal patterns, where most of the population is highly resident but a small proportion undergo long distance movements at some time in their lives. This has important evolutionary advantages and is probably more common than is currently evident (Attwood 2002). As no quantitative estimates are available on fishery exports described above, and we know this is likely to vary dramatically with MPA size, we elected to use a conservative amount of 1% of the stock in the MPA per annum per year, for our export production. Sensitivity of the model to variations in this parameter were tested by varying this figure from 0.5% up to 2% per annum.

6.3 Results

6.3.1 MPA management costs

Management costs for Tsitsikamma MPA were R3 264 420 (calculated from data supplied by Tsitsikamma National Park management), an order of magnitude more than Goukamma and Robberg. Management costs per unit area were remarkably similar for the three MPAs, ranging from R7500 to just over R10 000 per km^2 (Table 6.1).

Table 6.1. Current annual running cost of the three MPAs in the Garden route

MPA Scenarios	MPA area Km^2	Management costs R/y	Management costs R/km^2	Management costs R/km
Goukamma Nature Reserve	40	300 000*	7 500	27 273
Robberg Nature Reserve	20.4	200 000*	9 800	11 111
Tsitsikamma National Park	318	3 264 420	10 265	54 407

*Approximate

Management costs per unit area did not decrease with increasing reserve area as might be expected due to economies of scale. It is also interesting to note that the MPAs in which fishing is allowed do not have higher management costs than Tsitsikamma. Thus the costs of extending the existing MPAs in the Garden Route area were estimated simply as a proportional increase in the current costs. For example, increasing Goukamma from its existing 40 km^2 to 149 km^2 by extending the boundary both out to sea and westwards as indicated in Figure 6.2, we estimate total running costs will increase by some R270 000.

6.3.2 Opportunity costs of existing MPAs

It was necessary to run the model in time steps of days (rather than yearly time steps used for the previous model) due to the rapid rate at which fish stocks in the MPA were depleted. In the case of the roman fishery (Figure 6.3) the population in the MPA crashed within 33 days with an applied effort level of 10 commercial line fishers and 10 recreation boat anglers fishing per day, and in only 9 days under an applied effort level of 20 commercial line fishers and 20 recreational boat anglers fishing per day. It is likely that other species in the MPA targeted by commercial linefishers and recreational boat anglers will follow the same path as the roman, with the less desirable or sought after species taking only marginally longer than this before their abundance levels decline to levels corresponding to those outside the MPA. Maximum economic benefit accrued from the roman caught in the MPA up until abundance declines to the level corresponding to those outside the MPA is the revenue of commercial line fishers in catching their share of the roman (R352 000) and the expenditure by recreational boat anglers in catching their share (R48 000). Net economic benefit from the roman caught from the MPA is thus R400 000. Given that red roman probably make up no more than 10% of the total biomass of species likely to be exploited by commercial linefishers and recreational boat anglers in the MPA, then the economic benefit that would accrue from opening up 1 km of an MPA to fishing would probably be in the region of R4 million.

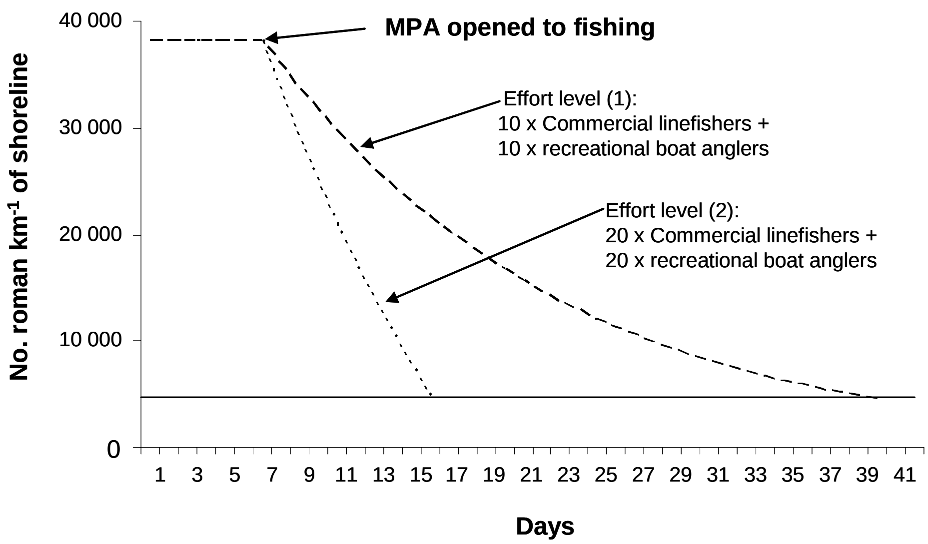

Figure 6.3. Simulated change in population size of red roman within a 1 km stretch of coastline in the Tsitsikamma MPA after opening it to fishing under different levels of fishing effort. Under Effort Level 1 (the dashed line) fishing effort was limited to 10 commercial line fishers (CPUE linked to abundance) and 10 recreational boat anglers per day (bag limit of 2 fish per person per day) and under Effort Level 2, fishing effort was limited to 20 commercial line fishers and 20 recreational boat anglers per day (similar conditions as for effort level 1). The solid line at the bottom of the graph corresponds with estimated abundance of red roman outside the MPA (4 736 $roman.km^{-1}$ of shoreline).

In the case of the galjoen fishery (Figure 6.4) the population in the MPA crashed within 28 days with an applied effort level of 10 recreation shore anglers fishing per day, and in only 14 days under an applied effort level of 20 recreational shore anglers fishing per day. It is likely that other species targeted in the recreational fishery will follow the same path, with the less sought after species taking only marginally longer to decline to similar levels to those outside the MPA. Maximum economic benefit accrued from the galjoen caught in the MPA up until abundance declines to the level corresponding to those outside the MPA can be estimated as the amount of money potentially invested by recreational shore anglers in catching the surplus amount of galjoen in the MPA. Net economic benefit from the galjoen caught in the MPA is thus R 78 680. Given that galjoen probably make up no more than 10% of the total biomass of fish likely to be exploited by recreational shore anglers in the MPA, then the net economic benefit that would accrue from opening up 1 km of the MPA to fishing would be in the region of R800 000.

It should be noted that the effort levels assumed in this analysis are probably conservative, given the potential response of both commercial and recreational fishers to opening up an MPA after more than 40 years of protection. As such, time taken to reduce the fish populations to similar levels as in adjacent exploited areas can only be considered conservative!

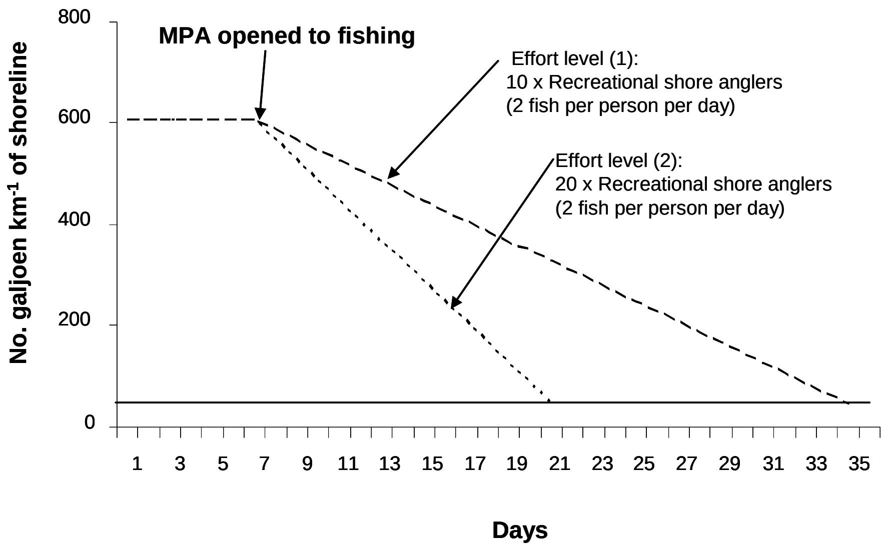

Figure 6.4. Simulated change in population size of galjoen within a 1 km stretch of coastline in the Tsitsikamma MPA after opening it to fishing under different levels of fishing effort. Under Effort Level 1 (the dashed line) fishing effort was limited to 10 recreational shore anglers per day (bag limit of 2 fish per person per day) and under Effort Level 2, fishing effort was limited to 20 recreational shore anglers per day (similar conditions as for effort level 1). The solid line at the bottom of the graph corresponds with estimated abundance of galjoen outside the MPA (50 galjoen.km^{-1} of shoreline).

6.3.3 Opportunity costs of a expanding the MPA system

Model estimations of impacts of MPA proclamation on net and cumulative costs to a simulated linefishery under varying stock recovery scenarios in the MPA (20-60% after 10 years), and various estimates of stock export from the MPA (0.5-2%) are depicted in Figure 6.5 and Figure 6.6. Total net costs and time elapsed before net cost to the fishery is zero for the each simulation is provided in Table 6.2.

It is clear from all of these simulations that the opportunity costs of MPA proclamation are relatively short-lived, with net fishery losses declining to zero within 8-18 years of proclamation (Figure 6.5). The benefits derived thereafter balance these losses within 9-32 years (Figure 6.6)[1].

[1] Note that this assumes a constant rate of time preference. If discounting was applied the breakeven point would be later.

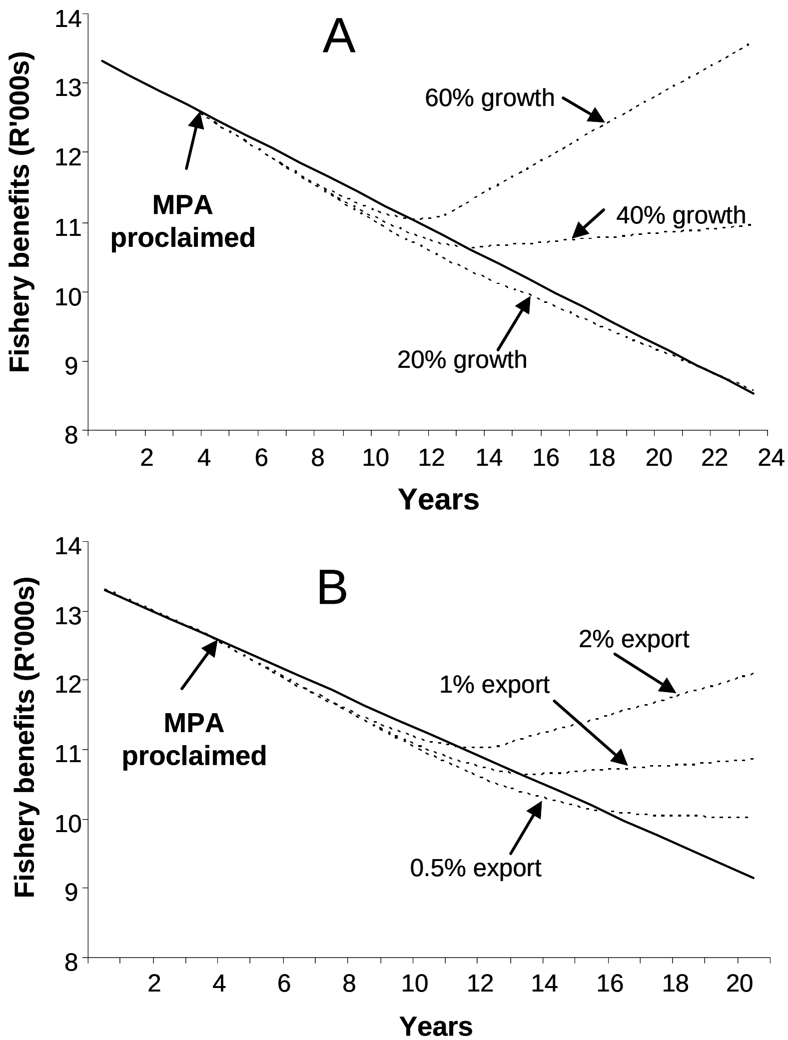

Figure 6.5. Projected change in net benefits accruing from the linefishery on a hypothetical stretch of coastline on the Garden Route prior to and after proclamation of an MPA in an adjacent area. The solid line indicates the trajectory of net benefits derived from the fishery prior to declaration of the MPA and hypothetical benefits that would have been derived from the fishery without an MPA (year 4 onwards). The dashed lines indicates the benefits accruing to the fishery after proclamation of the MPA under varying stock recovery scenarios in the MPA, wth a constant export rate of 1% (A), and for various estimates of stock export from the MPA, assuming a recovery rate of 40% in the MPA (B).

Total net costs to the fishery up until the point where catches in the area adjacent to the MPA match those where no MPA was declared ranged from a minimum of R5 439/km up to a maximum of R68 802/km. Where recovery of the stock in the MPA was set at 40% above that of exploited areas (considered to be a realistic but conservative estimate) net costs to the fishery of declaring the MPA declined to zero within a little over 9 years after proclamation, and subsequent benefits balancing the losses a little over 12 years after proclamation. Total net cost to the fishery in this case was R10 553/km. In the case where recovery of the stock in the MPA after 10 years was set at only 20% above that at the time of proclamation, a long period of time (18 years) was required before yield from the MPA was able to bolster catches in the adjacent area to the extent that they matched those before proclamation (i.e. net cumulative cost = zero). Similarly time taken for cumulative costs to decline to zero under this scenario was also very long (32 years). Total net cost to the fishery in this case was the highest of all the simulated values (R68 802/km). This is considered an extremely unlikely scenario and only arises due to the fact that the starting catch rates used in this study are averaged over a very large area. In order for the recovery in the MPA to be so low, fish habitat within the MPA would have to be extremely poor and as such would never have been able to support such high catch rates in the first place (i.e. would historically have been an extremely poor fishing area and a very poor site for placement of an MPA). When higher levels of recovery were used (60% increase above that at the time of proclamation after 10 years) net costs declined to zero in a little under 8 years, with cumulative opportunity costs having declined to zero by year 9. Total net cost to the fishery in this case was low (R5 114/km).

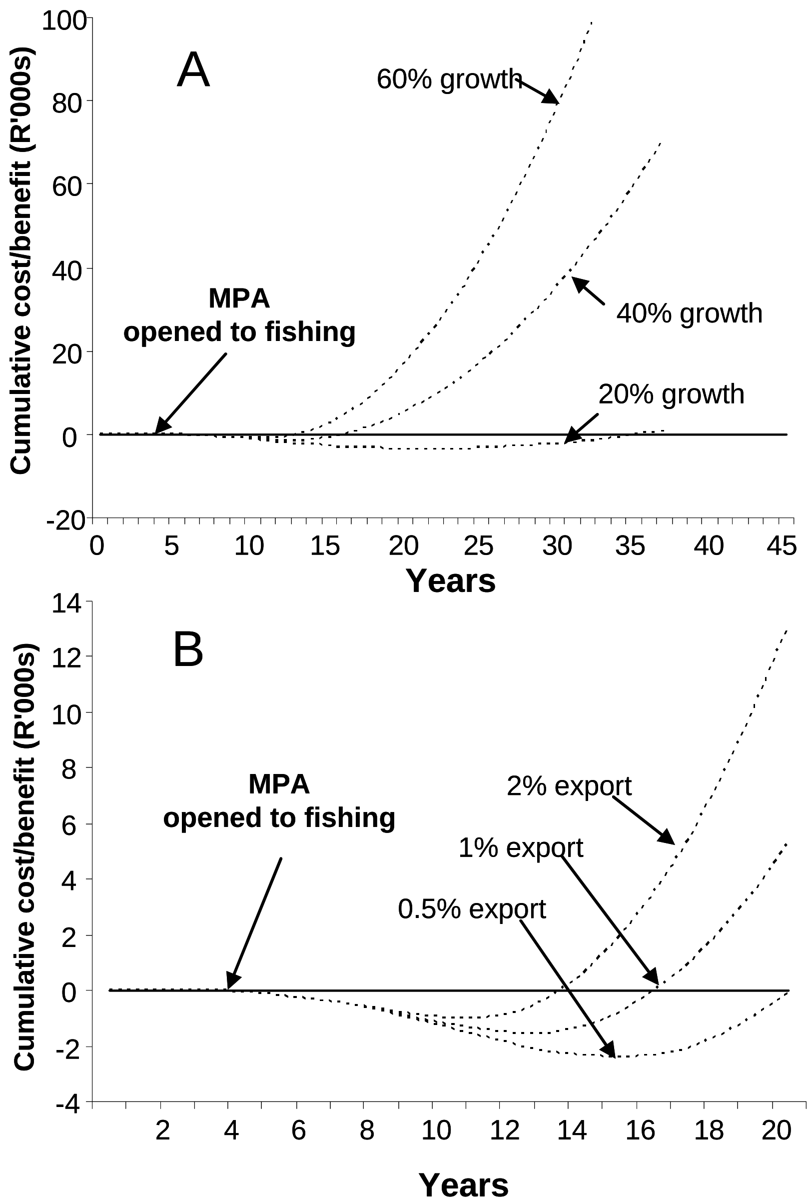

Figure 6.6. Projected change in cumulative cost/benefit accruing from a linefishery on a hypothetical stretch of coastline on the Garden Route, South Africa prior to and after proclamation of an MPA. Dashed lines indicate the benefits accruing to the fishery after proclamation of the MPA under varying stock recovery scenarios (A), and various estimates of stock export from the MPA (B).

Model sensitivity to the amount of fish exported from the MPA was fairly marked, with time elapsed before net costs of MPA proclamation declined to zero ranging from 7.5 years (export level set at 2%) to 12 years (export level set at 0.5%). Similarly time taken for cumulative costs of MPA proclamation to decline to zero with export levels from the MPA set at between 2 and 0.5% ranged from a little under 10 years (2%) and just over 16 years (0.5%). Total net cost to the fishery for these two simulations ranged from R5 439/km (2% export) to R21 746/km.

A feature of interest a many of the model simulations is that fact that benefits accrued to the fishery show continued growth (i.e. an upward trajectory). While this provides further support for MPA proclamation it is in part at least an artefact of the fact that the model does not incorporate any increases in fishing effort over time. In reality, increases in fishing effort (certainly in the recreational sector) may ultimately consume all of the exports from the MPA.

Table 6.2. Time elapsed before catches return to original trajectory and the total undiscounted value of the losses up to that point for model simulations in which stock recovery levels in the MPA and levels of export from the MPA are varied.

Stock growth in MPA after 10 years (%)	Export level (%)	Time elapsed before catches return to original trajectory (years)	Total cumulative cost/km*
60	1	10	R10,553.53
40	1	13	R10,553.53
20	1	32	R68,802.25
40	2	10	R5,439.08
40	0.5	17	R21,745.71

*undiscounted

6.4 Discussion

The management costs of MPAs were found to be relatively low. It was unexpected to find a similar cost per unit area for management of small and large MPAs. This is, of course, based on current budget, and does not necessarily reflect the ideal management cost. Indeed, the current cost of managing an MPA in the Garden Route is well below the worldwide median cost of $2 700 ~ R 17 000 (Balmford *et al.* 2004). Using ideal management costs, Frazee *et al.* (2003) found a steep increase in management costs for protected areas smaller than 600 ha for terrestrial (fynbos) protected areas. It would also be expected to have relatively higher costs for managing MPAs in which angling is allowed, but this was not the case. It is thus difficult to predict what the actual costs of extending the protected area system would be. The marginal costs of adding additional shoreline to an existing protected area would be expected to be lower than the average costs per unit area. However, the actual costs will ultimately depend on how effectively the systems would be managed. Further research is recommended to investigate these cost relationships in more detail.

This study estimated the economic opportunity costs associated with the existing MPA system on the Garden route as well as potential opportunity costs associated with expansion of the MPA system, using a dynamic spreadsheet model. It is clear from all of these simulations that the opportunity costs of MPAs are relatively short-lived. The fishery benefits of de-proclamation of an existing MPA are likely to be depleted well within a single year, and net fishery losses decline to zero within 8-18 years of proclamation of a new MPA. The catches derived thereafter balance these losses within 9-32 years. Total undiscounted costs to the fishery up until the point where catches in the area adjacent to the MPA match those where no MPA was declared ranged from a minimum of R5 400/km up to a maximum of R68 800/km. These estimates are preliminary, and might be improved with more sophisticated modelling. However, there are limited additional data to support such models at present.

7 SYNTHESIS & CONCLUSIONS

This study has found that MPAs along the Garden Route coast provide substantial value over and above the value that these coastal areas would otherwise generate. Just in terms of the tangible values, the additional recreational value attributed to managing these areas as MPAs is in the order of R9 million per annum, when taking consumer surplus into account, and is far greater than the management costs of these systems. The total economic value of the MPAs includes the export of fish which add value to recreational and commercial fisheries in surrounding areas, a value that we estimated to be in the order of R33 million per annum. The non-use value of the MPAs, when estimated as an annual value, is also substantially greater than the recreational use value alone. Acknowledging that one has to also consider the opportunity costs of conservation, we estimated that these could be as much as R421 million for the current MPA system. This is a substantial cost, which therefore requires that the overall costs and benefits are compared in order to determine if increasing protection incurs an overall gain or loss in welfare.

Using the findings reported in the preceding chapter, we estimated the present value of each of these types of value over a 20 year period, using a discount rate of 6%. We also estimated the change in these values for each of the following scenarios:

5. The current status quo
6. Zero protection
7. Reduced protection: Opening 5km of Tsitsikamma coastline to angling
8. Maximum protection: Closing MPAs to fishing and extending the Goukamma MPA seawards (by 2.8 km) and westwards (by 10 km)

The overall result is presented in Figure 6.7. The first important conclusion is that the costs of MPAs are outweighed by the benefits. This is in spite of the fact that the costs were not conservatively estimated, while the benefits were. The second important conclusion is that there is an increase in overall net present value with an increase in the level of protection. Indeed the overall net present value of the MPA system[2] is positively correlated with the % protection that was estimated for each scenario (Figure 6.8).

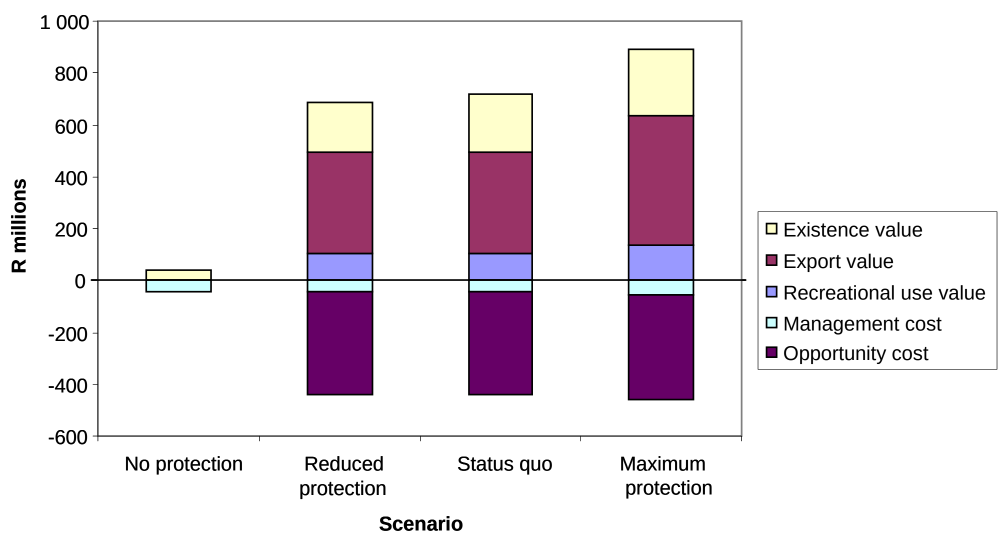

Figure 6.7. Present value of costs and benefits of MPAs under different protection scenarios. Values are calculated over 20 years at a discount rate of 6%.

[2] Note that these values are cannot always be added in that they represent slightly different measures, but since there is no double-counting, they are added here in order to give a rough estimate of overall values.

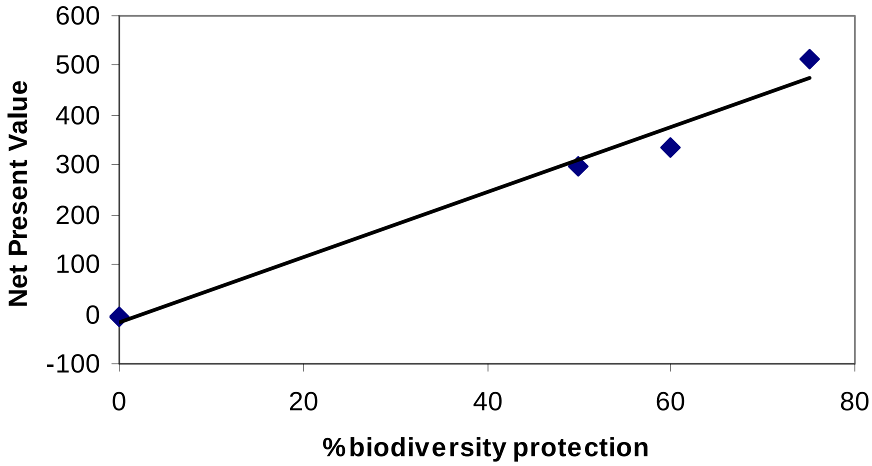

Figure 6.8. A very rough indication of the relationship between net present value of the MPA system and the level of biodiversity protection

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