Economic Values, Distributional Impacts and Conservation Outcomes for Coral Reef Marine Protected Areas.

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This work is dedicated to my mother, who has been a source of infinite happiness and inspiration for me

and to my father, who I hope would have been proud of me.

These woods are lovely, dark and deep.

But I have promises to keep,

And miles to go before I sleep,

And miles to go before I sleep.

Robert Frost.

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Acronyms.

CBD	Convention on Biological Diversity
CS	Consumer surplus
CVM	Contingent valuation
FoN	Friends of Nature
GDP	Gross domestic product
GSMR	Gladden Spit Marine Reserve
GEF	Global environmental facility
HDI	Human development index
LDC	Less developed country
MDC	More developed country
NPV	Net present value
OLS	Ordinary least squares
PS	Producer surplus
SD	Standard deviation
TEV	Total economic value
WHS	World Heritage sites
WTP	Willingness to pay

Abstract.

Marine protected areas (MPAs) are the dominant global strategy to counter widespread coral reef degradation, which threatens these coral reef ecosystems, the biodiversity they support, and the direct and indirect benefits they provision for millions of stakeholders, many of whom are in developing countries and have a high reliance on natural resources. Insufficient understanding of the conditions that enable MPAs to achieve their conservation and development goals means MPAs are yet to achieve their full potential. Similarly, inadequate awareness of the distributional aspects MPAs generate can leading to conflict and ultimately MPA failure. This research explores the links between two key themes of MPAs; efficiency and equity.

A local case study in Belize is used to explore the ability of a MPA to provide a suite of benefits (net of costs) related to fishing, tourism, recreation and existence and bequest values in 2007. The values quantified demonstrate that the reserve represents an excellent return on conservation investment, particularly if non–user values are included. Survey effects associated with contingent valuation are found to be important and merit further research. Current entrance fees do capture much of the consumer surplus values which the reserve generates. Optimal fees are explored using the demand curve generated from the CVM. Non-use and local values, which are too rarely incorporated into MPA valuations are shown to be large, thus they are important to ensure well-informed decision making. A distributional analysis is undertaken, which quantifies transfers of wealth between stakeholders. This shows that incentives differ between stakeholders; where fishers, tour operators and international NGOs are incurring the direct costs. Contrary to what may be occurring elsewhere, the distribution of costs at local, national and international scales is found to be equivalent, although the benefits are highly skewed towards international stakeholders. Finally, I show that local community members, who will ultimately cause an MPA to fail or succeed, perceive costs and benefits fairly accurately. Thus the provision of local benefits is likely to improve MPA performance.

A global coral reef MPA evaluation is undertaken, utilizing expert knowledge from MPAs in 33 countries. This constitutes the most comprehensive coral reef MPA performance evaluation to be carried out to date with a single methodology. MPA performance is shown to vary widely and to be unrelated to MPAs aims. Conclusions as to which are the most effective MPAs are also frequently altered, when incorporating temporal changes and spatial comparisons (assessing the counterfactual case). This dataset is also used to explore the extent to which different facets of success are coupled. I find that socio-economic and ecological benefits do not always occur concurrently and that a better appreciation of trade-offs is needed. The large variation in sample outcomes is used to explore drivers of success, including MPA features, management actions and contextual variables. MPA features such as size and zoning are found to support widespread hypotheses about the drivers of effectiveness. A non-linear temporal component of performance is identified, as are interactions between MPA features and outcomes. The provision of direct and indirect community benefits emerges as a crucial component of success. Frequently however, threats beyond the control of management and those inside the MPA which stem from inadequate resources are found to be undermining the effectiveness of coral reef MPAs.

1.1 Introduction.

Coral reefs are among the most diverse and productive ecosystems in the world. They provide a vast array of goods and services related to their use, their ecological services and their existence. Their importance from a human welfare perspective is illustrated by the fact that almost 500 million people depend on reefs for food, coastal protection, cultural items, and tourism income. Of these, 30 million of the poorest people are estimated to depend entirely on coral reefs for food (Wilkinson, 2004). For many of the world's poorest counties, their reefs constitute a major part of their natural capital, as they have enabled economic growth though fisheries and reef-based tourism. Many Small Island Developing States have few resources other than coral reefs and ecotourism. Poverty alleviation is critically linked to the health of these ecosystems. Increasing human populations, unemployment and inappropriate development will only add further pressure to these resources.

Yet these reefs are severely threatened. A recent global report estimates that 19% of the world's coral reefs have been effectively destroyed and show no immediate prospects of recovery and predicts that 15% of the world's reefs are under imminent risk of collapse through human pressures; and a further 20% are under a longer term threat of collapse (Wilkinson, 2008). The most severely threatened reefs are concentrated in the tropics, which also have rising populations, increasing per capita consumption and large numbers of poor people who are extremely reliant on natural resources for food and employment (Burke et al., 2002). This means that the prognosis for these ecosystems, the species they contain and the people that rely both directly and indirectly on the ecosystem services provided by these natural resources could be poor (Daily, 1997). A major and widely used strategy to reverse and halt this decline is marine protected areas (MPAs).

MPA is used as a catchall term including a range of protection from totally off limits to all forms of use, to restrictions of use to a set of users, to very few restrictions (Boersma & Parrish, 1999). Francis et al., (2002) define MPAs as coastal and sea areas enjoying some level of legal protection nationally or locally, and that are especially dedicated to the conservation, protection and maintenance of biodiversity and associated cultural resources. MPAs are expected to enable marine ecosystem management by contributing to maintenance of biodiversity and ecological processes that maintain resilience while enhancing fisheries, increasing opportunities for non-consumptive activities and building knowledge for improving coastal management (Dayton et al., 2000). MPAs are indeed recommended as a key mechanism for sustainable development of the coastal and marine environment and in several international environmental conventions and multi-lateral environmental agreements[1]. Thus MPAs are expected to continue to dramatically increase in numbers (Allison et al., 1998) as the principal policy for sustainable development and protection of the coastal and marine environment including coral reef ecosystems (Salm et al., 2000).

[1] including in chapter 17 of Agenda 21 of the United Nations Conference on Environment and Development, in the Convention on Biological Diversity, in the United Nations Convention on Law of the Sea and the Nairobi convention. (McClanahan, 1999)

1.2 Aims and Objectives.

In this thesis I aim to evaluate the performance of MPAs as a conservation tool for coral reefs using two approaches; a global analysis of the factors driving the reported performance of MPAs for reef ecosystems, and a detailed case study analysis of the distribution and types of costs and benefits of an MPA to stakeholders in Belize.

This research has eight principal objectives;

- To explore the extent to which coral reef MPAs globally are achieving conservation and welfare goals.
- To develop performance indicators which use counterfactual comparisons to evaluate multiple aspects of conservation and welfare improvements.
- To explore the relative importance of drivers of MPA performance, including MPA features, financial aspects, management actions and contextual factors against ecological and socio-economic goals.
- Measure a full range of net economic values, to understand their drivers and the effects of the distribution of costs and benefits for stakeholder support, management and conservation at a case study MPA
- To quantify and understand the drivers of the economic value of a case study MPA, taking into account all the major economic values, net of costs, including non-use and community values.
- To examine the links between the distribution of the costs and benefits generated by the case study MPA and stakeholder attitudes to the reserve.
- To explore methodological issues associated with contingent valuation as a stated preference technique to elicit a variety of economic values held by stakeholders from both developed and developing nations.
- To provide recommendations for coral reef management.

1.3 Research Rationale.

This research has three major themes, which relate to MPA efficiency and equity; MPA effectiveness, costs and benefits generated and distributional impacts. These are discussed here briefly in turn, with more detail in chapter 2.

1.3.1 Marine Protected Area Effectiveness.

Despite the fact that MPAs continue to be established and hundreds of millions of dollars are being invested into MPA establishment and management, there remains a need for development of rigorous and inclusive measures of MPA success beyond traditional ecological measures, to justify these investments. There has been increasing emphasis, partly driven by donors, on MPA efficacy assessments. Many types of assessments have been developed, mainly funded by non-governmental organizations (NGOs). In particular, The Nature Conservancy (TNC), the World Conservation Union (IUCN) and the World Wildlife Fund (WWF) have been active in this area (Ervin, 2003; Pomeroy et al., 2004; The Nature Conservancy, 2003). However, this research is usually limited in the information it generates, as it is a way of summarizing often qualitative opinions about the MPAs' effects or information about management inputs, using small case studies and published in the grey literature. In addition many of these studies have focused exclusively on one or two aspects, such as fisheries, without incorporating other factors that could compromise the MPA's success (Boersma & Parrish, 1999).

There is also a growing body of research related to measuring conservation impacts of protected areas or projects. However, these detailed site assessments are often flawed as they have no control sites and no baseline variables by which to judge success (Ferraro & Pattayak, 2006), although these are routinely incorporated into ecological research. The focus on one or a few outcomes is at odds with the multiple and often conflicting aims MPAs are established with (Mora et al., 2006a). They also provide little robust information on MPA impacts and about what factors are needed to enable their diverse goals.

I will examine global patterns in coral reef MPAs and enable the effect of multiple social, ecological and policy based reserve attributes and impacts related to conservation success to be assessed. The type and detailed nature of the information required for research into multi-dimensional aspects of MPA success is not currently available despite the increasing number of databases with information on MPAs. Thorough and critical assessments need next to be applied on a regional or global scale, to judge the progress against MPA goals, to test the appropriateness of MPAs as a conservation strategy and to provide management recommendations.

1.3.2 **Quantifying the costs and benefits of MPAs**.

Many benefits of MPAs, particularly those associated with ecosystem quality, fisheries and recreation, have been characterised qualitatively (Roberts & Hawkins, 2000; Sanchirico, 2000). However, these values have rarely been comprehensively quantified, despite the investment into marine ecosystems that MPA establishment and management entails, which should be judged on a cost-benefit basis in the context of limited conservation funds, as is the case for investments elsewhere (Alban et al., 2006). Where regional and global values for coral reefs have been estimated e.g. (Cesar et al., 2003), these have relied on secondary market data from published statistics and benefits transfer approaches, which are widely acknowledged to be highly inaccurate (Downing & Ozuna, 1996). This is because the generation of site specific and fine-grained information on economic values of marine environments using primary data collection is time consuming and methodologically challenging. As a result, far too little information has been gathered on these values and methodological improvements are still needed. Advances are also needed both to improve the accuracy of valuation and to reduce its costs. The International Coral Reef Initiative note that there is a serious lack of country-specific valuation data to guide sustainable coastal management (Spurgeon & Roxburgh, 2005).

There is also a large variation in the types and magnitudes of economic values at different sites, depending on factors such as the ecosystem quality, the level of coastal development and the methods used. This means that regional estimates rarely provide sufficient resolution for natural resource conservation and management decisions. Non-use benefits may make up the largest share of the value of reefs (Spurgeon et al., 2004) but are very rarely valued, due to the large effort and cost associated with face-to-face stated preference techniques that are currently the only way to measure non-market values. Measuring economic values also provides an opportunity to explore methodological issues, which can be used to improve the use of contingent valuation, particularly for developing countries where it is much less often used.

I use a case study approach to complement the global study and measure direct costs associated with the case study MPA to quantify a range of net benefits generated under current management in 2007.

1.3.3 Distributional impacts of MPAs.

MPAs can affect one user group disproportionately (Ferraro, 2002), which means distributional issues among the stakeholders are generated (Sanchirico, 2000). They also produce goods that are both public and private in nature, giving rise to complex patterns of economic impacts. If conservation efforts are perceived as being unfair, conflicts over resource use and other benefits will arise. The distributional aspects of conservation initiatives have often been poorly considered and can be the reason for the failure of conservation projects (Hutton & Leader-Williams, 2003). If local communities are expected to pay the opportunity costs of MPAs, but receive few of the benefits, their lack of support will undermine any management (Mascia, 2004). Despite the longstanding realization that conservation policies, including MPAs, can have negative consequences for local communities (Newmark & Hough, 2000; West & Brechin, 1991), there exist few quantitative analyses of the local effects of PA establishment; exceptions include De Lopez (2003) for a terrestrial PA. There have been advances in modelling theoretical effects of no-take areas taking a bio-economic approach (Prezzey et al., 2000; Sanchirico & Wilen, 2001), but empirical work to quantify these effects in case study sites has been slow to follow.

Failure to measure and counteract the local costs of protection may lead to unworkable conservation strategies (Ferraro, 2002) which overestimate benefits. Where studies exist, these have been focused on terrestrial PAs. However passive values and opportunity costs can be very site specific (Carter, 2003) and distributions of costs and benefits will be different for marine systems (Balmford & Whitten, 2003), so this research needs to be extended to MPAs.

Minimal research has focused on distributional impacts in tropical MPAs, beyond the insight that they depend on size and location of a reserve in the context of the local fishery, the level of development of the country, and the state of the local labour market (Alban et al., 2006). They are also likely to be altered by MPA regulations and enforcement, which are very heterogeneous policies outside the MPA, including compensatory measures for fishers.

Three types of distributional aspects of costs and benefits are important to consider as these can provide powerful incentives to either conserve or deplete natural resources, which will ultimately affect long term MPA success.

1. The apportioning of costs and benefits at different scales. For example Kremen et al., (2000) examined incentives for conservation quantitatively using land value estimates of Madagascan forests and found high local and international conservation benefits, but poor benefits at the national level.

2. The apportioning of costs and benefits among different stakeholders at the local level. Those who receive the benefits of protected areas are frequently not those that suffer the costs (Balmford et al., 2004; Norton-Griffiths & Southey, 1995). Assuming that those affected by MPAs are a homogenous group with the same values and attitudes is incorrect and can mean that the marginal groups benefit least (Brown, 2002).

3. The inter-temporal trade-off related to the fact that many of the costs can be felt immediately, but substantial benefits may lag behind. This may not be morally acceptable in areas of extreme poverty and again could lead to collapse of conservation or sustainable use based management.

Net economic values of coral reef ecosystems, as with any open access resource, may not always be large. Associated economic rents have often been dissipated, meaning that the producer surplus is close to zero (Hardin, 1968). The extent to which this applies to MPAs is not well documented however. Economic impacts are also important as the distribution of the costs and benefits is expected to have more of an impact on stakeholder behaviour than the net values. There has been no research on the sensitivity of stakeholders to the ratio of costs and benefits that MPAs produce, although these have been hypothesised to be important (Pomeroy et al., 2007).

In conclusion, there is a real need critically to evaluate MPA effects and to understand the underlying processes, such as changes in economic and ecological conditions that may cause conservation efforts to fail or succeed in a variety of contexts, which is addressed by the global study. Squire and van der Tak (1975) emphasise the two key criteria for MPAs: efficiency (cost benefit analysis) and equity. This research addresses both of these areas, through an analysis of a case study MPA's value and distributional impacts on stakeholders and through an analysis of ecological and economic impacts in the context of direct costs incurred.

1.4 Overview of thesis and chapter outlines.

The thesis content is summarised in figure 1 below and a more detailed description follows.

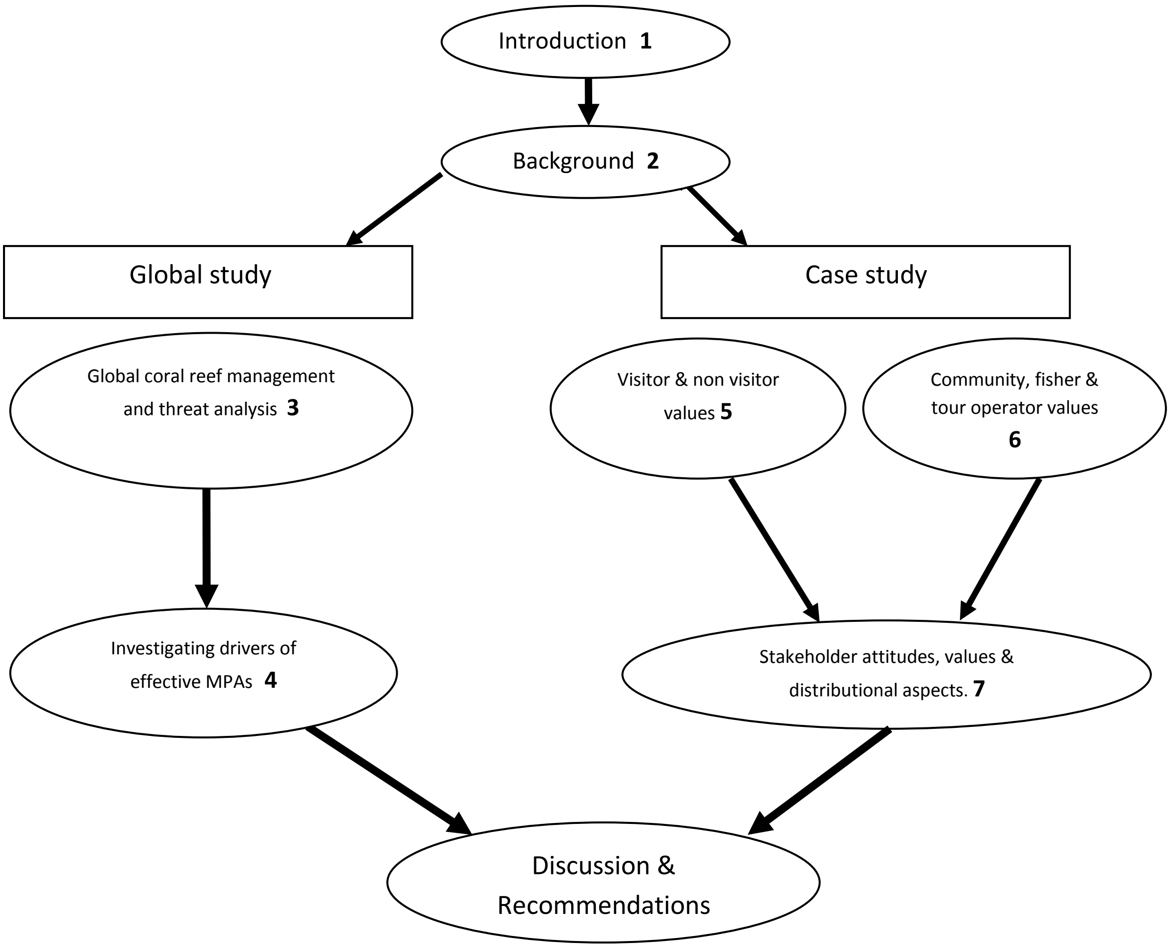


Figure 1.1. Thesis structure. Note: Chapter are indicated by circles, with numbers marked.

Chapter 2: Background.

This chapter provides the background of research that has been undertaken in various disciplines, associated with the designation and management of coral reef MPAs, natural resource valuation for reefs and MPAs for local communities, fisheries and tourism as well as distributional aspects of MPAs, protected area impacts and effectiveness. There is also a description of the case study site, the Gladden Spit Marine Reserve (GSMR) in Belize.

Chapter 3: Global Coral Reef Management, Financing and Outcomes: Are MPAs Providing Conservation and Welfare Improvements?

This chapter describes the global study, in which I used local expert respondents to gain a detailed picture of the context, extent and impacts of coral reef MPAs in 33 countries. Each MPA's contribution to conservation and welfare improvement was assessed, by evaluating and comparing ecological and socio-economic outcomes inside and outside or over time. I analysed the impact of MPA age, the existence of no-take areas and regional location on MPA outcomes. I also appraised the ability of MPAs to address the threats they face and the adequacy of MPA features, management actions and outcomes for ensuring conservation success. These performance evaluations were then used to test the often cited assertion that MPAs are failing to achieve both conservation and welfare improvement aims.

Chapter 4: Investigating Drivers of Successful Ecological and Socio-economic Performance in Coral Reef MPAs.

This chapter developed and presented performance indicators to evaluate distinct desirable outcomes in MPAs. Indictor validation was followed by an analysis of the relationship between the different performance indicators, to understand the extent to which they occur together, using principal components analysis and spearman rank correlations. A reduced set of indictors, which are not highly correlated, were then tested, to understand which MPA features, aims, management actions, financial aspects, threats and uses as well as contextual factors drive MPA performance.

Chapter 5: Visitor and Non-visitor Values for the Gladden Spit Marine Reserve.

This chapter used results from two valuation surveys, for tourists who have visited the reserve and those who have not. Samples were split to understand the effects of face to face and self completed responses. Values were assessed in the context of tourist experience, attitudes, preferences and socio-economic parameters, using a variety of econometric models. For visitors, sequential questions were used to quantify consumer surpluses for three distinct values; reserve visitation, whale shark interaction and non-use values, using scenarios involving entrance fees and donations. For non-visitors, a conservative taxation scenario was used to glean non-use values. Certainty estimates and follow up questions were used to better understand the quality and motivations behind stated bids. Values were aggregated to explore implications for fund-raising.

Chapter 6: Local values for the Gladden Spit Marine Reserve.

This chapter presents the results of a community household survey which explored local uses, knowledge, attitudes and involvement in management of the case study MPA, as well as indirect impacts of reserve related tourism. The contingent valuation methodology quantified household willingness to pay for tourism, fishing and recreation at the reserve, total economic value of the case study reserve and an aggregated value related to 2 additional nearby reserves. This quantification of different bundles of goods provided a test of sensitivity to scope. The extent to which each distinct local value can be predicted by expectations, experience, attitudinal and socio-economic variables was assessed and compared. Quantile regression was used to understand the importance of different drivers of values for those with low or high values. Producer surplus estimates were also generated for tour operators and fishers using the reserve in 2007, using detailed cost and revenue data from a number of surveys, including catch surveys. Community values were examined in the context of producer surpluses quantified.

Chapter 7: Real and Perceived Costs and Benefits Generated for Stakeholders of the Gladden Spit Marine Reserve.

Gross and net economic benefits from chapters 5 and 6 were used to compare individual or household values to aggregate values for the reserve. These values were added to calculate a total use value and an overall value which also incorporates non-use values for this reserve in 2007. The magnitude and distribution of aggregated values was compared to other MPA and reef valuation studies. A sensitivity analysis was used with different discount rates, to examine net present values of the reserve over 25 years. Costs were also presented by stakeholder groups, and used to calculate the cost to benefit ratio for each stakeholder group and at each scale. Finally, the relationship was examined between real and perceived benefits and costs. I evaluated who are the winners and losers in the case study MPA, by stakeholder group (tour operators, fishers, tourists and local community members) and by scale (local, national, international), and compared these results to perceived impacts.

Chapter 8: Discussion and Recommendations.

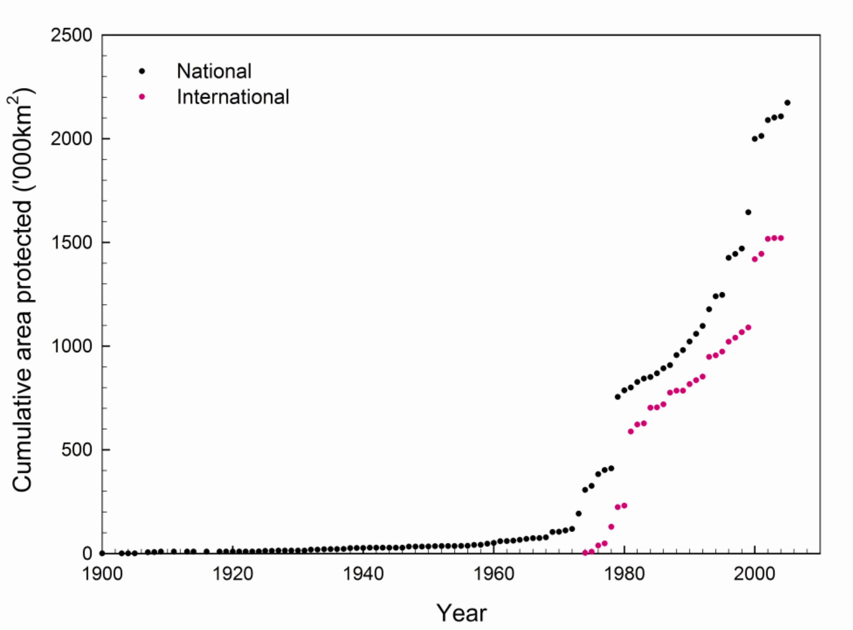
This chapter amalgamated the results from the case study and the global study, to examine what can be learnt about the link between MPA efficiency, values and the distribution of benefits to different stakeholders. The local case study was put into a wider context using the results from the global management survey, which enabled conclusions to be drawn about the generalisability of the case study results in a regional and global context. The contribution to knowledge of this research was outlined. Recommendations for management and for future research were also provided.

Chapter 2. Coral Reef MPA Status, Valuation and Performance.

2.1 Coral reef status and Management.

It was only in 1992 that the global threat to coral reefs was widely acknowledged (Wilkinson, 2006). Calls to increase protection resulted in many marine protected areas (MPAs) being established to protect marine habitats, including coral reef ecosystems (figure 2.1). Since the 1970s this policy has been endorsed by an increasing number of multilateral environmental agreements and NGOs. Protected areas are the key mechanism for achieving the Convention on Biological Diversity's overall goal of a significant reduction in the rate of biodiversity loss by 2010 and protection of at least 10% of the marine environment by 2012 (Wells, 2006).

Figure 2.1 Cumulative growth of total global marine area protected. As of October 2005 (CBD, 1996). National refers to sites created at the national and more local scales e.g. state/provincial, municipal, individual site etc. International refers to areas listed under international conventions or programmes, e.g. UNESCO World Heritage Convention.



Despite increasing protection, coral reefs inside and outside MPAs continue to be threatened due to global climate change, direct human pressures and poor governance (Wilkinson, 2006). In 2008, a global report which utilised experts from each coral reef country estimated that only 46% of reefs are unthreatened (Wilkinson, 2004; Wilkinson, 2008).

There has recently been an emphasis on databases to provide information about MPAs on a global scale. "MPA global" (Wood, 2007), currently represents the most up to date and comprehensive dataset on MPAs available. This study estimates that there are 4,600 formally or informally designated MPA sites and that 15% of coral reefs lie within MPAs, compared to 17% of mangroves. ReefBase, a coral reef-focused database, lists 1084 protected areas which contain coral reefs globally, although some of these are double entries (Tupper et al., 2008b). The regional extent of reefs, the coral reef health and MPAs are shown in table 2.1. These figures are misleading however, as MPAs are heterogeneous in terms of regulations, level of active management, budgets etc and those included in this database have no management requirements beyond basic designation. Many MPAs are also "paper parks", which lack any active management. In addition, many of the MPAs in developing countries have not achieved their management objectives (McClanahan, 1999). Globally, half the MPAs are found in Asia, where the greatest extent of coral damage has occurred. In the Americas, there are many small MPAs whereas Africa and the Pacific have established comparatively few MPAs.

Table 2.1. A summary of current status of coral reefs in 17 regions. [a] = *data from world atlas of coral reefs (Spalding et al., 2001),* [b] = *data obtained from ReefBase,* [c] = data from Wilkinson (2006). [1] *includes the Red Sea, The Gulfs, East Africa and SW Indian Ocean.* [2] *includes South Asia, SE Asia, E and N Asia, Australia / PNG and Micronesia.* [3] *includes SW Pacific Islands and Polynesian Islands.* [4] *includes Hawaiian Islands, Caribbean, Central America, Eastern Antilles and South Tropical America.*

Region	Reef area (km2 x 1000) [a]	% of global reefs [a]	No. MPAs [b]	% of MPAs [b]	Destroyed reefs (%) [c]	Reefs at critical stage (%) [c]
Africa [1]	33.5	11.7	81	7.5	14.5	12.1
Asia [2]	192.8	67.5	536	49.5	23.7	13.9
Pacific [3]	33.8	11.8	98	9	3.8	14
Americas [4]	25.7	9	368	34	13.2	23.4
Total	**285.8**	**100**	**1083**	**100**	**19.3**	**14.6**

Many PAs lack even basic requirements that enable a management presence (Leverington et al., 2008). Balmford et al., (2004) estimated global management running costs using both a manager survey and publications for 83 MPAs. Recurrent annual expenditure on the MPAs sampled, which were likely to be biased towards better funded MPAs, ranged from zero to US\$28 million per km^2 per year, with a median of US\$775 per km^2 per year (in 2005 value). They reported that annual running costs were highest for MPAs in developed countries, those with fishing bans and those that were smaller and nearer to coasts. Indirect and opportunity costs were not assessed, so these estimates represent a lowest cost estimate. A manager survey of 79 MPAs estimated a median funding gap of 15% between current income and the minimum necessary to achieve even minimal conservation objectives (Gravestock et al., 2008). The PA funding gap is particularly acute in developing countries and for some MPAs (Emerton et al., 2006).

2.2 MPA effectiveness

2.2.1 MPA goals.

In order to understand MPA success, the cited reasons MPAs are established and their aims should examined. However MPAs are often established on an ad hoc basis (Alder, 1996), usually under the impetus of international organisations (Pelletier et al., 2005), because they are thought to achieve several, possibly competing outcomes in a cost-effective fashion (Roberts & Hawkins, 2000; Sanchirico, 2000). Another key difficulty in assessing MPAs generally is that their aims, objectives and intended benefits vary and they may have many, often conflicting goals, or have failed to set out any goals. Objectives are also often general and poorly defined and therefore difficult to measure quantitatively (Kay & Alder, 1999).

Alder et al., (2002) classify three types of objectives that MPAs can have: utilization (e.g. education, fishing, ecotourism), management (e.g. protecting spawner biomass, improving yield), and protection (e.g. rare species, habitat diversity). MPAs frequently also are envisaged to have various secondary goals in addition to the main goal, including most commonly: fisheries enhancement or recovery, recreation / tourism / scenic beauty enhancement, local community economic development, conflict management, species protection, education/ research, biodiversity protection, ecosystem protection and cultural heritage protection (Boersma & Parrish, 1999). Associated benefits such as reducing conflict by controlling access to resources are also cited as justifications for increasing numbers of MPAs (Agardy, 2000). These goals and expected outcomes constitute the outcomes that MPAs should be assessed against, with control sites (Hockings et al., 2000).

2.2.2 Achieving Multiple Objectives in MPAs.

MPAs are usually judged on biological criteria, possibly because the primary aim of most MPAs is biological and it is acknowledged that MPAs should be assessed as a function of their goals (Halpern, 2003). However, most MPAs also have socio-economic and governance goals and objectives (Pomeroy et al., 2004). Ecological goals can include fisheries improvements, habitat, biodiversity or endangered species protection (Roberts & Hawkins, 2000). Socio-economic goals can include improving food security, supporting employment, increasing environmental awareness and knowledge, decreasing conflict and minimising local costs (Pomeroy et al., 2007; Sanchirico et al., 2002). Governance goals usually relate to adequate representation of all stakeholders including minority groups (McField & Kramer, 2007; Pomeroy et al., 2004).

Some authors assert that it is impossible to achieve multiple policy objectives simultaneously (Pomeroy et al., 2007). Others feel that while goals are not necessarily mutually exclusive, they do require explicit consideration of trade-offs (Dixon, 1993). Goals which are informally agreed or formally recognized in management plans can be contradictory or unequally appealing to different stakeholder groups (Christie et al., 2003), resulting in conflicts and controversy which can destabilise an MPA (Christie, 2004). Indeed these dynamics do contribute to the high rate of MPA failure, of almost 90% in some countries (White et al., 2002).

Socio-economic and ecological systems are highly linked (Sanchirico et al., 2002). A lack of ecological improvement is unlikely to foster economic development or reduce conflict. Similarly, social considerations are likely to lead to or undermine ecological success (Christie, 2004). Some research suggests that social factors, not biological or physical variables are the primary determinants of success or failure (Christie, 2004; Fiske, 1992; Kelleher & Recchia, 1998; McClanahan, 1999; Roberts & Hawkins, 2000). Pollnac et al., (2001a) and Christie (2003) warn that immediate biological gains will disappear unless social issues in terms of benefit sharing and equity issues, are addressed. If this is true, social benefits would be expected to emerge coupled with ecological improvements, but few MPAs with ecological improvements and poor socio-economic outcomes.

Importantly, there may be a temporal dimension of benefit provision and ecological and socio-economic outcomes. Ecological improvements rarely occur immediately after protection (Syms & Carr, 2001) and local support may only follow once these have materialised. Also, opportunity costs can occur immediately and reduce support and compliance (Pomeroy et al., 2007; Sanchirico et al., 2002), however, if new income generating opportunities occur, local socio-economic benefits could occur quickly (Mascia, 2004), even before habitat or fisheries benefits have materialised.

Nevertheless, research has demonstrated that MPAs do have the potential to simultaneously provide successful outcomes for ecological and social systems (Balmford et al., 2004; Clark et al., 1989; Dixon et al., 1993; Gell & Roberts, 2003; Russ et al., 2004; Vogt, 1997). Less is understood as to the extent to which this occurs and under what conditions, for example MPA use in the context of an areas' ecological carrying capacity, which is rarely known (Dixon et al., 1993). It has proven challenging to demonstrate quantitative linkages between human, natural and institutional factors (Otter & Capobiano, 2000), thus greater research is still needed to examine socio-ecological systems within conservation initiatives (Christie et al., 2003; Mascia, 2003; Pomeroy et al., 2004; Wells, 2006). Whilst it is important to look at all these factors, several authors have cautioned that combining these facets of performance into composite scores masks underlying relationships and provides little helpful information (Holtzman et al., 2009; Hudina, 2006).

2.2.3 Critical requirements for ecological conservation in MPAs

In order to assess the proportion of MPAs likely to achieve habitat and/or fisheries conservation, it is critical to examine research findings as to the features which determine MPA effectiveness. These include the cessation of fishing (no-take areas), MPA size, age and threat reduction.

No-take areas are defined as areas where no fishing, hunting or extraction is allowed (McField & Kramer, 2007). No- take areas (commonly referred to marine reserves) are known to be crucial for coral reef resilience to threats, due in part to the maintenance of functional organization through the trophic relationships they protect (Hughes et al., 2007). Fisheries benefits of no-take areas are dependent on the size of the no-take area relative to the species' mobility (Boersma & Parrish, 1999). It is not possible for reserves less than 1–2 km^2 in surface area (40% of MPAs) to provide enough protection for several key functional groups. Thus a critical minimum size of about 10 km^2 is necessary (Vilayleck & Andrefouet, 2006), although the exact requirement will vary by site and species targetted. Lauck et al., (1998) suggest that reserve size needs to be extremely large (50–90% of total habitat) to hedge against the uncertainties of overexploitation and environmental change. Thus the great majority of MPAs are far smaller than recommended as a long-term buffer (Lauck et al., 1998) and the current size and placement of protected areas falls far short of comprehensive or even adequate conservation requirements (Boersma & Parrish, 1999).

Importantly, benefits and MPA targets are unlikely to occur immediately. For example there will usually be a lag between coral reef protection and the ecological changes (figure 2.2). This time lag in addition to enormous ecological and socio-economic variability makes assessing the impacts of management extremely difficult. However, in general PA effectiveness will increase over time (Leverington et al., 2008).

It is implicitly understood that since damage to reefs is directly attributed to human activities (Wilkinson, 2006), so the cessation of these activities is a pre-requisite of coral reef protection, especially as reduced stress is associated with increased resilience to natural and human threats (Tompkins & Adger, 2004). Thus the greater the level of regulation in terms of extractive activities, the greater the protection. In terms of management category, this would mean that MPAs designated with low IUCN numbers (denoting stricter levels of protection) are likely to reduce threats more than those with unset or high categories. In addition, the budget (and staff) available are likely to influence threats through their effect on detection and enforcement.

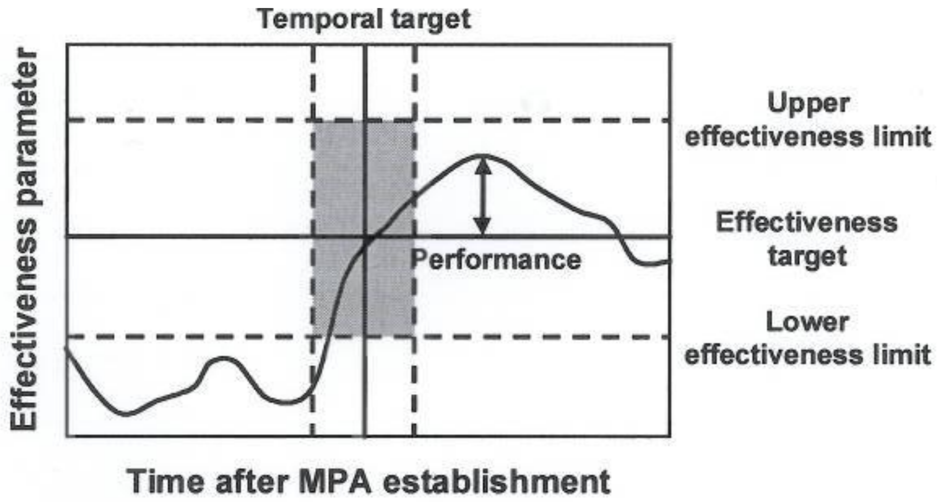


Figure 2.2. Effectiveness of a MPA is evaluated by the trajectory of the effectiveness parameter (e.g. spawning biomass) of an MPA over time. From (Syms & Carr, 2001).

Both over-crowding and congestion from recreational visits and fishers need to be limited in reef ecosystems, since they may surpass biological thresholds beyond which ecological health declines (Davis & Tisdell, 1995). Various attempts to identify carrying capacity for coral reef sites have produced varying results, from 4000- 15,000 dives/yr^{-1} (Dixon et al., 1993; Hawkins et al., 1999; Hawkins & Roberts, 1992). Similarly, fisheries benefits afforded by MPAs are known to be strongly dependent on the level of fishing pressure. It should be noted however that while limiting exploitation is expected to produce benefits (Jennings & Polunin, 1995), these rapidly reduce once exploitation resumes (Alcala & Russ, 1990). Evidence also suggests that MPAs have to be no-take *and* minimally affected by external risk to provide appropriate protection of coral reefs (Sale et al., 2005; Storms et al., 2005).

Since MPAs do not have functional boundaries, they cannot control key issues such as infrastructure development or pollution which have important implications for MPA effectiveness (Boersma & Parrish, 1999). MPAs cannot be relied on solely for marine conservation, as without adequate protection of species and ecosystems outside reserves, effectiveness of MPAs will also be severely compromised (Allison et al., 1998). As a result coastal zone management outside MPAs is also critical to reduce stressors on these habitats (White et al., 2005b). Similarly, single reserves need to be large and networked to accommodate bio-physical patterns of larval dispersal and recruitment (Carr & Raimondi, 1999).

2.2.4 MPA evaluation framework

The 1992 world parks congress resulted in the establishment of the management effectiveness task force in 1996 (Hockings, 1998), which developed the framework that was used as the basis for many subsequent protected area success assessment methodologies (Hockings et al., 2000). Before this, there was a lack of a unifying theoretical structure for evaluations (James et al., 2001). This framework is based on the 6 key elements of protected area management evaluation, which are given equal weighting (figure 2.3).

	Design issues		**Appropriateness of management**		**Delivery of protected area objectives**	
	Context	Planning	Inputs	Processes	Outputs	Outcomes
Criteria used	Significance Threats Vulnerability National context	Legislation & policy System design Reserve design Management planning	Resourcing of Agency / site Effectiveness of agency in implementing program Partner Contributions	Suitability of management processes	Results of management actions Services and products	Impacts: effects of management in relation to objectives, maintenance of values & abatement of threats
Focus of evaluation	**Status**	**Appropriateness**	**Economy**	**Efficiency Appropriateness**	**Effectiveness**	**Effectiveness Appropriateness**

Figure 2.3. WCPA Framework for assessing Management Effectiveness of Protected Areas (from Hockings et al., 2000).

Many evaluation methods for protected areas have subsequently been developed, addressing issues related to economics, efficiency or effectiveness (Corbett, 1992). These have been informed by the management effectiveness literature, conservation impact literature and policy and project outcome research. The major methods are outlined in appendix 2.1.

Wells (2006) identifies common elements in all these assessments. These include analysing biophysical and socio-economic characteristics, defining values and management objectives and analysing status and trends in biodiversity, socio-economic, threat and governance issues. Assessments more interested in accountability will probably focus more on inputs, outputs and outcomes, whereas those focusing on providing information for adaptive management would give more equal weighting to all aspects (Hockings, 2005). The Convention on Biological Diversity characterises three basic PA management effectiveness approaches (Wells, 2006);

1. **In-depth, evidence based** assessments for monitoring systems and long-term understanding of management in an individual protected area, e.g. the Enhancing our Heritage system for World Heritage sites.
2. **System-wide peer–based assessment** developed for use on a system-wide scale such as the WWF RAPPAM system.
3. **Scorecard expert–based assessments** includes understanding the relationship between effectiveness, threat and significance, e.g. World Bank GEF scorecard.

Different assessments often measure the same variables (Hudina, 2006) and the underlying principles and approaches are often the same (Stem et al., 2005). Indicators of desired outcomes or achievement of goals are frequently used, especially for more qualitative and general goals e.g. increasing the quality of life of local communities. In general the governance field is best represented in MPA assessments and two indicators are common to almost all evaluations: existence of a management plan and level of stakeholder participation (Hudina, 2006). Other frequently used indicators of MPA success include changes in biodiversity, infrastructure, compliance to regulations and primary stakeholder involvement in management (Francis et al., 2002).

On the other hand, assessments differ in terminology, the indicators assessed, information used, fields covered, the sequence of each method, the number and type of participants involved as well as the financial cost (Hockings, 2000). The context and purpose of these assessments vary from rapid qualitative judgements to detailed quantitative monitoring. Trade-offs between assessment methods are in terms of time, cost and data quality (Wells, 2006). Results will also differ in their robustness, credibility, reliability and comprehensiveness (Hudina, 2006). The various methods are a result of distinct perspectives on MPA success or effectiveness, which whilst having intuitive meaning, have not yet resulted in a precise definition.

Where quantitative indicators have been developed, they are usually costly and difficult to measure accurately (Kay & Alder, 1999), especially for biophysical and socio-economic impacts (Pelletier et al., 2005), as a result few evaluations include them (Pomeroy et al., 2005). For example, putative social benefits for local communities are rarely tested, despite the fact that some authors suggest that demonstrating these is the basis for evaluating the outcomes of management.

Thus, there remains little consensus on the evaluation criteria or performance metrics for each outcome (Pelletier et al., 2005). The most popular indicators are not necessarily the best, as they are frequently chosen based on capacity and feasibility of measurement, rather than because they are better indications of management effectiveness. Many assessments focus exclusively on ecological outcomes, such as a higher abundance of key ecological indicators inside versus outside a protected area (Halpern, 2003). Others highlight the importance of reserve design (Boersma & Parrish, 1999). There is an increasing emphasis on other aspects, such as economic sustainability and compliance in the context of intended levels of protection and improved quality of life for nearby communities (Watson et al., 2003).

2.2.5 Marine Protected Area Evaluations

Previous terrestrial protected area evaluations have limited applications in the marine environment, due to key differences in scale, extensive ecological connectivity, high levels of variability and management differences (Allison et al., 1998; Jones, 2001). The first broad MPA management effectiveness assessment was carried out in the early 1990s and included 383 out of a global total of 1,306 MPAs. Roughly a third were judged to have met their management objectives, one-third partially met their objectives, and the remaining had inadequate information, suggesting they had failed to meet their objects (Kelleher et al., 1995; Kelleher, 1996). Bryant (1995) assessed 1108 coastal MPAs and estimated that 59% occurred in areas currently sustaining a high risk of degradation due to development-related activities. Crawford et al., (2000) assess some of the community based sanctuaries in the Philippines and estimated that of the 400 or so MPAs that have been established, only 20-25% are successful; however they used only four focus groups, success was not defined and no quantitative measures were used. More recently, in Southeast Asia, Burke et al., (2002) assessed 332 MPAs and found that only 14% are effective management, 48% have partially effective management and 38% have inadequate management. Similarly, (Tun et al., 2004) find that only 10-20% of South-East Asian MPAs have effectively management, which they define as well prepared management plans that are enforced. Collectively, these studies support the assertion that the great majority of MPAs fail to meet their management objectives and that the most MPAs are 'paper parks' (Jameson et al., 2002).

Despite a plethora of empirical studies, demonstrations that reserves enhance adjacent fisheries are rare and equivocal or anecdotal (Dayton et al., 2000). The lack of conclusive evidence is partly due to spatial and temporal variability of inshore ecosystems (Garcia-Charton & Perez Ruzafa, 1999), the cost of undertaking a significant number of replicates and lack of control sites (Willis et al, 2003). Nevertheless, Halpern (2003), who synthesized over 100 studies, showed that protection from fishing can lead to rapid increases in biomass, abundance and average size of exploited species within the MPA, plus increased species diversity. Where spillover (export of harvestable biomass) is occurring outside fully protected areas, it is likely to result in the congregation of fishers adjacent to reserve boundaries (Murawski et al., 2000; Shorthouse, 1990), so this is a good indication of fisheries impacts of MPAs, although it is anecdotal.

Limitations common to the majority of protected area evaluations are that; (a) very few studies include reference sites outside MPAs, (b) few have funds to carry out statistically robust monitoring and replication of sites and (c) very few have any baseline data to look for effects over time. As a result, they provide weak evidence of MPA outcomes. There are also issues related to the lack of training in indicator measurement and only focusing on biological data (Stem et al., 2005). Meaningful cross comparison or evaluation of methods is also hampered by the fact that most methods are usually simply documented as methods, without published results (Hockings, 2003), or because any studies that are carried out are only informally published (Stem et al, 2005). There is also a lack of standard methodologies, differences in robustness and comprehensiveness of methodologies, as well as inconsistent language, where result, impact and outcome or pressure and threat are used to describe the same thing (Stem et al, 2005). Additionally, only rarely has more than one method been applied at a single site and weightings, if applied to each measure are arbitrary and subjective. Indeed evaluation year was a proxy for methodology, as methods are quickly replaced as new ones are published, meaning there is little consistency over time, despite the fact that new evaluations are often hybrids of previous ones (Hudina, 2006). In addition, almost no analyses quantitatively measure secondary benefits such as tourism, educational benefits, or reduction in conflict.

Importantly, there is also a tendency to confuse expected outcomes associated with actions and actions themselves (inputs and outputs, effects and effectiveness) and theoretical developments have yet to reduce uncertainty over the link between MPA effects and whether these effects enable MPAs to achieve a given result and achieve their objectives. For example, the degree of local reliance on marine resources is often included, although this has only an unclear link to MPA effectiveness (Stern, 2006). In addition, uncertainty (from natural sources of variability interacting with anthropogenically-induced changes) weakens the precision as to which the magnitude and timeframe of an expected outcome can be made. Advances in evaluation assessments should focus on developing quantitative targets, parameterizing the magnitude of effects, evaluating them with respect to stated objectives, and assessing confidence in the results (Syms & Carr, 2001).

Hudina (2006) developed an integrated management effectiveness index, with 29 merged indicators using sites where more than one methodology had been applied. A single management effectiveness index was not possible, as a composite or average score obscured the actual status of MPA performance due to differences in methodologies' comprehensiveness and robustness. Adjusting data for robustness and quality was also not recommended, as it was found to obscure the results (Hudina, 2006).

In the most comprehensive coral reef MPA study to date, Mora et al., (2006) compiled a database of 980 coral reef MPAs, covering 18.7% of the world's coral reef habitats and quantified the area to fall within criteria related to protection against fishing, perceived levels of poaching and risk from external threats such as pollution. They found that 147 coral reef MPAs (10.8% of coral area) are at low risk and less than 0.01% of the world's corals are within MPAs defined as no take with no poaching and at low risk. Effectiveness varied between countries. In addition, 40% of MPAs were identified as smaller than 2 km^2 which negates fisheries protection effectiveness for many species.

2.2.6 Factors associated with conservation impacts of MPAs

Research which has sought to determine aspects of MPA effectiveness has taken a variety of approaches and been published both informally and in the academic literature (see above). Increasingly, global networks of managers are forming networks to informally share experiences of outcomes from management interventions (LMMA, 2008), which is a testament to the need for generalised information on what improves MPA performance.

Traditionally the focus was on demonstrating fisheries benefits of MPAs, which proved to be costly and somewhat elusive (Willis et al., 2003). More recently, there has been a research emphasis on understanding the achievement of positive outcomes in certain types of MPAs, such as community managed MPAs (Axford et al., 2008; Christie et al., 2002) or fisheries focused MPAs, or MPAs in a single country or region e.g. (Christie et al., 2002; McClanahan et al., 2005a; Parvese et al., 2007; White & Vogt, 2000).

A number of methods have been used to assess MPA performance. The terrestrial PA literature has used satellite images to determine rates of land cover change (Bruner et al., 2001), which is not an option for MPAs. Approaches for MPAs include Pomeroy (Pomeroy et al., 2007), who use correlations in contextual and management variables between a number of community based MPAs in the Philippines to develop models of direct and indirect links in the social dimensions of success. A number of studies have assessed MPAs using surveys to gauge stakeholder perceptions, the best of which have included control sites (Leisher et al., 2007; McClanahan, 2004; McClanahan et al., 2005b; Webb et al., 2004; Williams & Polunin, 2000). However, these are extremely costly and so can only be applied to a small number of MPAs. Other approaches have looked for evidence of positive health or economic benefits as a result of MPAs e.g. (Aswani & Furusawa, 2007; Gjertsen, 2005), which help to elucidate social aspects of MPAs. Holtzman et al., (2009) use internal reports from 24 MPAs to code qualitative data into ordinal data for 33 indicators and looked for correlations between outcomes and inputs. Tupper et al., (2008a) used in depth qualitative analysis of 56 reef related management projects to establish lessons learnt from success and failure. Pollnac et al., (2001a) looked at probabilities of association between independent variables and a composite measure of success for 5 variables including coral health, resource perception and compliance. Mascia (2000) synthesized 74 presentations on MPAs at a coral reef conference to summarize their insights into the characteristics of effective coral reef MPAs. Halls et al., (2002) assessed the contribution of 258 technical, socio-economic and political attributes of 119 sites and using catch per unit area and catch per unit effort as proxies for management success, but relevance of this research is limited to fisheries benefits from artisanal co-management. As yet there has been no research to explore drivers of socio-economic and ecological performance using a single evaluation method with a large enough sample size to enable parametric approaches for coral reef MPAs at a global scale.

Next I examine the conclusions and recommendations from studies using all these approaches, to develop hypotheses as to the drivers of MPA performance. I discuss in turn, the MPA features, management actions, financial aspects, local and national contextual variables from these sources of literature.

Table 2.2 Variables hypothesized to impact facets of MPA success. This table summarises the variables which have been shown quantitatively or anecdotally to influence MPA performance. For expected direction of the direction of the impact on performance reported or hypothesized; Q denotes a quadratic relationship, + a positive and – a negative.

	MPA / management variable	Expected direction of relationship	Study
MPA features	MPA size: goal achievement, habitat quality, fisheries	Q / +	(Alder et al., 2002; Holtzman et al., 2009; Lauck et al., 1998)
	Existence or size of no-take area: fisheries	+	(Boersma & Parrish, 1999; Claudet et al., 2008; Holtzman et al., 2009; Hughes et al., 2007; Lauck et al., 1998; Sumaila, 1998)
	Age: effectiveness, fisheries, habitat conservation	Q / +	(Claudet & Pelletier, 2004; Leverington et al., 2008)
	Low IUCN number (strict regulations)	+	(Naughton-Treves et al., 2005)
	Zoning: conflict	-	(Christie & White, 2007; Tupper et al., 2008a)
	Community managed (dummy)	+?	(Pomeroy et al., 2007)
	Government managed (dummy)	-?	(Pomeroy et al., 2007)
	Multiple (co) management (dummy)	+	(Christie & White, 2007)
	Part of physical or monitoring network of MPAs: effectiveness, species conservation, habitat quality	+	(Jameson et al., 2002; Wilkinson, 2004)
Region	Americas, Asia	-	(Wilkinson, 2006)
	Pacific	+	(Wilkinson, 2006)
Aims	Multiple aims	-	(Pomeroy et al., 2007)
Management actions	Existence management plan (dummy)	+	(Halls et al., 2002; Tupper et al., 2008a)
	No. staff / level activity	+	(Bruner et al., 2001; Leverington et al., 2008)
	Staff training (dummy)	+	(Kelleher & Recchia, 1998; Kelleher, 1996; Wilkinson, 2004)
	No. regulations or bans on potentially destructive activities	+	(Halls et al., 2002; Pomeroy, 2007)
	% activities detected and/or enforced; effectiveness, fisheries	+	(Halls et al., 2002; Kelleher & Recchia, 1998; Lundquist & Granek, 2005; Mascia, 2000; McClanahan et al., 2005a; Ostrom, 1990; Pomeroy et al., 2007; Walmsley & White, 2003)
	Community involvement and/or consultation; effectiveness, conflict	+	(Leverington et al., 2008; Mascia, 2004; Pollnac et al., 2001a; Pomeroy et al., 2007; Tupper et al., 2008a),
	Resource user participation, community institutions	+	(Charles & Wilson, 2009; Lundquist, 2005; Ostrom, 1990; Pollnac et al., 2001a)
	Creating local community incentives	+	(Pomeroy et al, 2006 Wilkinson, 2004, (Pollnac et al., 2001a)
	Environmental education and outreach programs (dummy)	+	(Browning et al., 2006; Christie & White, 2007; Mascia, 2000; Tupper et al., 2008a)
	Conflict resolution mechanisms (dummy)	+	(Halls et al., 2002; Ostrom, 1990; Pomeroy et al., 2007)
	Social and ecological research and monitoring (dummy)	+	(Kelleher, 1996; Leverington et al., 2008; Lundquist, 2005; Mascia, 2000; Tupper et al., 2008a)
	Management effectiveness evaluation (dummy)(dummy)	+	(Lani et al., 2003; Leverington et al., 2008; Tupper et al., 2008a)
	Technical supervision / advice from outside organization e.g. NGO (dummy)	+	(Christie & White, 2007; Jameson et al., 2002; Pollnac et al., 2001b; Rudd et al., 2001)
	Compensation to groups suffering user costs (dummy)	+	(Bruner et al., 2001; Emerton, 1999; Rettig, 1994)

Financial	MPA funding (absolute / per area / for active management costs)	+	(Gladstone, 2000; Gravestock et al., 2008; Kelleher, 1996; White et al., 2002; White et al., 2005b)
	Extent facilities, equipment and infrastructure	+	(Leverington et al., 2008)
	% funding from user fees	+ / -	(Christie & White, 2007; Emerton et al., 2006)
	% funding to local community projects	+	(Emerton et al., 2006)
Threats / uses	No. threats inside or outside	-	(Allison et al., 1998; Wilkinson, 2006)
	Number of fishers / fishing pressure: effectiveness, habitat quality	-	(Halls et al., 2002; Roberts & Polunin, 1991)
	Number of visitors/ visitor pressure: effectiveness, conflict, economic benefits habitat quality	+ / -	(Davis & Tisdell, 1995; Dixon et al., 1993; Roberts & Hawkins, 2000; Sanchirico, 2000)
Local context	Local community benefits, equitable distribution of benefits	+	(Charles & Wilson, 2009; Jameson et al., 2002; Leverington et al., 2008; Mascia, 2004; Ostrom, 1990; Scanlon & Kull, 2009)
National context	Coastal zone management beyond MPA (dummy)	+	(Cho, 2005; Christie et al., 2002; Tupper et al., 2008a; White et al., 2005a; Wilkinson, 2004; Wilkinson, 2006)
	Fisheries management beyond MPA or inside (dummy)	+	(Tupper et al., 2008a; Wilkinson, 2004)
	GDP pc / economic development / more developed country (MDC)	+	(Agardy et al., 2003; Holtzman et al., 2009; Wilkinson et al., 2006)
	Less developed country (LDC), high degree of dependence on natural resources	-	(Balmford et al., 2003; Francis et al., 2002; Pollnac et al., 2001a)
	Human development index (HDI)	+	(Holtzman et al., 2009; Leverington et al., 2008)
	% reefs at risk	+ / -	(Burke et al., 1998)
Survey variables	Respondent is part of management staff (dummy)	+	(Bhagwat et al., 2001)

Many of the relationships posited in table 2.2 are complex and inter-related. For example, tourism can lead to numerous benefits, as well as costs e.g. increased conflict as the re-allocation of rights to non-consumptive users (Mascia, 2004) and linked to resentment from perceived loss of traditional ways of life (Hoagland et al., 1995). Zoning schemes can help to reduce conflict, if there is sufficient capacity for enforcement.

Similarly, the level of absolute funding is also not the only factor. There is also the critical question of how existing funds are spent, as funds must be shared between active management (e.g. staff, office overheads and enforcement), funds for community and development projects and many MPAs also return a portion of funds to the national government. Management costs vary depending on the MPA objectives and regions (Balmford et al., 2004), and there is evidence that on-going funding requirements are driven by MPA size and visitation rates, with smaller PAs (James et al., 1999) and those with higher rates of visitation needing most funds per area (Gravestock et al., 2008). Nonetheless, money for start up, recurrent or capital costs is rarely given as the only reason for failure and goals may not be met because they are unrealistic (Agardy et al., 2003; Oracion et al., 2005) and not simply because funds are lacking (Christie & White, 2007).

The source of funds may also have an impact in terms of MPA objectives. Other sources of funding include the national government, national organizations, donations from visitors and international NGOs and foundations. Each of these may incur restrictions as to how funds are spent, for example some funders require management effectiveness evaluations (Emerton et al., 2006). Excessive reporting requirements or inflexible funding schedules can hinder effective management (Tupper et al., 2008a). User fees or government based agreements can provide more funding stability than short term donor funds (Leverington et al., 2008; Tupper et al., 2008a), but are likely to be associated with greater visitor pressure.

There is also no single approach to community engagement (Tupper et al., 2008a) and benefits can be in-kind contributions such as community or development programs and revenue sharing initiatives (Emerton et al., 2006). Incentives through for example new markets and running alternative income projects (where community members are trained in a new employment sector, such as being dive guides or seaweed farming) will improve performance. Fisher compensation could include loans, vessel but-backs, re-training or joint venture contracts (Roberts & Hawkins, 2000).

Non-linear relationships could be expected in several variables. Holzman et al., (2009) found that smaller MPAs (under 100km^2) had higher effectiveness scores than those of intermediate size, but results were inconclusive on large MPAs (over 2500km^2). Also, whilst protected area effectiveness is expected to increase over time, many benefits seem to have non-linear relationship with the age of the MPA (chapter 3).

Each MPA is unique in terms of the economic, social, political and institutional elements at community, national and international scales in which it operates (Lundquist, 2005), which will also strongly affect outcomes (Christie & White, 2007). Contextual factors which vary between MPAs include the social and economic situation of people using marine goods and services, the type of governance (Jennings, 2009), the source and severity of large scale threats outside MPA boundaries (Kelleher et al., 1995). This is why MPAs should always be assessed in the context of adjacent areas (Mascia, 2000). Several studies have concluded that endogenous factors explain more variation in MPA performance than large scale contextual and exogenous factors (Holtzman et al., 2009; Pollnac et al., 2001b; Pomeroy et al., 2007). I will test this assertion for this sample.

Finally, it is worth noting that there will be much confounding and many interactions between these variables. For example, the size or source of funding may impact management actions, features may be related to the MPA's aims, features and the management type, region and MPA size could be related. As a result, reliance on bi-variate analyses is of limited use.

2.3 Economic costs and benefits generated by MPAs.

2.3.1 Economic values of reefs and MPAs

Coral reef ecosystems produce a suite of direct and indirect benefits to society (table 2.3). These are well quantified for direct use values, less so for non-use values and to a very limited extent for ecosystem services (Balasubramanian et al., 2003; Hargreaves-Allen, 2004). These goods and services depend on the existence of healthy ecosystems and are not all provided by heavily degraded reefs. Most MPAs have ecosystem conservation as at least one of their primary aims, so the designation of an MPA should contribute to the provision of these benefits, locally and more widely.

Table 2.3. Economic Values Attributed to Coral Reefs. Adapted from Molberg & Folke (1999).

Use Value	**Direct Use**	**Extractive:** fisheries, mariculture, aquarium trade, curio/jewellery, pharmaceutical products, industrial, constructional, agricultural products, genetic material, mineral oil and gas. **Non extractive**: tourism, recreation, research, education (pollution and climate record), aesthetic, artistic, religious and spiritual values.
	Indirect Use	**Biological support** to species & other ecosystems **Physical protection** to other coastal ecosystems, coastline, navigation **Global life support (ecosystem processes and functions)**: biodiversity (resilience), build up of land, genetic library, export of organic production, nitrogen fixation, carbon control, waste assimilation. **Social services:** employment opportunities, food security **Coral sand generation** **National coastal zone extensions**
	Option Value	Species, habitats, biodiversity, pharmaceutical goods.
Non-Use Values	**Bequest Value**	Species, habitats, way of life and livelihoods connected to traditional uses.
	Existence Value	Threatened habitats, endangered species, charismatic species, and aesthetic reefscapes.

MPAs which contain coral reefs also produce distinct marginal benefits and costs which occur due to the process of active management, which have been characterized mainly qualitatively in the literature. These are summarized in table 2.4. Economic analyses of MPAs should in theory focus on the marginal impacts of management of economic values, but they rarely do, as calculating marginal values is much more difficult than total values, partly due to ecological non-linearities, to limited understanding of bio-physical linkages and the requirement for many assumptions leaves estimates vulnerable to criticism (Pendleton, 1995). One exception involved modelling trends in all the major values under two scenarios: with and without management to estimate that management of the Taka Bone Rate MPA in Indonesia adds an additional US$3.5- 5.0 million in value (Cesar, 2002).

Table 2.4. Costs and Benefits Associated with Marine Protected Areas.
Based on Molberg and Folke (1999), Sanchirico (2000), Gutman *(2002),* Sanchirico and Wilen (2002), Carter (2003) and Lutchman (2005). Scales are local (L), National (N) or International (I).

Type of Cost	Examples for MPAs	Relevant scale
Direct costs Investment and operation management costs	Design, set up and operational expenditures e.g. running, enforcement, monitoring, staffing and equipment, infrastructure development, compensation payments, alternative livelihood programs.	L, N, I
Indirect costs Imposed on third parties due to negative externalities	Fishing related: Crowding and reduction in fishable waters from displaced effort, reduced catches, higher capital and search costs, increase in safety risks, increased congestion, ecological effects of changes in species removal. Tourism related: higher price local goods, crime, loss of cultural identity, lack of accessibility to traditional recreation grounds, damage from divers, pollution from tourist related development User conflicts, MPA associated fines and penalties.	L
Opportunity costs Maximum return forgone in assoc. with limited or alternative economic activities	Forgone income from resource extraction (e.g. oil, gas mineral), forgone fishing income, unrealised development (industrial / tourism)	L,N
Type of Benefit	**Examples for MPAs**	**Relevant scale**
Consumptive – on site	Enhanced ecosystem productivity. Broadly improve the health of the ecosystem within the boundaries, restoration of healthy trophic levels. Increases in fishery stock abundance, age/size composition, spawning stock biomass, yield per recruit. Increased food security. Revenues from entrance fees	L, N
Consumptive – off site	Net revenue from harvest spill over (increase aggregate catch levels in the fishery). Reduction in harvest variance Greater benefits for any permitted uses. Enhance market value (alter catch composition and size). Economic multiplier values from employment, income and processing etc.	L,N
Non-Consumptive - on site	Opportunities for increased non-consumptive use values due to improved environmental quality and species diversity Ancillary, including education, diving, photography, tourism In situ conservation marine biodiversity. Option and quasi-option values. Research opportunities. Ecological services e.g. regulation of water supply, storm prevention. Donor investment	L, N
Non-Consumptive - off site	Ecotourism-related employment and revenues, tourism infrastructure, income and employment from alterative income initiatives. Support of existence and bequest values. Dispersed ecosystem services e.g. climate & nutrient control, carbon regulation.	L, N, I
Institutional	Savings in enforcement costs over other management models. Hedge against potential management failures, ecological disasters and uncertain stock. Scientific knowledge and educational opportunities.	L, N, I

2.3.2 Social Costs and Benefits of MPAs.

Social and economic benefits from successful MPAs are likely to be linked to income and employment benefits from improved natural resource extraction and sustainable tourism, as well as indirect ecological services to local populations and the maintenance of non-use values, such as continuation of traditional ways of life (Dixon, 1993; Sanchirico et al., 2002). MPA funding can also extend to community projects, such as alternative livelihood schemes for fishers, and micro-credit schemes for new businesses and education programs. MPAs are also expected in theory to reduce conflict, by dealing directly with the lack of defined property rights that exist in marine environments (Kelleher, 1999) although conflicts can remain in multi-use MPAs (Davis & Tisdell, 1995) or even increase in practice (Fabiny, 2008).

MPAs whose regulations restrict or ban extractive activates will also generate opportunity costs which can be substantial, including lost earnings for those who extracted seafood or other materials from these habitats (Balmford et al., 2002). Opportunity costs associated with the use of international and government funds for MPAs, rather than fisheries management or poverty alleviation programs, could also be large, although this is challenging to quantify. Closing areas to fishers can also incur significant indirect costs for fishers, such as increasing congestion on the remaining open grounds or increasing the variable and search costs associated with new fishing locations (Sanchirico et al., 2002). Thus most of the non-direct costs incurred by MPAs are likely to fall on extractive users.

2.3.3 Distributional impacts and perceptions of benefits in MPAs.

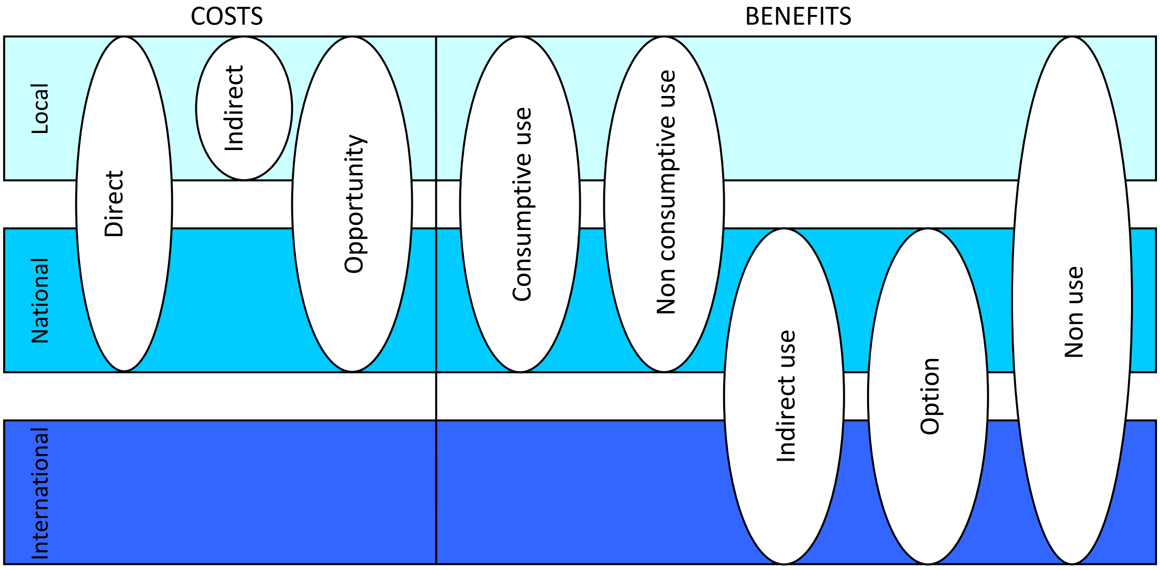
Distributional impacts and perceived equity of MPAs will determine their outcomes to a large extent. MPAs often reallocate rights and have complex distributional impacts which can undermine local support and compliance (Carter, 2003). An overall positive net value could hide these discrepancies between stakeholders. Distributional impacts depend on MPA size, location, the national level of economic development and employment possibilities (Alban et al., 2006).

Equity issues can arise as those stakeholders receiving MPAs benefits are frequently not those that suffer the costs (Balmford et al., 2003; Norton-Griffiths & Southey, 1995). If MPAs affect one user group disproportionately (e.g. see Ferraro, 2002), this can create distributional issues and increase conflict (Christie, 2004; Sanchirico, 2000). There can also be an inter-temporal trade-off, where most costs are incurred initially and benefits are only realised in the future. Thus quick provision of local benefits such as employment or compensation is likely to be a necessary to ensure local compliance.

Finally, MPAs can increase tourism and therefore contribute to poverty alleviation locally (Leisher et al., 2007). Secondary benefits of increased tourism can include improved infrastructure and the availability of new foreign goods into local market places. However, unsustainable visitation levels can lead to over-development, pollution, increased seafood demand and secondary social impacts such as cultural erosion, damage from visitor contact with coral and increased prices in local market places. In contrast to direct impacts, indirect impacts of MPA-related tourism have been little researched.

When addressing distributional impacts, local, national and global scales are all potentially important (figure 2.3) and it is not always obvious to whom which costs and benefits accrue. It is locally that MPAs will have their most immediate effect, by determining user behaviour and support for conservation (Mallaret-King, 2000; Pomeroy et al., 2007). However, many decisions made concerning MPAs and other natural resources have been made by national governments. At national level, costs arise from loss of taxes or fees, at the international scale from loss of trade. Local costs can also be transferred to international scales, through compensation schemes or alternative development programs. The international community and NGOs also play a key role, as conservation sponsors through foreign aid, technical assistance and MPA grants. NGOs are themselves funded by a combination of national and international taxpayers and donors and so span several scales. For conservation initiatives to work effectively, the benefits of conservation need to outweigh the costs at all scales (Kremen et al., 2000).

Figure 2.4. Hypothesized distribution of significant costs and benefits associated with MPAs at different scales. Adapted from: (Barton, 1994; Furst et al., 2000; Moberg & Folke, 1999; Munasinghe & Lutz, 1993; Spurgeon, 1992).



Perceptions of benefits and equity are potentially more important for local acceptability than equitable distribution of costs and benefits in reality (Alban et al., 2006). Perceptions of benefits in Kenyan MPAs were most determined by employment type, with fishers having significantly less positive perceptions towards areas closed to fishing than government managers (Kiringe et al., 2007). Government personnel thought that fishers and their communities benefited from area management, while most fishers did not. People with higher education levels perceived more benefits, as did those nearest the older MPAs. Similarly, stakeholders at Mafia Island Marine Park were dependent on proximity to the park and those most reliant on fishing (McClanahan et al., 2009). In contrast Naylor (1998) found no significant difference in perceived wetland benefits between different stakeholder groups. It should be noted that, valuation estimates using revealed and stated preference techniques can produce different conclusions regarding the distribution of benefits (Naylor, 1998).

2.4 Coral Reef and MPA Valuation.

Environmental valuation, based on microeconomic utility theory seeks to reflect people's wellbeing as a function of environmental goods and services. Natural resource valuation commonly uses contingent valuation or CVM (Garrod & Willis, 2000; Mitchell & Carson, 1989).

2.4.1 Economic Values of Coral Reef Fisheries.

Fisheries yields are difficult to measure accurately and vary by region and type of reef, gears used etc. Coral reef fisheries yields have ranged from 100 to 50,000 kg km^{-2} yr^{-1}, with an estimated global average of 6,600kg km^{-2} yr^{-1} (McClanahan, 2004). However, these vary substantially with a mean of 1,320kg km^{-2} yr^{-1} in the Caribbean, which was much lower than the mean of 3,000kg km^{-2} yr^{-1} in the Indian Ocean and 10,200kg km^{-2} yr^{-1} in the Pacific. Koslow et al., (1994) report yields in 7 sites in Belize, from surveys in 1991, which ranged from 78 to 2,92kg km^{-2} yr^{-1}, with a mean of 340kg km^{-2} yr^{-1}. The highest yields in Belize were from the Gladden Spit area (almost 3,000kg km^{-2} yr^{-1}). The appropriate level for a sustainable yield which will not undermine fisheries is also highly specific to the region, types of reefs, stressors and bio-physical characteristics. However, finfish harvests of 10,000-20,000kg km^{-2} $year^{-1}$ are generally considered sustainable in reefs (Jennings & Polunin, 1995; Munro, 1984).

Annually, fisheries in coral reef ecosystems yield at least 6 million tonnes of fish catches worldwide (Munro, 1996), which provides employment and food security for millions of fishers (Roberts et. al., 1998). This reliance on reefs for food and income is particularly strong in developing countries, where 25% of the fish catch originates from coral reefs (Bryant et al. 1998). Cesar et al., (2003) suggest that fisheries account for US$5.7 billion of the total US$29.8 billion net benefit of coral reefs per year globally.

Fisheries values have been used in many ways, including underscoring the value of local artisanal fisheries or to calculate fisheries losses associated with destructive uses (McAllister, 1988) or explore the potential changes in productivity which fisheries management of an area could produce (Munro, 1984). Sensitivity analyses are often used in these studies, typically with discount rates of 5-15%.

The majority of valuation studies have looked at gross fisheries values of coral reef fisheries and require assumptions such as typical yields or mean values, especially on national or regional scales. For example, reef fisheries of the Meso-American Barrier Reef of Belize, Honduras and Mexico are potentially worth US$15,000–150,000 km^{-2} yr^{-1}, based on catch values of US$1.00–

10.00kg^{-1} (Talbot & Wilkinson, 2001). In Belize, Cooper et al., (2008) estimate annual gross economic benefits of US$13–14 million from reef dependent fisheries and comment on the importance of fishing for local livelihoods and as a cultural tradition. Fisher consumer surplus (CS) values for fishing can be additional to producer surpluses (Pollnac et al., 2001b). This is because fishers experience welfare benefits, such as satisfaction with their way of life, beyond economic profits from fishing.

Since the costs of fisheries can be large, even to the extent of dissipating profits in an open access fishery, omitting costs for economic analyses would lead to values which overstate local profits by a large margin. Costs are increasingly incorporated into fisheries valuations, although the assumptions made as to the types of costs that are included and the rate of return from gross revenues vary. In the Caribbean, the annual benefits provided by coral reef fisheries, net of costs, are thought to be approximately US$300 million (Burke & Maidens, 2004). Fisheries accounted for US$1.3 million of the US$400.0 million in net present value of Jamaica's Montego Bay reefs (Ruitenbeek and Cartier, 1999). In Tobago, direct annual economic impacts are approximately US$0.7 – 1.1 million and in St. Lucia of US$0.4 – 0.7 million. Additional indirect impacts from the need for boats, fuel, nets, etc. are estimated at about US$0.1 – 0.2 million for both islands (Burke et al., 2008). These rough estimates are gleaned using catch and price estimates from a sample of fishers or based on likely fisheries productivity per unit of reef area and by using expert opinion on labour and non-labour costs as a percent of gross revenue.

Fisheries values have also been calculated at a number of MPAs. For example, fisheries supported by the coral reefs in Indonesia's Wakatobi National Park in Southeast Sulawesi produce an average of US$10,340 per km annually and have a net present value of over US$2.2 million, calculated over 20 years with a 10% discount rate (Hargreaves-Allen, 2004). Similarly, artisanal values of fisheries in Bunaken National Marine Park, Indonesia were in the region of US$2.48 million, compared to US$765,000 for commercial fishing (USAID, 1996), which underscores the importance of including catch beyond that which is sold formally in markets. The total estimated value of the park to local fisheries was US$3.884 million per annum at the park boundary.

In the Caribbean region, fisheries accounted for about US$19.0 million (compared to US$11 million for tourism) of the net value of the US$41-53 million in incremental benefits of the coral reefs and mangroves in Jamaica's Portland Bight Protected Area, over a 25-year period at a 10% discount rate (Cesar et al., 2000). Jamaica's Montego Bay Marine, a small area of only 43ha, had a net present value of US$1.7 - 7.5 million from trap, net, hand line and spear-fishing by local fishers (Ruitenbeek and Cartier, 1999). If the shadow price of labour is raised from 75% to 100% of the market rate however, the net present value becomes negative.

These studies demonstrate the differences both in the magnitude of fisheries yields, but also their values both absolutely and compared to other values. Part of the reason that producer surpluses from these fisheries may vary widely are likely to be due to the changes in property rights at different MPAs. Some MPAs remain de facto open access areas, others are closed to fisheries and others grant exclusive access to certain stakeholders. Provided exclusivity is enforced, a common property regime is similar to a private property regime (Bromley & Cernea, 1989) and would be expected thus to have more profitability than an open access fishery.

2.4.2 Tourist values for coral reefs and marine reserves.

Economic valuation studies related to reefs continue to proliferate, although many of these are not published in academic journals (Brander et al., 2007). There are several key areas of relevant research; (a) recreational values for reefs and MPAs held by tourists, (b) non-use values, (c) welfare effects with changes in coral reef quality and (d) economic impact studies of reef or MPA related tourist spending. These are discussed in turn.

2.4.2.1 Recreational use values and entrance fee WTP for reefs or MPAs

Where tourist access is good, recreational values are often the greatest single value attributed to a coral reef ecosystem and this may also be true at the global scale (Cesar et al., 2003). Studies have usually used travel cost (TCM), contingent valuation (CVM) and to a lesser extent choice modelling (CM) to measure a range of recreational values, including willingness to pay (WTP) and consumer surplus (CS) values. Of these, CVM is the most widely applied method to estimate tourist values of coral reefs (Brander et al., 2007) and often emerges as the most conservative method (Casey, 2006; Hundloe et al., 1987). Table 2.5 shows several of these studies.

Most of the available CVM studies estimate WTP to access MPAs through an entrance or user fee, as fees are charged at many MPAs and these are therefore familiar and realistic hypothetical scenarios even in areas where they are not currently charged. Entrance fee WTP has been especially researched in SE Asia and in the Caribbean (table 2.5). WTP in SE Asia range from US$1.85 per visit in Vietnam (Nam & Son, 2001) to US$5.50 in the Philippines (Arin & Kramer, 2002). Those in the Caribbean range from US$2 (Cesar et al., 2002a), to US$19 per visit in Belize (Dharmaratne, 2002), and from US$27.40 per year (Dixon et al.,

2000) to US$122 per year in Bonaire Marine Park (Parsons & Thur, 2007). Similar values of US$15-20 per visit are recorded in the Western Indian Ocean (WIO). Depondt and Green (2006), explored user fees in MPAs of South-East Asia and the Francophone countries of the Indian and Pacific Ocean and gave a general estimate of mean user fees of US$20-30 per visit per diver.

These WTP estimates can be used to identify which values are potentially suitable for revenue raising, where visitors benefit from large welfare gains and would therefore be willing to pay more for entrance fees. However, the application of these CS estimates is complicated, with unexpected and inconsistent elasticises of demand, which have produced contradictory results, calling into question the validity of some of the analyses (Lindberg, 2001). Also, even where WTP has been shown to be high, user fees are rarely adjusted (Depondt and Green, 2006). Only 25% of MPAs containing reefs charge divers user fees, and those that do often only charge US$2-3 (Green & Donnelly, 2003). Therefore, the potential these values generate for revenue raising or for controlling visitor numbers has not been fully utilised.

Relatively few studies have measured net values. For example, Cesar and van Beukering (2004) estimate that recreational users of Hawaiian coral reefs enjoy an additional CS of US$133 million each year and Ayob et al., (2001) found that visitors to Pulau Payar MPA in Malaysia enjoy a CS of US$223 per person.

The two studies that estimate values for Bonaire (Dixon et al., 2000; Parsons & Thur, 2007) have WTP estimates too different to be explained by inflation over time. It is likely that elicitation format and scenario specifics produced this variation. Interestingly, the lowest value was estimated with an open-ended elicitation format, which is the least incentive compatible and should therefore have been the highest. The highest value came from the payment card approach. Parsons & Thur (2007) note that at the time of the first study, entrance fees were purely hypothetical, which was not true for their study, which may have had an effect in terms of familiarity with the entrance fees.

In the most comprehensive review to date, Brander et al., (2007) carried out a meta-analysis of recreational values associated with reefs, using a standard metric of US$ (in 2000 prices). They calculate mean values per visit are US$184 and median ones are US$17, due to a skewed distribution with a long tail of high values. They find that different methods produce widely different results, with CVM producing the lowest WTP estimates, which they suggest is due to the measurement of different welfare estimates, such as Marshallian CS, changes to consumer or producer surplus from quantity or quality effects or gross or net revenues.

Table 2.5. Contingent Valuation Studies on WTP for User or Entrance Fees to Visit MPAs or coral reef dive sites in 3 regions. WIO = Western Indian Ocean.

Study	Study Area Reported	Mean WTP per person
(Nam & Son, 2001)	Hon Mun Islands MPA, Vietnam, SE Asia	US$1.85 / visit
(Khanh & Hung Son, 2004)	Hon Mun Islands MPA, Vietnam, SE Asia	Local Visitors: US$1.24 /visit Foreign visitors: US$1.85 /visit
(Yeo, 1998)	Pulau Payar Marine Park, Malaysia, SE Asia	US$4.20 / visit
(White et al., 2000)	3 diving areas, Philippines, SE Asia	US$3.27 - 5.34 / visit
(Arin & Kramer, 2002)	Philippine MPA, SE Asia	US$2.4 - 5.5 / visit (local and international visitors)
(Dharmaratne, 2002)	Belize Barrier reef, Caribbean	US$19 / visit US$36 / "dive passport"
(Cesar et al., 2002a)	Grenada, Caribbean	US$4 / visit (current condition)
(Cesar et al., 2002a)	Negril, Caribbean	US$18 / visit (current condition)
(Cesar et al., 2002a)	Hol Chan MPA, Belize, Caribbean	US$2 / visit (current condition)
(Simmons, 1996)	Buccoo Reef Marine Park, Caribbean	Foreigners US$6.24 / visit Trinidadians US$5.62 / visit
(Dixon et al., 2000)	Bonaire MPA, Caribbean	US$27.40 / year
(Parsons & Thur, 2007)	Bonaire MPA, Caribbean	US$62.50 and $122.36 / year US$10.49 – 20.39 / visit
(Mathieu et al., 2003)	Seychelles MPAs, WIO	US$19.80 to scuba dive/ visit US$12.20/ visit (CS US$2.20/ visit)
(Mohamed, 2007)	Dhigali Haa MPA, Maldives, WIO	US$15±5 / visit
(Hundloe et al., 1987)	Great Barrier Reef MPA	A$8/adult (CS of A$4/visit)

Thus despite the increasing number of reef-related valuations, making general inferences about reef studies remains difficult. This is because even when studies use the same method, they often vary in terms of assumptions made, methods used, services assessed, goals and context. They also vary in terms of units used to calculate total values, for example in per unit area, per visitor, for a certain period of time (day, visit, year), in different currencies and years of value. This means that the value estimates may not be comparable.

However, various trends can nevertheless be seen. For example, the quality and uniqueness of an experience are major determinants of value as are other highly site-specific attributes such as crowding and area of reef (Brander et al., 2007; Dharmaratne et al., 2000). There was a positive relationship between the size of dive sites and their value, providing the first evidence of scope sensitivity in reefs and a negative relationship between number of visitors and value (Brander et al., 2007). Regional means were shown to be similar, although the Caribbean values were the highest and combinations of activities were more valuable, with snorkelling alone producing quite low values. Of concern was the fact that authorship explained 65% of the variance in recreational values, in contrast to a meta-analysis for woodland recreational values carried out by Bateman and Jones (2003).

It should be noted that the focus of these valuation studies on highly visited areas means that these values are unlikely to be lower elsewhere. Publications are increasingly using secondary data to look at regional patterns of economic benefits generated by reefs (Burke et al., 2002). However, there remains a poor understanding of the regional and global differences in the full spectrum of tourist values associated with reefs. Benefits transfer using previously estimated recreational values is unlikely to be accurate, given mean absolute percentage errors of 186% (average) and 79% (median) (Brander et al., 2007). To ameliorate this problem, these authors recommend more high quality recreational value studies combined with more information on coral quantity and quality in published studies.

2.4.2.2 Welfare impacts of changes in environmental quality, including conservation, for coral reefs and MPAs.

Coral reefs can be improved or damaged, whether or not they occur within formally protected areas. There has been little discussion of the effect of improvements and damage on reef recreational values, as research tends to value a recreational experience given current conditions. These types of study can be an important decision making tool, for example to understand potential changes in visitation with decreased environmental quality from damage, or increased quality from management and protection. Table 2.6 summarises the main studies using CVM to understand these effects for MPAs and coral reefs.

These studies do however demonstrate benefits of conservation in the context of general ecosystem decline. For example, Bhat (2003) used TCM and CVM to estimate that quality improvements in coral, fish abundance and diversity in the Florida Keys would result in a 69% increase in recreational values per trip and that management costs incurred would only constitute 1-2% of recreational benefits generated. Similarly, Parsons and Thur (2007) used CVM to estimate economic losses from coral quality decline in Bonaire (based on visibility, species diversity and percentage coral cover). They found that modest declines in quality resulted in annual economic losses of US$45 per person and larger losses of US$192 per person. Another study by Setiasih (2000) used choice modelling to evaluate the tradeoffs between price, coral quality, and reduced crowding. Visitor WTP for a 1% increase in living coral cover was estimated at US$0.15 and WTP for a decrease in each additional boat at the snorkel location was US$0.53 (reported in Lindberg, 2001).

Most CVM scenarios use trusts and conservation projects as WTP elicitation vehicles. Some studies produced large number of protest responses, but could nevertheless have large mean values e.g. (Casey, 2006; Mohamed, 2007). Interestingly, Mohammed (2007) found that the mean WTP for a conservation fee was US$20 higher than that of a user fee, which could be due to the perception of the conservation fee as additional to the entrance fee or strategic behaviour. The type of survey was found to affect the results of the conservation fee estimate. The effect of the scenario specifics was also observed by Setiasih (2000).

These studies demonstrate that tourists are willing to pay for reef improvements, from US$0.45 per visit for reef improvements in the Philippines (Ahmed et al., 2007) to US$18 per year in Jamaica (Wright, 1994). There is also evidence that they are willing to pay towards trust funds that will improve reefs in the future (Cesar et al., 2002b). A few studies estimated both WTP and CS e.g. where CS was found to constitute 18% of the total WTP estimated (Mathieu et al., 2003) or where it constituted 28% (Park et al., 2002).

Although tourist values of unprotected coral reefs areas have been more highly researched, MPAs are potentially more suitable for studies estimating use and non-use values, as they are self contained units with defined boundaries and valuation estimates are sensitive to scale. While tourist recreational values for coral reefs are likely to be limited to non-extractive use values, values held by tourists for MPAs and reef conservation can in theory span the entire spectrum of the values. They may include significant appreciation of ecosystem services (indirect use values), continued support of local traditional direct use values of local communities, as well as option and non-use values. Thus MPA-related recreational values would be expected to be larger than those of unprotected areas of reefs, where MPAs are effective (Williams & Polunin, 2000).

Reef improvements and conservation are of course inextricably linked and there is little information available to tease apart the relative effects of quality of experience and conservation benefits generated by the hypothetical endowments that many studies use, or the marginal changes in values generated by management induced changes in attributes of reefs within MPAs (Williams & Polunin, 2000).

Table 2.6. Results of Some CVM research to value changes in environmental quality, including conservation, for coral reefs and MPAs.

	Study site Study reference	Scenario Valued	Mean WTP per person (US$)
MPAs	Curacao Marine Park (Spash 2000)	A per annum payment for 5 years to be paid into a trust fund to improve environmental quality from 35% to 75% of its potential	$25.21/ annum for 5 years
	Jamaican Marine Park (Spash 2000)	A per annum payment for 5 years to be paid into a trust fund to improve environmental quality from 60% to 100% of its potential	$25.89 / annum for 5 years
	Bali Barat National Park (Setiasih, 2000)	Additional WTP of snorkellers if (a) went directly to park and (b) if it went to the government	$2.90 / person $0.43 / person
	MPAs in Hawaii (Cesar et al, 2004)	Coral reef conservation fee per experience (additional to current costs)	Incl non-payers; $2.81. Excl non-payers; US$3.77 / visit
	Dhigali Haa MPA, Maldives (Mohamed, 2007)	Mean one-off conservation fee per visit for all tourists visiting Baa Atoll	$35±5 / visit
	Bonaire MPA (Parsons & Thur, 2007)	Welfare impacts of losses in coral quality per person per year	$45 for modest changes $192 for larger losses
	Hol Chan MPA, Belize (Cesar et al, 2002)	WTP for reef experience with environmental improvement	$9 / visit
Coral reefs	Negril, Jamaica (Cesar et al, 2002)	WTP for reef experience with environmental improvement	$19 / visit
	Ko Chang, Thailand (Seenprachawong, 2006)	WTP for increase in entrance fees (from 0.65c) to fund better mnt	$5 / visit
	Eilat Coral Beach Nature Reserve (Wielgus et al., 2002)	WTP per dive for moderate improvements in quality	$1–3 / visit
	Phi Phi Islands, Thailand. (Seenprachawong, 2003)	A per annum payment for 5 years to be paid into a trust fund	Local Visitors: $7.17 Foreign visitors: $7.15
	Negril, Jamaica (Wright, 1994)	(a) WTP for reef in current condition (b) to restore reefs to "excellent" condition	(a) $31 / year (b) $49 / year
	Montego Bay Coral Reefs (Spash et al., 1998)	WTP for trust fund to support strategies to improve marine biodiversity by 25%	$1.17 to $2.98 / visit
	Curaçao Coral Reefs (Spash et al., 1998)	WTP for trust fund to support strategies to improve marine biodiversity by 25%	$0.26 to $5.82
	Grand Anse, Grenada (Cesar et al., 2002)	WTP for conservation	$18 / year
	Bolinao, Philippines (Ahmed et al., 2007)	WTP per year for reef improvements	$0.45 / visit $1.60 / annum
	S E Florida Reefs (Johns et al., 2003)	Increase in trip cost per person-day	$12.74 for natural reefs $8.63 for artificial reefs
	Mexican corals (Casey, 2006)	WTP for public trust to protect corals	$57.93
	Florida Keys (Park et al, 2002)	WTP to preserve the current water quality and health of the coral reefs	$735 (CS is $207)

2.4.2.3 Economic impacts of tourism

Economic impacts of MPAs are generated through reserve-related tourism (creating jobs and income), which may have a significant tangible effect on local incentives and attitudes. Indeed a number of countries with marine protected areas rely on ocean-based tourism as a central component of their economy (Dixon, 1993) and tourism is the fastest growing sector associated with coral reefs (Hoegh-Guldberg, 1999).

These transfers of funds from one group to another represent financial impacts of MPAs, rather than net economic values. They have made explicit flows of money generated from these reefs and the large financial impacts reef-related tourism and spending generate in markets. From a local perspective, these may be more important than net welfare-related non-use and option values, which cannot necessarily be captured.

Several studies have quantified gross financial values associated with tourism at coral reef sites and MPAs, to the local economy and sometimes to the wider economy using economic multipliers. For example, diving in South Florida was also estimated to produce US$625 million in expenditures and 16,000 jobs and snorkelling US$340 million in expenditures and 7,400 jobs (Johns et al., 2003). The Great Barrier Reef has a gross value of US$1.5billion in terms of holidays on island resorts, reef trips and accommodation (Driml, 1999). In the Caribbean, direct gross economic expenditures of visitors on accommodation and reef recreation are estimated at US$43.5 million for Tobago and US$91.6 million for St. Lucia (assuming 25% of 40% of tourism is linked in part to the reefs). Additional indirect economic impacts, driven by the need for goods to support tourism (such as boats, towels and beverages) contribute another US$58–86 million to the national economy in Trinidad and Tobago and US$68–102 million in St. Lucia (Burke et al., 2008). In addition, the value of local residents' use of the reefs and coralline beaches was estimated to be US$13–44 million in Tobago and US$52–109 million in St. Lucia (based on average wage rates and typical durations of trips). Similarly, Bunce and Gustavason (1998) calculated a net present value of US$315 million in 1996 for Montego Bay coral reefs in Jamaica.

These studies have demonstrated the financial gains which can be produced by tourism, which is suggested as a more sustainable alternative to fishing at these sites. As a result, there have been increasing calls for investment in alternative livelihood schemes, which typically re-train fishers as dive guides (Beger et al., 2004; Westmacott et al., 2000). Yet tourism is also known to have negative consequences for reefs, through trampling and over-development of coastlines which generates pollution and often involves habitat modification such as mangrove clearance and dredging (Hawkins & Roberts, 1993). Tourism can also increase demand for fish, which increases fishing effort locally.

A smaller number of studies have quantified gross or net values associated with tourism at coral reef sites or MPAs. For example, annual benefits of dive tourism in the Caribbean in 2000 were estimated at US$2.1 billion, of which US4.7 billion was in gross revenues, with an estimated return of 0.35 and a 1.25 multiplier effect (Burke & Maidens, 2004). Divers make up about 10% of all visitors but contribute about 17% of all tourism revenue in the Caribbean, where tourism is projected to grow at 5.5% a year. Israel (2004) value the direct gross contribution of the Virgin Islands Marine Park to GDP through tourism and recreation at US$45 million per year, with an additional US$25 million in indirect impacts to the economy. In addition, (Ruitenbeek & Cartier, 1999) estimated a net present value of tourism spending of US$315 million for the Montego Bay Marine Park, in Jamaica. Dixon et al., (2000) estimated US$4.7 million in diver expenditures and US$340,000 in revenues from taxes in 1991 at the Bonaire Marine Park.

Large recreational impact estimates for coral reefs are used to emphasize their importance to policy makers, stimulate investment and increase support for conservation measures. However, in isolation from further research these studies provide little information on the motivation behind spending in terms of use or non-use values.

2.4.2.4 Wildlife tourism

It has been estimated that 20-40% of all international tourists have an interest in some form of wildlife watching (The International Ecotourism Society, 1998). Interactions with large charismatic creatures, such as whales and sharks can draw people from all over the world and have both a large economic impact, related to the generation of significant non-extractive and non-use values e.g. (Christ et al., 2003; Tapper, 2006). Where reef-related species focused valuation has been carried out, tourist spending has usually been used. For example, Newman et al., (1997) estimate that whale shark ecotourism generates about A$12 million annually in Western Australia and US$3 million in Phuket, Thailand where 45% of the funds generated from the US$100 per person entrance fee went towards park management. In the Seychelles, whale shark watching by just 496 people in 2005 provided a total income of just over US$35,000, of which US$20,500 was to support a whaleshark monitoring programme. The total added value of tourism from visitor expenditure was calculated to amount to nearly US$1.75 million. In a rare application of CVM to species related values, Loomis and Larson (1994) estimated a WTP for grey whales of about US$20 per household, with users having higher WTP.

Wildlife tourism is expected to continue to grow. In 1991 an estimated 4 million people watched whales, by 1998 this had risen to 9 million people, and the total expenditures related to whale watching stood at just over a billion US dollars, more than three times the revenues in 1991, and benefited 495 communities around the world (Hoyt, 2001).

2.4.3 Local community values for and impacts of conservation in developing countries.

Leisher et al., (2007) carried out 950 local community interviews in villages near 4 highly successful MPAs to compare changes over time and compared to control sites. They found evidence of significant resident benefits, such as employment diversification, poverty reduction, new governance mechanisms, as well as health and development benefits. Loper et al., (2008) reviewed research to assess socio-economic conditions based on 885 household surveys in 16 sites in Central America and find that reef dependence exceeds 50%; 29% of households were dependent on fishing as their main source of income, compared to 25% in tourism, but that tourism was replacing fishing over time. This contrasts to communities in the Pacific and SE Asia, which are still highly dependent on small scale subsistence or commercial fishing. 26% of households are concerned by illegal fishing as a key threat, followed by climate impacts for 21%, as well as tourism and industrial development. Despite a general perception of resource decline, they found low awareness and support of MPAs in the Caribbean as people had major concerns as to the effects of tourism on their way of life, despite generally supporting increased tourism (Loper et al., 2008).

The majority of PAs are expected to produce significant and concentrated costs for local residents. However Wittemyer et al., (2008) show that for 306 terrestrial PAs in 45 countries in Africa and Latin America, population growth rates near PA borders (10km buffer) were nearly double rural growth rates (they were higher than national growth rates in 80% of MPAs). This growth was positively correlated with international donor investment into conservation programs, including community development and capacity building projects. It was also correlated with national GDPs, which would be expected to affect national funding of PAs. This effect was evident even in similar eco-regions (which controls for the confounding effect of different eco-regions), suggesting this is not only a result of PAs being placed in areas of high ecological integrity. Growth rates were also higher inside for 85% of PAs, meaning that displacement is not the cause of this trend. These results suggest that PAs are attracting immigrants, due to their perceived benefits from increased economic and occupational opportunities. Unfortunately, this growth could threaten conservation efforts, as it was also correlated with deforestation.

Most CVM applications in developing countries have focused on water supplies and health and sanitation services and have shown that people are usually WTP for services if they make up less than 5% of household income (Garrod & Willis, 2000). CVM can be a useful tool for decision-makers, to value resource that have traditionally been provided free of charge and regarding investment strategies for the management of PAs in developing countries (Maharana et al., 2000). However, it has only rarely been applied to measure local values for protected areas and even less for MPAs (Adams et al., 2008). The main studies that have carried out CVM to assess local values for marine conservation are given in Table 2.7. These studies suggest that local communities in developing countries are WTP for access to and conservation of marine resources (even despite negative impacts e.g. (Naylor, 1998), although they are highly constrained by their incomes. Several elicited a large number of zero bids, including but not limited to protest responses e.g. (Adams et al., 2008). Mean WTP ranged from US$1.50 per person to US$23 per household per year, with values largely reflecting the level of dependence on marine resources. WTA values are less conservative (Arrow et al., 1993), so are likely to overstate local values. Adams et al., (2008) comment that the current government budgets allocated to the park are small in relation to the welfare gains local people gain.

2.4.4 Using CVM to for natural resource valuation in developing countries.

Meta-analyses of CVM studies, showed that a large number did not report a significant income effect, which may be an artefact of the survey method (Schlapfer, 2006). This is of concern, as theoretical validity is tested by demonstrating predicted changes in WTP based on economic theory (Mitchell & Carson, 1989), e.g. it should be linked to ability to pay and 'sensitive to scope'. Insensitivity to scope refers to the problem of when the value of a good is not increased by the inclusion of a greater quality or quantity of the good (Boyle et al., 1994). Insensitivity to scope has been a major criticism of the CVM method (Carson, 1997). Similarly, embedding effects, where WTP for a good varies depending on whether it is evaluated on its own or as part of a more inclusive category (Kahneman & Knetsch, 1992), is a major bias associated with CVM and this can also be assessed by looking at bundles of categories and single uses.

The NOAA panel recommends that CVM studies should include tests of sensitivity to scope, by seeing if the values elicited are sensitive to the quantity of the good being offered (Arrow et al., 1993). Most studies do seem to pass these tests (Carson, 1997), although less so for unfamiliar goods. Familiarity with resource reduces hypothetical nature of question for poor communities (Naylor, 1998). Certainty estimates can also be used during econometric analysis to exclude uncertain bids, where respondents are unlikely to stand by the bids they initially give, however certainty estimates can constitute a somewhat arbitrary and subjective way of reducing bids (Brouwer et al., 2009). Murphy & Stevens (2004) caution that most of the calibration techniques lack a theoretical justification, and therefore need to be used with caution and based on a better understanding of why hypothetical bias exists.

Table 2.7 CVM studies to assess local values for aquatic conservation in developing countries.

Study site (reference)	Main results	Notes
Morro do Diabo State Park, Brazil (Adams et al., 2008)	WTP for park conservation US$1.58 per person (use and existence values). In aggregate corresponds to US$2.11 million per year.	High incidence of null WTP and protest votes. 91% had never heard of the MDSP, but 96% stated that the park should be preserved. Preservation value is strongly associated with income.
Wildlife and wetland reserve in Nepal (Shrestha, 2007)	Average WTA for households near the reserve is US$238. WTA was affected by distance to reserve, availability of substitute sites, the household family size, the respondents age and education, occupation and environmental attitude.	Open-ended CVM to assess WTA for 160 households to forgo access to natural resources. 34% zero responses. Households who collect grass inside the park have lower WTA, which may be since this is seen as in-kind compensation for costs.
Mangrove swamps, Micronesia (Naylor, 1998)	WTP US$1-1.26 million per year for conservation and access to mangrove swamps indefinitely, although mode WTP was US$0. Find premium on existence and indirect ecosystem services of mangroves, over and above the direct use values. WTP estimates were 8.3% for tax and 4.6% for permits of monthly household income (median values were 2.5% and 2.1%). Poorer households relied more on these swamps, but were WTP less for access.	Open-ended CVM. Respondents preferred a tax system for conservation and use to a permit system simply for access. Over 80% thought fees for use were a good idea. Assume net value of collected species is equivalent to gross value, as OC of labour is very low and equipment costs are negligable (gill nets). Income effect was stronger than substitution effect. Subsistence sector gets 58% of gross market benefits.
Effective wetland conservation in Sri Lanka (Wattage & Mardle, 2008)	Median WTP is Rs. 264.26. Non-use values make up 45-55%.	Expectation of future use was significant, but income was not. They comment that CVM's ability to measure values for unfamiliar and complex goods and embedding effects are poorly understood.
Borivli National Park, India (Hadker et al., 1997)	WTP for the maintenance and preservation on average, Rs7.5, per month, for the next five years. Extrapolating to the city of Bombay, this amounts to Rs20 million each month for five years.	Needed to statistically adjust for embedding and anchoring effects.
Khangchendzonga National Park, India (Maharana et al., 2000)	WTP for the maintenance and conservation of the park US$6.20/household per year by local community members. Average WTP of US$1.91/domestic visitor per visit for improvement in environmental conservation.	WTP was strongly influenced by age, education and income. However, they suggest that since CVM does not include non-monetary contributions, it underestimates true values.
Pulau Weh MPA, Indonesia (Iqbal, 2006)	WTP US$13.60 per household per year to preserve the MPA.	People involved in nature-based tourism near the MPA had an annual per capita income of US$216 compared to US$150 for those working in other sectors.
Wakatobi MPA, Indonesia (Hargreaves-Allen, 2004)	Mean WTP of approx US$23 per household per year for access and use of reefs. Non-use, recreational and spiritual benefits were approx US$5 per household per year.	Largely subsistence community. Use values were linked to direct use, income benefits and option values. Non-use values were highly linked to ceremonial and traditional uses.
Hon Mun MPA, Vietnam (Khan Nam et al., 2005)	Domestic visitors' WTP US$3.10 per visit.	Measured domestic visitor WTP only marginally larger than the US$3.90 international.

2.4.5 The relative contribution of different values in coral reef ecosystems and MPAs.

The proportion of values generated at a coral reef site varies depending on many factors. Fisheries values will depend on local aspects such as on the degree of local reliance on fishing for subsistence purposes, accessibility to markets, search costs and the number of fishers. Tourism values will depend highly on the degree of local tourism infrastructure and development, as well as the ability of the MPA and local businesses to capture consumer surpluses. Coastal protection values are complex to determine as they depend on many factors including distance to shore, frequency of storms and the size of the sand granules. Finally, ecosystem services will depend largely on biophysical features, which vary widely between sites and are costly to measure. Often, areas where tourism has become developed have decreased extractive uses, although this depends on the extent to which locals are able to retain income from tourist expenditure. Thus these values will also be expected to change over time.

An analysis of 14 studies which quantified several economic values for reefs or MPAs (table 2.8) suggests that tourism constitutes 11-84% of all values measured, with a mean of 51%. Similarly, fisheries make up from <1% to 85% of the values of these reefs, with a mean of 19%. Coastal protection, which is also frequently measured, ranges from 4-45% of the values measured, with a mean of 26%. Four of the studies also measure biodiversity values, which make up a mean of 6.4% of the values. The two studies which looked at local use, calculated it as a mean of 26% of the values quantified (Cooper et al., 2008) . The only study to look at carbon sequestration estimated it to be worth 8% of all the values measured (Cesar et al., 2000). The study by (Spurgeon et al., 2004) was unusual, as it measured non-use values for visitors (tourists) to the area, for local residents and for US citizens, who would not visit these reefs. These were worth 2%, 36% and 50% respectively and dwarfed fisheries values of 8% and coastal protection of 4%.

Although non-use values can constitute the greatest part of a resource's value, they are rarely included in valuation research (Balasubramanian et al., 2003), perhaps because they can be difficult to capture. This is also likely to be due to the high transaction costs involved in on-location stated preference studies, relative to use of secondary data for direct use value estimates. A recent exception was carried out by Spurgeon et al., (2004) who valued coral reefs in American Samoa using CVM. Relatively poor tourism development there means that tourism spending is low. However, they estimated that 75% of the US$5 million/year in total benefits accruing to American Samoa residents is made up of non-use values. This was additional to US$5 million/year in non-use benefits accruing to US citizens. Although they acknowledge uncertainty in US resident non-use values, they also write that true international non-use values could be significantly higher (perhaps by a factor of 10). Interestingly, an unpublished study of WTP for reef conservation in Hawaii and finds similar values for both visitors and non-visitors of these reefs (Cesar et al., 2004).

The typical ratio of non-use value to use value for natural resources such as wilderness areas, beaches and water quality is reported to range from 0.3-0.89, with a mean of around 0.6 (Hee Dong, 2002). Local community non-use value constituted 45-55% of effective wetland conservation WTP in Sri Lanka (Wattage & Mardle, 2008).

Only a handful of studies have measured both local population and tourist WTP for coral reefs or reef conservation. Some of these have reported higher values for tourists, e.g. Spash et al., (1998) in Curaçao and Maharana et al., (2000) for its maintenance and conservation of the Khangchendzonga National Park, a terrestrial PA in India, although the means are not very different. Others report marginally higher values of local communities e.g. Spash et al., (1998) in Montego Bay, and by Gustavson (1998) to restore Montego Bay biodiversity. WTP is often strongly influenced by age, education and income.

Table 2.8. The relative contribution of different values for coral reefs and MPAs.

Site (reference)	Overall value	Proportion of values measured
Global reefs (Cesar et al., 2003)	total net benefit per year of the world's coral reefs is US$29.8 billion	Tourism 32% Coastal protection 29% Fisheries 18%
Caribbean reefs (Burke and Maidens, 2004).	Caribbean reefs US$3.1 -4.6 billion in 2000	Dive tourism 54% Coastal protection 38% Fisheries 8%
Hon Mun MPA, Vietnam (Khan Nam et al., 2005)	Conservation value US$128,245 for domestic visitors (53%) and US$114,945 for foreign visitors (47%).	Local fisheries support function 32% benefits reef-related recreation industry 68%
Bohol Marine Triangle, Philippines (Samonte-Tan et al., 2007)	US$1.3 million in annual revenues. NPV US$11.5 million ecosystem goods and services, over 10 years with 10% discount rate.	Tourism 44% Fisheries 39%
Indonesia's Wakatobi National Park, Indonesia (Hargreaves-Allen, 2004)	Annual value of US$308,000 or US$12,100/km² in 2004. NPV over 20 years with a 10% discount rate is estimated at US$2.6 million.	Fisheries 85% Tourism 11% Coastal protection 4%
American Samoan coral reefs (Spurgeon et al., 2004)	US$10 million per year, of which non-use values make up 88%.	Coastal protection 4% Fisheries 8% Visitor non-use 2% Resident non-use 36% US citizen non-use 50%
Guam's reefs (Van Beukering et al., 2007)	Total Economic Value for was estimated at US$127.3 million per year	Diving / snorkeling 38% Fisheries 17% Biodiversity 9% Coastal protection 36%
Commonwealth of the Northern Mariana Islands coral reefs (Van Beukering et al., 2006)	TEV US$61.2 million per year (market values 73%, non-use 27%)	Tourism 74% Fisheries 2% Diving and snorkelling 10% Coastal protection 14%
Turks and Caicos Islands (Carleton & Lawrence, 2005)	US$47.3 million a year (of which US$17.7 million a year fed directly into the GDP)	Tourism 42% Fisheries 8% Biodiversity 11% Coastal protection 39%
Jamaica's Portland Bight Protected Area (Cesar et al., 2000)	NPV US$52.6 million for 25-year period and at a 10% discount rate	Tourism 21% Fisheries 36% Carbon sequestration 8% Biodiversity 1% Coastal protection 34%
Jamaica's Montego Bay reefs (Ruitenbeek and Cartier, 1999)	NPV US$400.0 million. NB 69% of biodiversity value is from international visitors and 31% from Jamaican residents.	Tourism 79% Fisheries 0.3% Coastal protection 16% Biodiversity 4.7%
Tobago's coral reefs (Burke et al., 2008)	Net value approx US$147 million. NB 38% tourism value direct. 86% fishing value direct.	Tourism 79% Local use value 20% Fisheries 1%
St Lucia's coral reefs (Burke et al., 2008)	Net value approx US$260 million. NB 52% tourism value direct. 85% fishing value direct.	Tourism 68% Local use value 31% Fisheries 0.002%
Belize's coral reefs (Cooper et al., 2008)	Gross values of US$220-310 million per annum.	Tourism 51% Fisheries 4.5% Coastal protection 44.5%

The use of comparisons between the absolute values and the constituent contributions of different aspects reported at different reefs is informative, as it can give a rough idea of the relative importance of different uses in these areas. It can also be used to understand the potential magnitude of specific values which, have not been measured in this research, but have been elsewhere, such as biodiversity values. However, such comparisons are difficult, despite the fact that fisheries and tourism values are most commonly measured, as similarly to other valuations, different methodologies are often applied which give different values (stated or revealed preference, WTP or WTA), or for a variety of stakeholders (local subsistence, local commercial, wider economic impacts). Also studies measure both gross and net values, measuring either consider contributions of spending or CS and PS, which are not comparable as rates of return from gross values vary widely between different types of values and in different regions. Furthermore, in terms of NPVs calculated for coastal resource valuation, time periods considered vary and discount rates applied range from 1% to 15%, although most common discount rate applied is 10% e.g. (Cesar et al., 2003; Hargreaves-Allen, 2004; Samonte-Tan et al., 2007). All these aspects must be considered when comparing values between studies and regions.

2.5 The Case study site.

2.5.1 Belize.

Belize is a small sub-tropical country of around 23,000km² in Central America. Wilkinson (2004) reports that 64% of reefs in this area are threatened by high levels of human activities, that there are few areas with highly protected MPAs and most of those that do exist are not enforced. Indeed only 6% of the 285 MPAs are rated as effectively managed. Large economic losses are predicted if coral reef degradation continues, of US$350-870 million per year by 2015 of the US$3,100 - 4,600 million of current annual benefits from fisheries, dive tourism, and shoreline protection services (Cesar et al., 2003).

Figure 2.5. The Meso-American Region. Belize is in shown in red.

Belize has a relatively small population of 291,800. Belize had an average GDP per capita of US$4,092 in 2005, which is relatively low for the Caribbean region. This region has one of the fastest growing tourism industries in the world, primarily focused on coastal centres and cruise ship tourism (Arrivillaga & Garcia, 2004).

The Belize barrier reef system (BBRS) is the largest living reef in the Western hemisphere, running parallel to the coast. It contains over 66 hard coral species and over 500 species listed as threatened in the IUCN red list (Baillie et al., 2004), in addition to numerous threatened and endangered species such as sea turtles and manatees. It was designated a world heritage site in 1996 and is remarkable given that it is the largest barrier reef in the northern hemisphere and is a significant habitat for threatened species. This is considered one of the richest regions in the wider Caribbean and has been identified as a global conservation priority, one of the 18 marine biodiversity hotspots (Roberts et al., 2002) and one of WWFs Global 200 eco-regions (Olson & Dinerstein, 1998).

The BBRS contributes around 30% to Belize's GDP through commercial fisheries (conch and lobster prominent among them), high-quality eco-tourism and, more recently, a boom in cruise tourism and various private sector investments for coastal development and aquaculture (Cho, 1995). However, Belize's reef has suffered major damage due to hurricanes in 2000, 2001 and 20002 as well as significant coral bleaching throughout the 1980s and 1990s (Kramer & Kramer, 2002). Coral cover has not recovered from these events (Almada-Villela, 2002). In addition, MPAs in this region suffer from lack of enforcement, and lack of adequate human and financial resources to protect these habitats (Burke & Maidens, 2004).

In 2004, 42% of the national area was protected, including forest, wildlife and marine reserves. Belize has established a network of 19 marine protected areas, since Hol Chan, the first marine reserve, was established in 1987 (Wood, 2007). This is the only reserve in Belize to be self financing through the collection of user fees (Cho, 1995). These MPAs have various levels of protection, levels of management, sizes, zones, primary management aims and other key features. Management responsibility lies with different groups for the different MPAs, but is usually co-managed between a local NGO and government department. While 45.4% of tourists visit the barrier reef, 29.3% of all tourists visit one of the marine protected areas, the most popular being the Blue Hole Marine Park, which received almost 55,000 visitors in 2006 (BTB, 2005).

The economy was traditionally based on agriculture, logging and fishing, although tourism makes up main income for 24% of the population (Loper et al., 2008). In general there is a relatively high level of poverty (11%) and unemployment (11%). 63% of the population is thought to be literate and mean household size in 4.5 people.

Loper et al., (2008) report that Belizean coastal communities perceive a loss of control, linked to fast infrastructure development and international purchases of coastline, which has increased prices beyond the reach of most locals. In Placencia, income from tourism is seasonal, and while being higher than other countries, is undermined by increased costs of living. 76% of households thought that their life is endangered by loss of resources in the region. The perceptions of management organisations are generally poor, with fishers feeling that MPAs solely benefit tourism and many believing that the MPA had negatively affected them.

Other research in 5 communities in Belize identified a strong relationship MPA support, the level of tourism development and the belief MPAs attract tourists local people (Deidrich, 2006).

Perceptions were generally positive about tourism (related to increase jobs and community development), although of these negative impacts were related to crime and drug use.

2.5.2 Tourism in Belize and on the Belize Barrier Reef

Tourism is one of the fastest growing sectors of the Belizean economy, with the US constituting 61% of the visitors. The Belize Tourism Board estimated that tourism income from spending amounting to Bze$400 million, by a quarter of a million visitors, accounting for 16% of GDP in 2005. Tourism is estimated to have produced 13,198 jobs, of which 87% are held by Belize nationals. Cruise ship tourism brought in 655,931 visitors in 2006, a 1300% increase since 2001. Belize's tourism industry seems to be at an early stage of development, with an average increase of 9% annually (Dharmaratne, 2002).

Snorkelling and diving are the two most popular activities of tourists, followed by sailing and recreational fishing (Dharmaratne, 2002). While 45.4% of tourists are estimated to visit the barrier reef, 29.3% of all tourists are also estimated to visit one of the marine protected areas, the most popular being the Blue Hole Marine Park, which received almost 55,000 visitors in 2006.

Cooper et al., (2008) suggest 64% of "tourist days" in Belize are spent in the coastal areas and involve reef-related activities such as snorkelling, sport fishing or using a coralline beach. They estimate that in Belize in 2007, tourists spent between US$30–37 million on sport fishing and diving alone. Total direct spending by reef tourists (e.g. on trips, accommodation) is in the region of US$150-$196 million each year, whilst additional indirect economic impacts, including locally manufactured materials that support the industry, contribute another US$26–$69 million a year. This makes up an expected gross value of US$135–176 million in reef-associated tourism to the national economy of Belize in 2007 (12-15% of GDP).

Recently, Dharmaratne (2002) used a zonal travel cost estimation function to value the CS from tourist trips to Belize at US$527 for US citizens and US$ 219 for UK citizens. By taking into account a respondent's indication of the importance of diving or snorkelling to their trip, these are estimated to be worth US$337 and US$149 for US and UK visitors respectively, which represents 57% of trip costs. However, results from the CVM analysis suggest that TCM had overestimated diver benefits and that dive values may correspond to a much lower percentage of the trip value (6-24%).

Belize is establishing itself as a reef and rainforest eco-tourism destination, with marine ecosystems key to its tourism success. However, Diedrich (2006) suggests that the current rapid rate of tourism expansion in Belize means that negative impacts could soon surpass positive ones and stresses that MPAs will be critical for maintaining the integrity of Belize's reef tourism through the effective establishment of user fees, carrying capacities and enforcement policies.

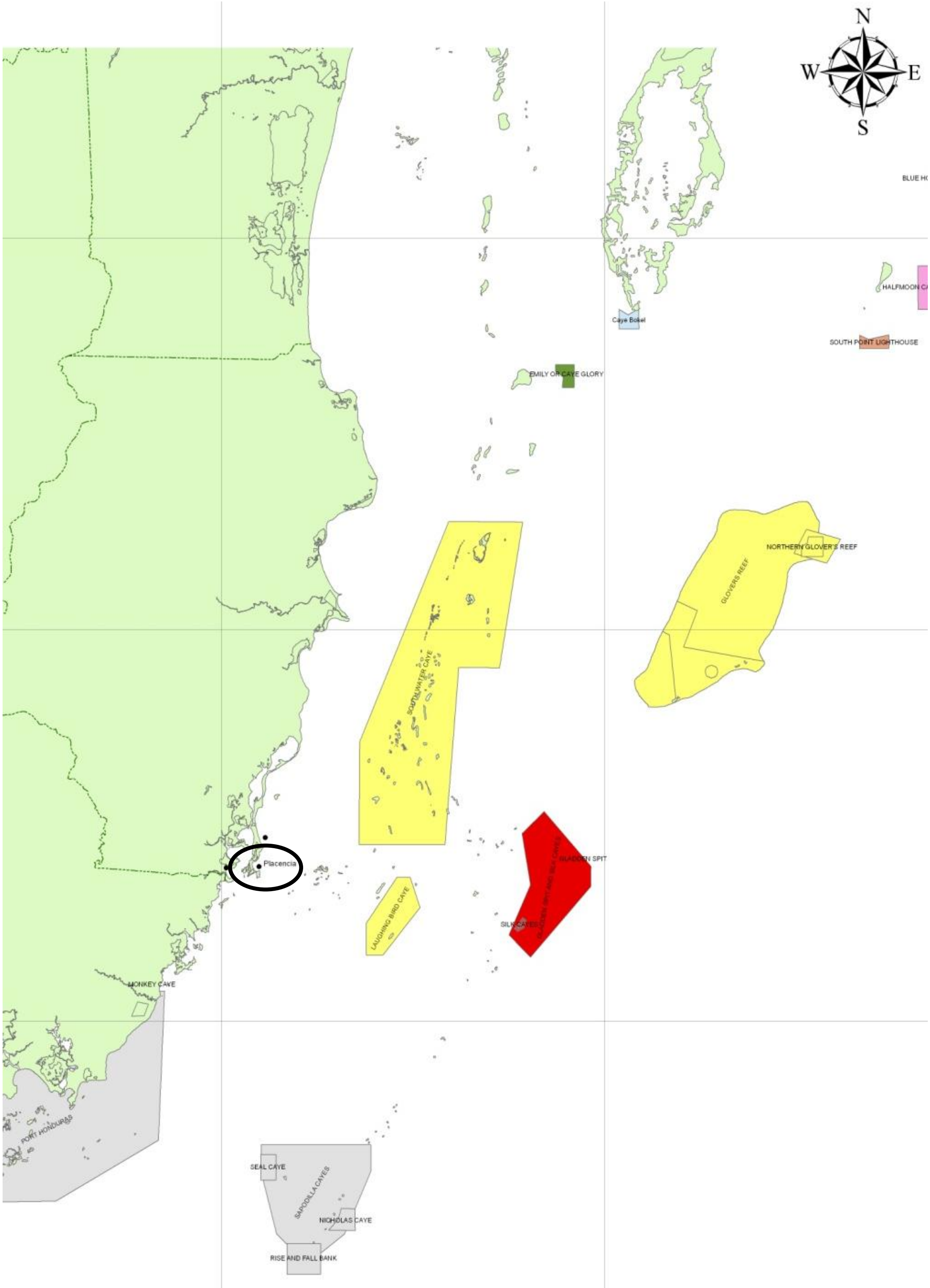


Figure 2.6 Map of the Coastline of Belize and the GSMR. Placencia is marked by a circle and GSMR is in red. Courtesy of Friends of Nature.

2.5.3 The village Of Placencia

The site of the community survey is the village of Placencia, which is the closest village to the reserve (36km offshore) and the main beneficiary. Placencia lies on a peninsular of the Stann Creek district, in the South of Belize. There are no recent population estimates. There are in addition, to Belizeans of from several ethnic groups in the village, including traditionally Creole communities, increasing number of international immigrants and second home owners, especially from the United Stated (McPherson, 2005). This village was for many decades primarily a fishing village, but tourism has become the main industry, although many people still fish for food or pleasure. During tourist high seasons, around Christmas and Easter, tourists flood the village's larger up-market hotels or small relatively inexpensive hostels. Placencia is ranked 3rd of all the tourist destinations in Belize, with 65+ hotels and 600+ beds and approximately 40% occupancy rates (Belize Tourism Board, 2008; BTB, 2008). Tourists out-number locals by up to 3 times during tourist high seasons in December, January and March.

Most people coming to the village take a marine tour. There are 139 registered fishers in the village, which is 7% of all licensed fishers in Belize. Many fishers also act as fishing guides at certain times of year. Fishers can sell their fish for a set price in the co-operative, who will buy finfish all year and conch and lobster during the 9 months that their seasons are open. However, fishers also sell directly to local restaurants and hotels, or middlemen, or simply give away part of their catches, but there are few records of these transactions. As a result, the volume and value of fish sold in the village is unknown.

For local communities, the mean income per capita in 2004 was US$1,569 per month, which compared very well to those of US$428 per month elsewhere in Belize. Placencia also has a strong local capacity, and high education level (Loper et al., 2008).

2.5.4 Gladden Spit and Silk Cayes Marine Reserve

Gladden Spit Marine Reserve (hereafter GSMR) was chosen as it is in many ways typical of marine reserves containing several zones, most with minimal regulations concerning extraction and use, and also a small no-take area. It is also of interest as it is in a developing country, and local people were reliant on it for income and employment, principally through fishing and tourism, and therefore some potential for conflict exists. It has been actively managed for several years (avoiding problems of interpretation due to transient dynamics and effects of designation), with frequent patrols, made possible partly through large grants from international organisations. This site is also of interest due to the presence of whale sharks, at certain times of year, which enable an opportunity to look at the effect of unique or unusual features on economic values and impacts created by the reserve. Finally, Friends of Nature, the organisation managing the reserve, have specific use for the results of this study and are willing to share their data as necessary.

It is a relatively large multi-use reserve (IUCN category IV, indicating relatively modest protection, with some extraction allowed), of 105.1km^2 (figure 2.7). It has a small no-take area where fishing is prohibited (outlined in red), which surrounds three small islands, where tourists are usually taken for picnic lunches. There are no limits set on fishing or tourist numbers in the reserve apart from in the whale shark area. This area is found at the reserve elbow and is the site of spawning aggregations for many fish, including several endangered species. Whale sharks come to this area, to feed on snapper spawn for ten days around the full moon, in March, April, May and June (40 days per year). Many tourists come to the area at this time specifically to take advantage of these aggregations, which can involve up to 15 individual whale sharks.

The great majority of tourists visiting the reserve originate in Placencia, which therefore captures almost all the tour operator and tourist spending benefits. Around 30% of tourists to the village are estimated to visit the GSMR (McPherson, 2005). An economic study was carried out relating to GSMR communities, to assess the economic impact of the reserve to local tourism, fisheries and social wellbeing (McPherson, 2005). That study was, however, limited to broad regional analyses and trends using secondary data and did not attempt to look at economic values held either by tourists or local people or to estimate distributional impacts of the MPA.

2.5.5 Management of the Gladden Spit Marine Reserve

The GSMR was designated in 2000, although management was not active until 2003. GSMR is managed in part by the Fisheries Department of the Government of Belize. They have entered a co-management agreement with "Friends of Nature" (FoN) who are responsible for day-to-day management of the reserve.

FoN was created out of a small coalition of dive guides, fishermen, tour guides and business people in Placencia, who were concerned about the threat of tourism development at another caye and was formally registered in 1996. Members of the board of directors come from all major nearby villages, but FoN's offices are in Placencia village. Management at the GSMR came about as a result of the increasing numbers of tourists visiting this area to see whale sharks.

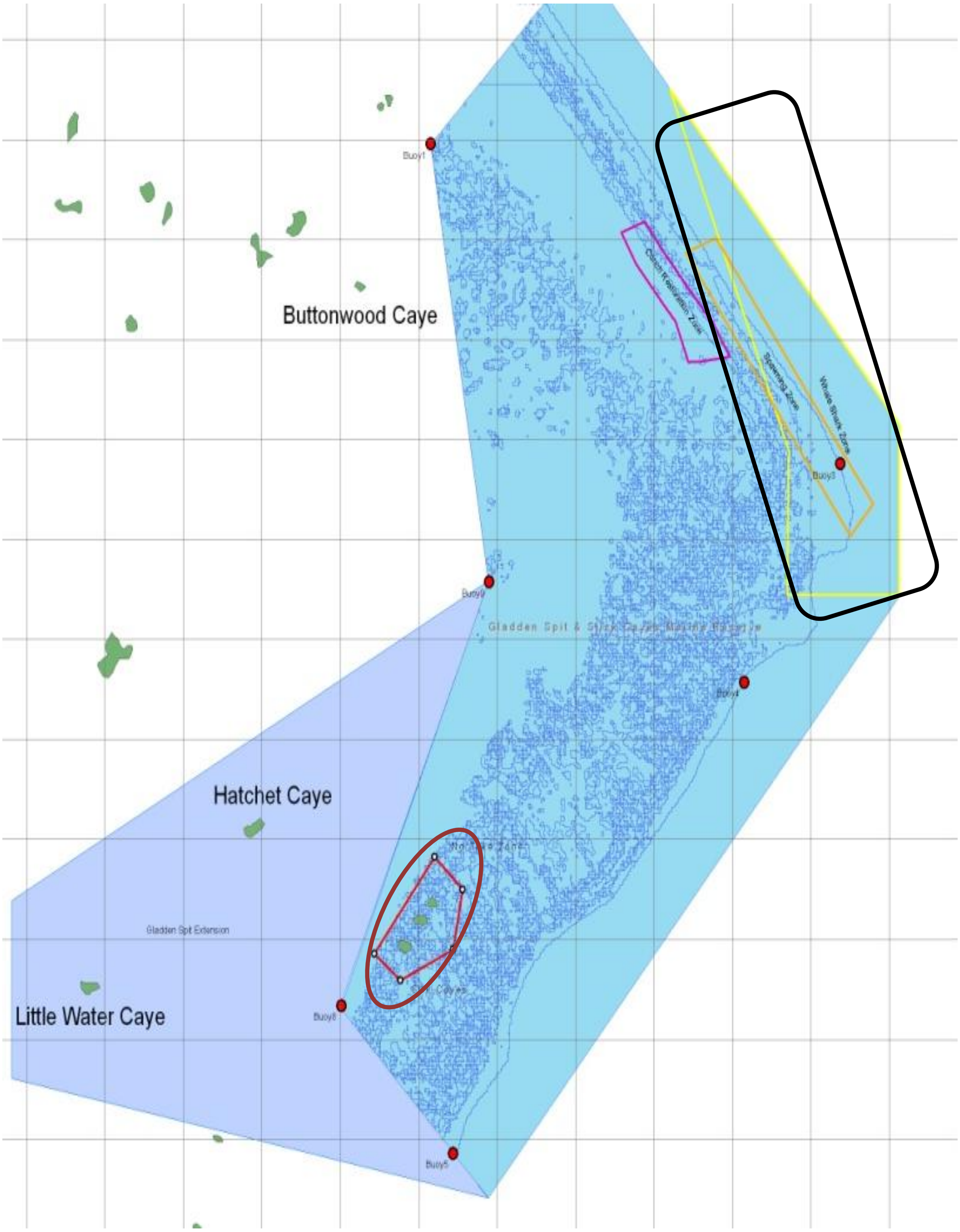


Figure 2.7 Map of Gladden Spit Marine Reserve. The no take area is outlined in a red circle and the whaleshark zone in a black box. Other marked areas are not managed in practice. Courtesy of Friends of Nature.

FoN has close links with both fishers and tour operators and holds consultations with both groups when it changes regulations or fees. Existing entrance fees were decided based on a community consultation in 2003. Rangers do daily patrols, which they use to enforce fishing regulations, as well as checking that tourists have paid entrance fees. Rangers can punish offenders with warnings and frequently confiscate illegal catches. More rarely fishers will also be arrested and have gear confiscated. There is little transparency in the punishments given, but international fishers are targeted more than local fishers, who are often relatives of the rangers. FoN also keep the picnic area on the Silk Cayes clean and provide toilets there, which is popular with tourists and tour operators.

In addition to active management on-site at the reserve, such as patrols and monitoring of spawning aggregations, FoN conduct numerous community orientated projects, including scholarships, environmental education programs and school trips to the reserve. In addition, there have been initiatives targetting fishers such as alternative livelihood schemes, funded by international NGOs and several fisher workshops, where exchanges have been made between fishers in different countries to exchange specialist knowledge. This has been very popular, as it resulted in the introduction of several new types of traps for lobster, which are now widely used.

There are eight full time rangers and three office staff who manage various aspects of the reserve, including research, outreach and fund-raising. Funds used to manage GSMR come from external grants awarded to FoN by international foundations and NGOs, as well as fee collection. In 2004, all funds collected from US$15 whale shark tickets were handed over to the government of Belize, with a portion of those funds were returned to FoN. The fisheries department still takes 23% of entrance fee revenues despite not contributing to substantial fee collection costs, such as fuel and boat maintenance, which made up 65% of management spending in 2007. The remaining 20% is spent on salaries and 15% on administration costs.

2.5.6 Fishing inside in the reserve

There is also a 16km^2 no-take area, where fishing of any sort is prohibited year round. Other than this, gill nets and spear diving are not allowed in the reserve. Rangers also enforce national regulations on seasons and minimum sizes for conch and lobster and check that fishers have a licence to fish and for their boat.

During the spawning aggregations, local fishers are required to purchase special licences, which entitle them to fish in the whale shark zone during these times. However, all fishers must leave this area at dusk, when the snapper and grouper begin spawning. Rangers make sure only fishers with these licences enter this area at this time. Fishers from other areas in Belize and other countries are not allowed to buy these licenses, so at this time of year, this is not an open access fishery.

There are two distinct types of fishers that use the reserve, "local fishers" and Sartenejan fishers. Local fishers come from villages nearby, most notably Placencia, Independence and Monkey River. They own small motor boats, which they use to vary fishing locations over the year and sometimes rent out. They usually fish with one member of family and use predominately hand-lines, to catch fish from the boat near the coast. They will also dive for conch and lobster periodically, sometimes using drums and traps which create underwater shade and therefore attract lobster. These fishers use the reserve most during spawning times, as there are large aggregations of snapper and grouper at predictable times in December to June. Local fishers monopolise the reserve during spawning aggregations (SPAGs), due to the requirement for special licences. Even fishers who fish only rarely will travel an hour each way to the reserve at this time. The fact that over 60 people buy special licenses for this privilege is indicative of its value. There are approximately 20 fishers from Placencia, who travel as far out as the reserve all year (36km offshore). These fishers using the reserve tend to be those who use nearby islands, as they can camp over several days to minimise petrol consumption, which is a major cost. Since lobster traps need to be regularly emptied, petrol costs make keeping these as far out as the reserve excessively expensive. Occasionally, local fishers will work in the reserve as guides for international researchers, who pay them a daily rate.

Sartenejan fishers live near on the border with Mexico and speak Spanish. They travel the entire coast of Belize throughout the year over trips of around 10 days, with 10 or more fishers on a sailing boat, using the wind to reduce petrol costs. When they anchor at a fishing spot, they will fan out in small dugout canoes and mainly free dive for lobster and conch. They rarely change routes, so that there are about 10 captains who spend at least one day inside the reserve, each trip, three times a month. They typically sell their fish to the co-operative in Independence, which is not the same co-operative as that of local fishers.

2.5.7 Tourism inside the reserve.

GSMR is a popular destination because of the whale sharks and the white sandy islands were tourists can picnic, despite not being the closest reserve. Most of the tours in the reserve involve day-long snorkelling or dive trips, costing US$50-150 each. Some tourists also pass through on their chartered boats. All tourists must pay a daily park entrance fee, a regulation which is successfully enforced, so ticket sales are a reliable estimate of actual visitation.

In 2006 there were 4340 international tourist snorkel or dive visits and a further 2261 whale shark visits (concentrated into 273 trips on 38 days), each spending US$10 or US$15 in entrance fees respectively, in addition to tour operator costs. These numbers had slightly decreased from the previous year, although over the last 5 years, visitor numbers have increased rapidly, especially for whale shark tours. Belizean national tourist numbers are uncertain for 2006, but probably in the region of 200 (FoN, pers comm.).

There are no restrictions on the number of tourist trips into the reserve for most of the year. During the whale shark season, a maximum of 6 boats (with up to 12 tourists each) can be in the whale shark zone at one time. FoN organizes 5 shifts of boats, for 1½ hours in the whale shark zone. Special tours are associated with whale shark visits, which are limited to minimise whale shark disturbance. These cost US$100-250 per day. Guides must have completed a tailored course. Tour operators can pay a deposit to guarantee two slots each day which is refunded if they take a certain number of trips. Otherwise, boats can come on a first come first serve basis. Last year, 20 tour operators had whale shark trips to GSMR, of which 13 had placed a deposit.

There are 20 tour operators or hotels with dive shops that offer trips to GSMR. Only 3 of these are not based in the village of Placencia. Tour guides must be Belizean, and have tour guide licenses and training. Whale shark tour guides must have special whale shark training, which involves a 3 day course run by FoN, which participants must pay for, in return for higher wages. Local tour operators usually have a set of core staff, often family, who oversee the business and then use freelance guides and boat captains for day trips. Some operators have purchased boats, which they use or rent out to those operators without boats. The four major hotels have their own dive centers with larger boats with more engines, more staff and more food. Tourism is highly seasonal in Belize and low in April-November, so the popular whale shark trips are extremely important to the local economy.

2.5.8 Other Nearby Marine Reserves.

GSMR is not the only reserve near the Placencian peninsula. The closest reserve to the village is the Laughing Bird Caye National Park (LBC), which lies only 23km out to sea. It has a sandy caye with good tourist facilities such as picnic areas, a learning centre and toilets. It is a small reserve of only 0.006km^2, which was made a World Heritage Site in 1996. It is the main tourist destination for snorkelling and diving and is frequently used by the local community for social occasions and family day trips. It is also run by FoN and has 24-hour patrols, as it is a no-take area for fishing. Glovers Reef Marine Reserve (GRMR) lies to the North of Placencia and lies 45km off the mainland. It was designated in 1993 and is run by a different NGO. It is a large MPA (350km^2), also with a small no-take area and several different zones, plus a very active research station. Since it has excellent coral, tour operators in Placencia offer tours here occasionally. However petrol costs are too high for Placencian fishers to use the reserve.

Global Coral Reef Management, Financing and Outcomes: Are MPAs Providing Conservation and Welfare Improvements?

3.1 Introduction and rationale for research.

Global estimates suggest that 34% of coral had been destroyed or are at a critical stage, with reefs in Eastern Africa, South and South-East Asia and the wider Caribbean being most threatened (Wilkinson, 2008). MPAs are regarded as the best strategy to conserve coral reef habitats and their biodiversity (Wilkinson, 2008). Recent estimates suggest there are approximately 1000 coral reef MPAs (Tupper et al., 2008b). However simply relying on the number of MPAs to estimate the area of reefs which are protected is highly misleading, as MPAs are highly heterogeneous and the great majority fail to meet their management objectives (Jameson et al., 2002; Jones, 2001). McClanahan (1999) finds that with a few exceptions, there is little evidence that the recent proliferation of MPAs in developing countries is resulting in marine conservation and that few have produced tangible conservation benefits.

Without effective management, MPAs are unlikely to meet the high expectations implicit in their inclusion as integral conservation strategies to meet CBD targets (Hudina, 2006). There is a need to differentiate between quality and quantity of protection of MPAs, as paper parks can provide a false sense of security. Indeed ineffective management or lack of management activity can become one of the key threats to reefs (Burke & Maidens, 2004). Thus the fact that 18.7% of the world's reefs appear to be "protected" is misleading. Only 2% of coral reefs are adequately protected i.e. mostly no-take, with low or no poaching, and at low to medium risk of threats from beyond their boundaries (Mora et al., 2006a).

The means by which MPA effectiveness is evaluated are not trivial and incorrect assessments can lead to biased results (Christie, 2004). Authors have stressed the need for more insight into assessing the ability of MPAs to achieve management objectives, by assessing the impacts of MPAs on ecosystems, resources and human activities , whilst taking into account manager expectations, needs and constraints (Pelletier et al., 2005). However, achievement of objectives alone is insufficient for MPA evaluation, as this would reward MPAs with modest goals and punish those with ambitious goals without enabling comparison of their relative success (Jones, 2001). Similarly, an overview of conservation laws and secondary data is unlikely to reveal enough information to make sound judgements about the conservation effectiveness of a particular area (Stern, 2006).

As yet there has been little research effort directed towards understanding the impact of the management strategies being used, the ecological and socio-economic outcomes that are occurring as a result of MPAs and the ability of MPAs to reduce the threats reefs face on regional and global scales. Outcome-based analysis is tested by determining if the policy intervention is (a) meeting its goals, (b) whether it has made a significant difference and (c) if it represents a reasonable return on investment (Schalock, 2000). This sort of analysis is frequently done in other policy research, but has been lacking in MPA evaluations. This is likely to be due in part to the fact that marine habitats are much harder to access, map and manage than terrestrial areas. Outcome measures represent the key test of the validity of relying on MPAs for coral reef ecosystem conservation, sustainable local employment and the variety of other benefits they are purported to provide.

There is a need to test if MPAs are providing benefits which are additional to what would have happened without their existence. General qualitative assertions of MPA benefits which do not use counterfactual cases and controls are insufficient to demonstrate that MPAs are a sound investment of conservation funds. Assessments must demonstrate measurable beneficial conservation outcomes, beyond simply asking which management actions are occurring (chapter 2.2).

There is insufficient understanding of the extent to which coral reefs within MPAs globally are likely to be resilient to current and future threats. However, success will critically depend on the threats that each MPA faces, as MPAs are unlikely to be effective if they are located in areas that are subject to numerous, and often uncontrollable, external stressors (Jameson et al., 2002).

The current climate of accountability and performance-orientated conservation goals has driven the need for carefully designed and realistic objectives and targets to enable adaptive management (Syms and Carr, 2001). For example, the major funding agencies such as the World Bank and the GEF also require PAs to conduct regular assessments, plus clear statements of expected outcomes and objectives to demonstrate their effectiveness over time (Hockings, 2003). This is essential as MPAs are expensive and compete with one another for funding and direct and opportunity costs are poorly understood and rarely quantified, although they could be significant (Pelletier et al., 2005).

Effective management is integrally linked to well designed evaluation systems (Margolis & Salafsky, 1998). MPA evaluation can be used for a variety of purposes, including (Day et al., 2003; Hockings et al., 2000; Hockings et al., 2002; Stem et al., 2005);

- demonstrating management effort, conservation impact and efficient use of resources
- raising awareness, for reporting and priority setting and to highlight under capacity
- maximising efficiency of conservation funds through appropriate resource allocation
- promoting accountability in terms of resources, expenditure, resource allocation and delivery of outcomes
- understanding MPA dynamics and providing evidence based feedback on the effect of management interventions
- as a tool for adaptive management and decision-making, to track progress, to identify gaps, to review and prioritise policies and programs

Pomeroy et al., (2004) suggest that managers should allocate 10% of their time to evaluation. The CBD recommends that appropriate methods, standards, criteria and indicators for evaluating effectiveness of PA management and governance should be adopted by 2008 and 30% of PAs should be assessed in each country by 2010.

In conclusion, a consensus has been reached about the need for MPA performance criteria, but less so on the actual criteria to use and how to evaluate performance against them (Alder et al, 2002). There is a dearth of quantitative assessment of on a regional or global scale as to whether MPAs promoting conservation and local community welfare improvements (Vilayleck & Andrefouet, 2006). Furthermore, there are very few comprehensive evaluations of management effectiveness and very few have included social or economic aspects or involved management staff (Day et al., 2003). Regional or temporal comparisons which utilise previously conducted studies are not feasible as it is exceptional for a methodology to have been applied twice in the same MPA or in different years (Hudina, 2006). Local environmental and economic conditions have an enormous effect on MPA impacts, hence a global analysis, which includes MPAs with different contexts, can provide more generalisable recommendations than analyses focusing on a few MPAs operating in similar conditions. Here a dataset compiled using a single methodology is used to evaluate MPA performance based on expert knowledge, to assess ecological and socio-economic outcomes related to conservation for MPAs on a global scale. By applying the same method in many MPAs from different regions, it was hoped that more reliable conclusions could be drawn than from single site or regional evaluations. Since the cost of collecting data from experts is small, it is cost-effective (Alder et al, 2002) and represents an important but underutilised resource.

See also sections 2.1, 2.2.1, 2.2.3, 2.3.2, 2.2.4 and 2.2.5 for background to this section.

3.2 Aims and objectives.

The aim of this study is to utilise local expert understanding for MPAs globally to gain a detailed picture of the context, extent and impacts of coral reef MPAs. I assess MPA's contribution to conservation and welfare improvement, by addressing the following research questions;

- What ecological and socio-economic impacts are MPAs having relative to before they were established and the area outside the MPA?
- What is the relationship between general conservation success, desirable outcomes and the achievement of each MPA's primary aim.
- What is the relationship between temporal and spatial changes in ecological parameters i.e. coral cover?
- How do MPA age, the existence of no-take areas and regional location affect MPA outcomes?
- Are MPAs able to tackle the threats they face, given their resources and features?
- What features and actions can help MPAs reduce threats?
- Are the assertions that MPAs are failing to achieve their aims or to produce conservation benefits borne out by this analysis?

3.3 Methodology

3.3.1 Survey design

I aimed to obtain detailed site level information for a wide a range of MPAs. Since monitoring data are almost never published, this needed to utilise opinion and scoring, as is widely used in rapid assessments (Wells, 2006). MPA managers' jobs depend on successful management, so they may exaggerate positive MPA impacts (Bhagwat et al., 2001). Therefore, academics and NGO employees with over one years' experience with an MPA were also invited to complete a survey. A large amount of information was collected on each MPA, as this would enable a more holistic understanding of the MPA outcomes and contexts. Since replication over time and randomisation of experimental treatments was not feasible, as many samples were included as possible and modelled potentially confounding factors explicitly (Stone, 1993).

The evaluation method for MPA success was informed by Stem et al., (2005), who advise that evaluations should include biophysical, socio-economic and management issues, as well as the status of actual and possible threats, plus the intervention, the management process and the confounding variables. The survey instrument was developed principally by adapting the "World Bank GEF MPA project scorecard" (Staub & Hatziolos, 2003), the "How is your MPA doing?" methods (Pomeroy et al., 2004) and the common reporting framework for marine conservation effectiveness (Stern, 2006). Indicators were obtained for both outcomes and management, implementation and monitoring, ecological and social attributes and both locally specific and more generaliseable indicators. While the survey contained questions related to each section of the evaluation framework, the focus was geared towards context and outcomes, which are related to status and efficiency (Hockings et al., 2000).

Information on management actions enabled understanding of management effort and resources and the context under which outcomes occur. Questions were designed to detect temporal changes and spatial comparisons in threats (Hockings et al, 2004). Mora et al.,'s (2006b) caution was also heeded to distinguish between threats that are non local, difficult to monitor and could undermine management efforts, and those that can be addressed by management.

Information on MPA aims and MPA regulations and illegal activities was also collected, as effectiveness should be assessed with respect to a stated objective and target (Syms & Carr, 2001), as an important application of this research is to test the extent to which MPAs meet their management objectives (Jameson et al, 2002).

Outcomes were a key feature of the survey, as outcomes are the most meaningful measures of management performance (Alexander & Rowell, 1999; Jones, 2001). I wished to ascertain whether MPAs were improving a variety of outcomes absolutely or relative to comparable areas outside the reserve borders, by wherever possible testing outcomes measured established baselines to reduce causal uncertainty (Syms & Carr, 2001). Respondents were asked to provide monitoring data or published studies for any outcomes. To aid comparability, all current coral cover estimates were from 2005. For perceived changes, respondents were asked to use defined ordinal categories. Perceived changes in both fisheries and species conservation were included to reflect aims on distinct ecological levels (Pelletier et al., 2005).

Social and economic factors were also included (Hockings et al, 2000), as these can override ecological factors (Côté et al., 2001) and if omitted would be likely to be confounding variables (Stem et al., 2005). Outcomes also included fishing pressure, effectiveness of enforcement and habitat characteristics as recommended by Cote et al., (2001). Rigorous comparisons were attempted by wherever possible comparing inside versus outside managed areas and before and after implementation (Kareiva, 2006) using both quantitative and qualitative information supported by measurement or evidence (Hockings, 2003). Questions were designed to produce a quantifiable measure on a scale that clearly ranges from low to high effectiveness indicators wherever possible and open-ended questions were used as little as possible, to aid comparison at a regional or global level (Stern, 2006).

3.3.2 Data collection.

A questionnaire was developed designed to gather information on seven areas related to MPA success or effectiveness (see appendix 3.2 for full questionnaire);

- The management context, including budgetary information
- Respondent opinion about the extent to which the MPA is a "success".
- The existence of threats compared to outside the MPA and the changes in destructive activities over time and compared to outside the MPA
- The achievement of the principal MPA objective and the extent to which banned activities occur
- Ecological outcomes related to habitat and fisheries quality
- Social outcomes related to aspects such as equity issues and indirect effects of regulation and tourism

- Economic outcomes related to the creation or support of wealth and employment

The pilot survey was sent to 10 respondents (key informants), who completed the survey and were then asked detailed follow up questions related to time required, language and interpretation. The survey was shortened, scientific jargon was removed and various phrases and questions were clarified. The survey was translated into Spanish for wider dissemination. The final survey took approximately 40 minutes to complete. Three ways of administering the survey were used, none of which were random. First, people were approached with a self completed survey at an international MPA management symposium in Mexico, October 2006. All MPA managers were approached and the response rate was about 60%. In addition, in 2007 a website was set up in both Spanish and English, which contained instructions for the survey. Respondents could read the background and were then asked to download the survey. This had been designed to be self completing, where drop down menus and tick boxes were used, to speed up the completion time. To alert people to the website, notices were posted in internet forums, MPA and reef related websites, newsletters and many mailing lists. Finally, MPA practitioners were also emailed directly, with the survey attached. Their email addresses were gleaned from conference proceedings, internet sites and using a snowball approach, where respondents were asked to pass on the survey. This approach would not result in a random or unbiased sample, but was necessary given the need for as large a sample size as possible. Respondents were advised that by completing a survey, they would be entered into a prize draw, where there were ten chances to win US$300 in cash prizes, as an incentive to increase response rate (Stone, 1993).

In total, 78 responses were received from 33 countries. One was discarded as the respondent had limited knowledge about the MPA. In addition, there were 11 instances from different respondents who had completed surveys for the same MPA. This was desirable, as it enabled basic triangulation, by comparing evaluations of the same MPA from different respondents. For three of the MPAs, less than 10% of the answers were different and none greatly so. For two of the largest sites (the Great Barrier Reef Marine Park and the Komodo National Park) there were 16 and 24 different answers respectively out of 141. As a result of the similarity of responses, one of the responses for each MPA was chosen at random and the other was discarded.

3.3.3 Data analysis.

Statistical analyses were carried out using Stata.8 software and R. Initially, data were examined for errors and outliers using summary statistics and frequency tables. National average live coral cover estimates were taken from Wilkinson (2004). Other national level statistics, such as economic data and indexes were taken from national contextual variables included the gross domestic product (GDP per capita), the human development index (from 2005) and the population growth rate (from 2006), from the CIA fact-book with the same year was used for each variable (CIA, 2007), as in Holtzman et al., (2009). Impacts of the no-take area, MPA size and management type were investigated using Wilcoxon signed ranked tests, chi-squared tests and t-tests, as appropriate for each type of data. Non-parametric methods were mainly used, as the data were rarely normally distributed. However, parametric tests such as t-tests were used to examine effects of some variables such as live coral cover estimates, which did fulfil this assumption.

Logit regressions were used to understand factors explaining whether MPAs experienced coral damage from visitors and whether the main threat originated within their boundary and an OLS to explore the number of large threats MPAs faced.

Multivariate methods including ordinary least squares and logistic regressions were used to explore the predictors of management budgets and MPA threats, based on the distribution of the dependent variable. A few independent variables were coded by the author, based on open-ended questions. These included whether the described major threat originated inside or outside the MPA and a qualification of the suitability of the management action used to address the main threat, on a three point scale. For example, seeking increased financial support would be ineffective against outside pollution, potentially effective against poaching and highly effective for lack of staff.

Other variables were calculated to summarise respondent answers to questions, such as the number of threats and unsustainable uses and their comparison to outside MPAs. Non-linear relationships were included for several variables, such as MPA age, size, no-take area size and budgets. In addition, interactions were explored between MPA age and size and no-take areas age and size. Only variables which were expected to influence each dependent variable where included in each regression. Model simplification involved removing non-significant variables in a stepwise procedure (Crawley, 2007). Successive models were compared against each-other using analysis of variance. This process was repeated, until a final minimal acceptable model was reached, where removal of any variable did not change model fit significantly. For each model, model assumptions were tested such a normally distributed errors and homoscedasticity.

Budgetary information in terms of initial and current budgets was converted into US dollar equivalents for 2005, using the exchange rates from that year, taking into account purchasing power parity. The quality and source of data for the coral cover estimates were coded; whether it was an opinion, from a one-off study or long term monitoring and in terms of the respondent affiliation was also included. This enabled biases and the effect of self-reporting self-reporting to be gauged. Combining the various outcomes into a composite performance measure was not attempted, as it was thought that this would obscure relationships between different outcome types and would not enable meaningful comparisons between MPAs (Holtzman et al., 2009).

3.4 Results.

3.4.1 Sample population features, management and budgets.

The final reduced sample contained 66 MPAs, from 33 countries, equivalent to 7% of all coral reef MPAs. Summary statistics are shown in table 3.1. Comparison of the global spread of all types of MPAs by region (figure 3.1) showed that the sample population's regional distribution was not significantly different from the global population (chi^2 =3.35, n =66, df=3, p =0.34). The sample also did not significantly differ from the global database for IUCN categories[2] (chi^2 =2.7, n =65, df=5, p =0.85), despite containing many more MPAs with unset or unknown categories (appendix 3.4). 80% of the sample MPAs were found in developing countries, compared to 82% of coral reef MPAs globally. Since sample MPAs were not randomly selected, they could be skewed towards better funded and staffed MPAs. However some of the MPAs included seem to be paper parks, as they reported no staff, budgets or management actions.

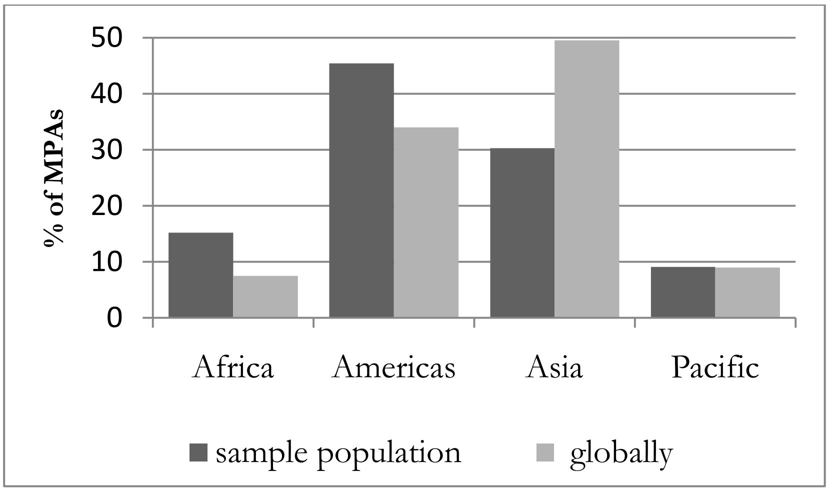


Figure 3.1. The Regional Distribution for the Sample of MPAs and the Global MPA population.

There was a mixture of respondent affiliations, with 34% of respondents being management staff, 33% academics / researchers, 28% NGO staff and 5% from government departments. The sample population contained a large variation in terms of MPA size, age and to a lesser extent no-take area size (appendix 3.5). 61% (n=40) of the MPAs sampled had a no take area. No-takes areas had a mean size of 3,892km². In total the no-take areas in this study covered 641,047 km² of marine habitat, equivalent to 24% of the area under management (153,201

[2] IUCN has defined a series of protected area management categories based on management objective in *Guidelines for Protected Area Management Categories* (IUCN, 1994)

km^2). Half of the MPAs were managed by more than one group. The most frequent management group is the host government (55%), followed by the community (28%) and NGOs (28%). Only one MPA was privately managed.

Table 3.1. Sample population statistics (all MPAs).

Variable	Mean	Median	St Dev	Range
Age (years)	14.4	12	10.7	1 to 69
Size (km^2)	9,713	75.3	45,840	0.09 to 344,000
No take area (km^2)	2,260	0.2	14,696	0 to 115,395
No. zones	2.1	2	1.9	0 to 5+
Set-up budget (US$'000)	266.6	13.1	549	0 to 2,546
Overall budget (US$'000)	648.4	97.1	1,809S	0 to 12,000
Budget per km^2 (US$'000)	240.1	1.8	1,519	0 to 11,300
Management budget per km^2 (US$'000)	229.5	1.1	1.6	0 to 11,300

MPA budgets are very varied both as a whole and per area managed (table 3.1). Median budgets were more representative of all MPAs due to exceptional budgets such as those of Hanauma Bay in Hawaii of over US$11 million per km^2. Forty percent of respondents did not report the initial set up budget, especially for older MPAs. Of those who did, 30% had zero finances allocated, with a median set-up budget of US$13,096 (in 2005 equivalent). In total, the 40 MPAs who provided this information represented a total investment of US$10.7 million. For the 59 MPAs who reported current budgets for 2005, the median was US$97,000 for the whole MPA which corresponded to a median of just under US$1,800 per km^2, with 13 MPAs (22%) having no funds at all. Total funds invested in the 56 MPAs were US$36.3 million. Developing country (LDC) budgets were significantly lower than that of developed countries (MDCs) per km^2 protected, with a median budget of US$ 1,528per km^2 compared to US$4,775 for MDCs ($t=1.86$, $n=56$, $p= 0.068$).

The majority (39%) of funding for MPAs originated from governments (23% of the sample had no government funding and 15% entirely government funding). International NGOs provide a mean of 27%, followed by national NGOs (9%), donations (4%) and other sources such as research permits (3%). MPA-generated revenues met a mean of 18% of budgets (46% of MPAs no revenues and 8% entirely from these revenues). Whilst LDCs received an average of 34% of funds from the government, MDC MPAs receive 65% ($f=2.51$, $df=1$, $n=61$, $p=0.015$). Newer MPAs had significantly less government funding compared to older MPAs ($f=2.12$, $df=1$, $n=61$, $p=0.010$).

Respondents described how 63% of budgets were spent on management costs (just under US$20 million), although 18% went to government departments. A significant proportion of funding benefitted local communities through projects (8%) and the rest was used principally for research and education (11%). The budget available for direct management costs (minus funds used for community projects or returned to government departments) averaged just over US$375,000 per MPA, which is 58% of the absolute funds. LDC MPAs used 56% of their funds for management costs, compared to 92% for MDC MPAs (f=11.5, df =1, p=0.001).

Budgetary analysis showed that LDC MPAs and WHSs had lower budgets per km^2 (table 3.2). In contrast MPAs with lower coral cover than the national average had higher budgets. Those MPAs with larger budgets also had more staff per area and more regulations and were perceived as having a greater impact on species conservation. Variables which did not relate to budgets, but might have been expected to be included were MPA age, management type, MPAs with international funding grants or those with higher numbers of tourists and greater funding from on-site revenues.

Table 3.2. OLS Analysis of variables related to log budget per km^2 (f=13.01, n=50, Adj R^2=0.632, p=0.000).

Constant	1.861 (0.000)***
Size of MPA (km^2)	-0.00043 (0.070)*
Developing country	-0.445 (0.096)*
World heritage site	-0.707 (0.025)**
No. of staff per km^2	0.029 (0.000)***
No. banned activities	0.149 (0.001)***
Coral cover compared to national average	-0.018 (0.001)***
Perceived change in species conservation	0.809 (0.005)***

Management plans, staff training, education initiatives and NGO affiliations were commonplace (appendix 3.6). Although only 42% of MPAs were part of wider coastal zone management, 61% were part of a designated MPA network and 66% were linked to an explicit community institution(s) (appendix 3.6). Half the MPAs had active fisheries management and 55% endangered species-specific management. Almost 90% of MPAs had some ecological and 75% socio-economic monitoring, 64% through international monitoring initiatives. Management effectiveness assessment was fairly common (62%).

In addition, these MPAs had used and continue to use a large variety of redistributive conservation tools in relation to local communities (appendix 3.7). MPA-related alternative livelihood schemes and community development initiatives were being carried out by over half. Community benefit sharing schemes and conflict resolution initiatives were carried out in over 40%. Whilst grants, micro-credit schemes, buy-back schemes and compensation payments occurred relatively rarely. Benefit sharing, conflict resolution strategies and developments have increased in use, while grants and buy-back schemes are being used less than previously.

The average MPA regulated 12 extractive and non-extractive activities and banned 9. Coral mining, blast and cyanide fishing had been banned in at least 97% of MPAs, international commercial fishing in 90%, endangered species hunting in 83% and mangrove extraction in 80%. On the other hand, subsistence fishing had only been banned in 29%, commercial and sports fishing in 47% and aquaculture in 49% of these MPAs (appendix 3.6).

3.4.2 MPA use.

Tourists were the most numerous users of these MPAs. On average, 112,910 tourists visited each MPA annually, which corresponds to almost 75,000 per km^2 (the maximum was equivalent to 2.75 million per km^2). MPAs had an average of 748 fishers using them (maximum 7500), which corresponds to 224 per km^2, with 16% of MPAs who provided fisher estimates not having any fishers within their boundaries.

Recreation was ranked the most important use by local communities 52% of MPAs (appendix 3.9). However, using mean ranks suggests subsistence fishing is most important (it was the main use in 37% and did not occur in only 14%), followed by recreational use and then commercial fishing. In comparison, 28% had no local extraction and 30% no cultural use by local communities. Local commercial fishing was the key local use in only 6.5% of MPAs, not occurring at all in 22.5%.

Extractive activities by any user occurring inside MPAs are largely related to fishing (appendix 3.9). Subsistence fishing occurred frequently in 61%, commercial fishing in 36%, sports fishing in 24%. International fishing never occurred in 62% of MPAs, sports-fishing never in 46%, commercial fishing never in 26%. Aquaculture occasionally in 26% of MPAs. Traditional hunting of endangered species and extraction of materials took place occasionally in a third and not at all in over half of MPAs. Highly unsustainable uses including mangrove wood extraction, coral mining, blast fishing and cyanide fishing had been effectively halted in 68%, 82, 83 and 84% of MPAs respectively.

3.4.3 Achievement of MPA aims.

Respondents rated each MPA's success in general and in the context of the MPA's primary goal. A Spearman's rank test showed that these measures are statistically linked (Spearman's rho =0.811, n=65, p=0.000). However, while 32% of respondents felt that MPA was a success in general, only 11% felt that it had achieved its primary aim. The remaining MPAs were characterised as having no success in 12.2% of cases, some in 21.5% and to a large extent in 34% and having achieved aims not at all in 9%, to some extent in a third and to a large extent in almost half of MPAs. Respondent affiliation did have a significant link to perceived success (chi^2 =19.6, n =65, df=3, p =0.021) and the extent of MPA aim achievement (chi^2 =26.1, n =65, df=3, p =0.002). Management staff were more likely to assign higher scores to these measures, especially for the achievement of aims.

Whilst 20% of the MPAs reported that they had stopped all banned activities occurring, over 40% still had one or two still taking place. A mean of 2.7 banned activities still occurred within the MPAs. There was no significant difference between regulations and the actual occurrence of the majority of activities. Activities which showed significant differences between regulations and occurrences include foreign commercial fishing, which has been banned in 89% and regulated in 6% of MPAs, but nevertheless occurred frequently in 3% and occasionally in 36%. Similarly, blast fishing had been banned in 97% of MPAs, but occurred occasionally in 18% of MPAs, and cyanide fishing had been banned in 98.5% of MPAs, but occurred occasional in 16.2%.

MPAs typically had several goals but the majority of MPAs had one principal aim. For the sample MPAs, habitat conservation was the most common aim, followed by fisheries management, tourism management and species conservation (figure 3.3). Remarkably, there was no significant relationship between reported changes in habitat quality, fisheries enhancement, species conservation and economic development and whether these were the primary aim of an MPA. Twelve percent of the MPAs that were set up to preserve reefs thought they had fulfilled this aim completely, 41% thought they had to a large extent and 32% to some extent and 15% not at all, so that this was the goal with the worst performance. Species conservation aims were also highly variable, as some MPAs had seen specific improvements in this area and others had seen little or none, despite this being their main focus. Fisheries improvements were seen either to some (30%) or a large extent (70%), but never completely, suggesting moderate improvements in many MPAs. There was a significant link between fisheries specific management actions and fisheries improvements: MPAs with active fisheries programs had seen twice as many fisheries improvements than those which had none (Pearson chi^2=10.3, n=62, df=2, p=0.006), however the same was not true for targeted species conservation measures (Pearson chi^2=2.6, n=63, df=1, p=0.273). MPAs with multiple, education and economic development aims tended to report moderate success. Tourism aims were thought to have been completely realised in 22% and to a large extent in 33% of tourism focused MPAs. Both multiply managed and NGO managed MPAs were perceived as achieving their primary aims significantly more than other governance types (chi^2=6.98, n=65, df=3, p=0.072 and chi^2=6.89,n=65, df=3, p=0.076 respectively).

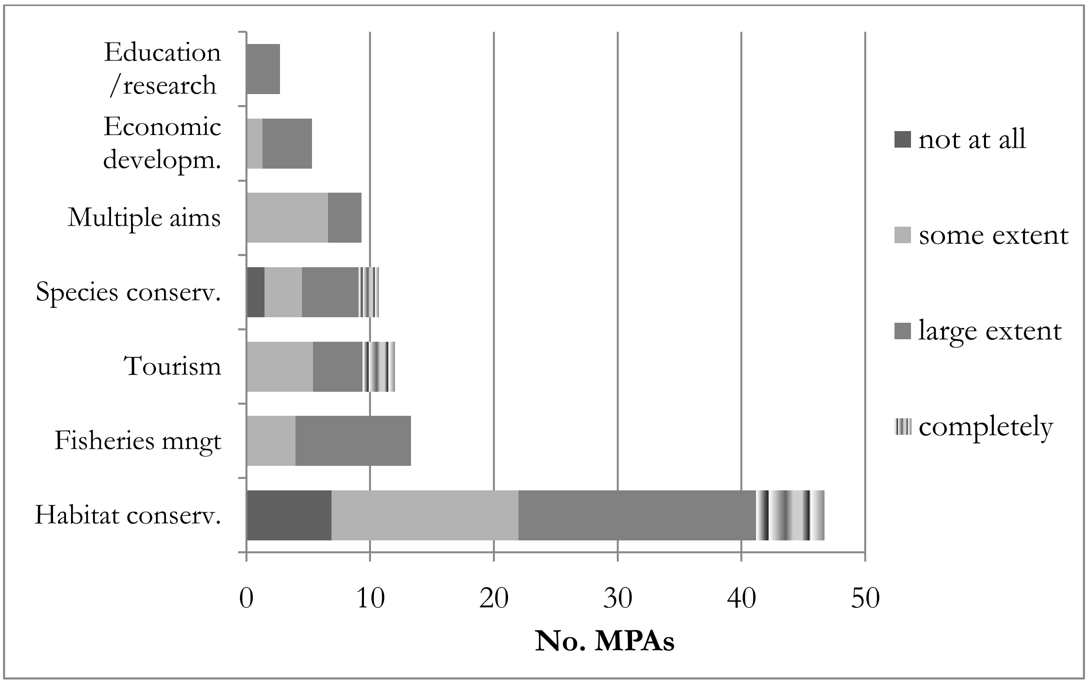


Figure 3.2. The primary aim and the extent to which these have been achieved. The length of the bar corresponds to the number of MPAs which gave this as the main aim

3.4.4 MPA Threats.

Very few managers faced no major threats (such as extreme weather, sedimentation, pollution and large scale pollution) inside their boundaries. The mean number of large scale threats was 3.3. If the number of threats occurring inside the MPA was compared to the number outside (figure 3.4), it was apparent that while some MPAs have outperformed outside conditions, others were subject to more threats inside than outside their boundaries. In aggregate however, the number of large scale threats inside and outside the MPA were not different (t=-0.1303, n=66, p=0.897). MPAs in Africa and the Pacific reported 4 threats or fewer, whereas 25% of MPAs in the Americas and 33% in Asia had more than 5 large scale threats. All of the MPAs in the Americas reported at least one large scale threat, usually cyclones and hurricanes.

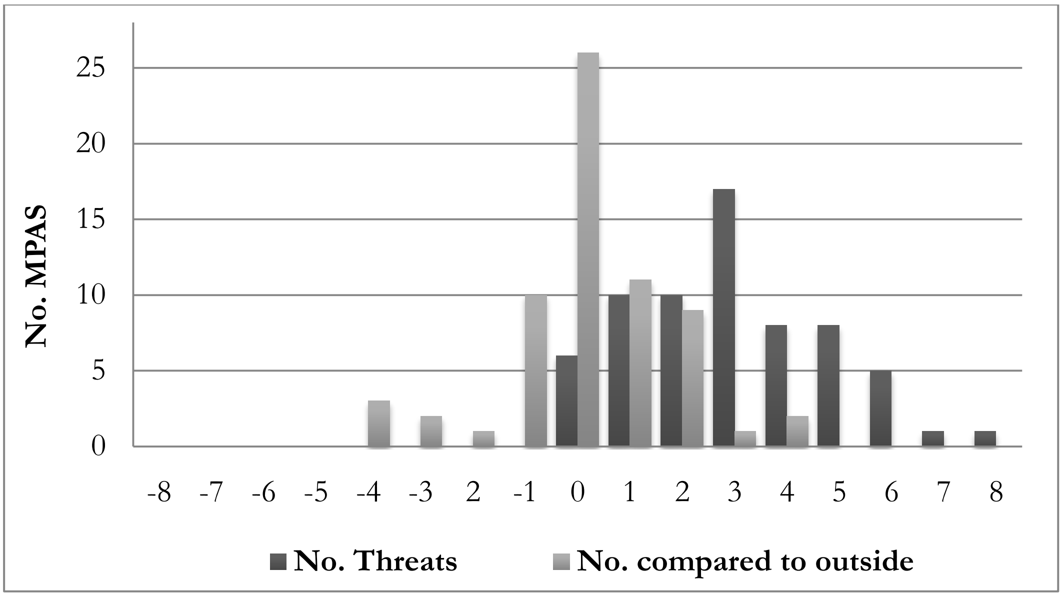


Figure 3.3 Number of large scale threats and compared to outside the MPA. Dark grey bars denote the number of large threats occurring inside the MPA. The light grey bars show number of threats outside – number of threats inside, so that 0 denotes no difference in threats and some MPAs have more and others less than outside.

Of all threats recorded, the most frequently cited was coral bleaching (70%), followed by hurricanes (60%) and sedimentation (56%). Different regions face different levels and combinations of threats (figure 3.5). Pacific region respondents cited fewest threats, where 60% of MPAs were suffering coral bleaching and 40% faced hurricanes and natural disasters. MPAs in Africa were less affected, but faced a greater variety of threats. MPAs in the Americas and Asia are reported to be much more threatened than elsewhere. Roughly a third of MPAs in both of these regions are threatened by intensive coastal development. In Asia, respondents cited sedimentation as the most common threat, with chemical pollution also occurring at 57% of MPAs.

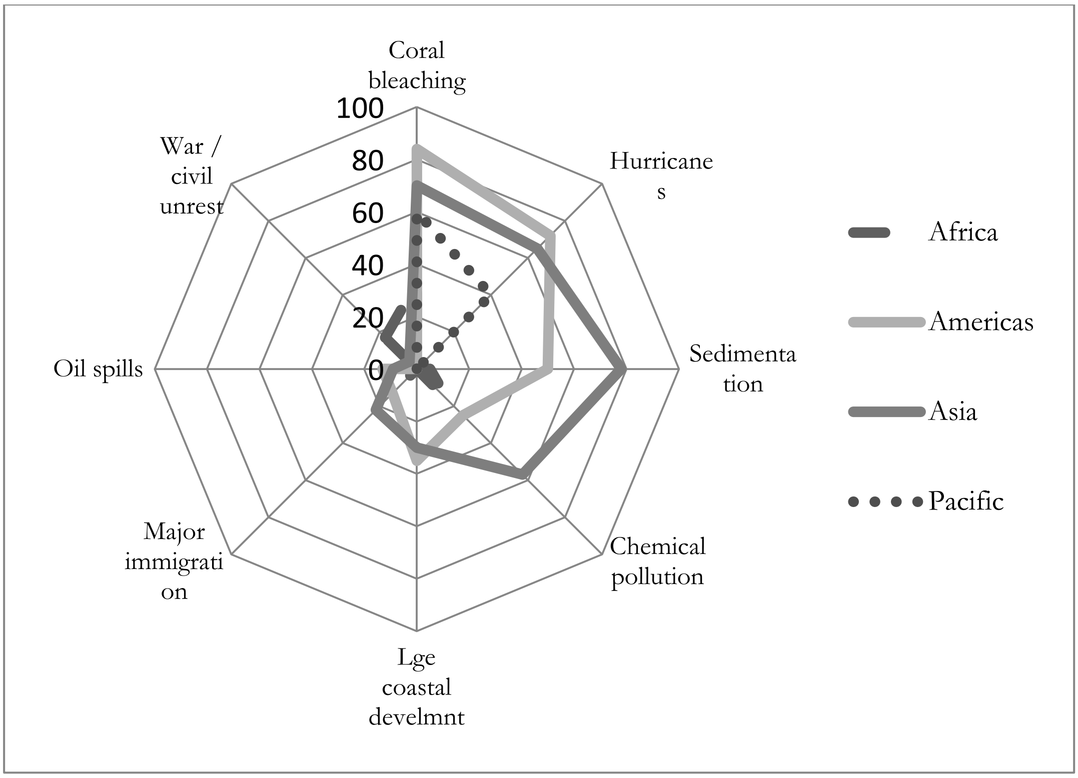


Figure 3.4 The occurrence of large scale threats for MPAs in each region. Scale is from 0-100% of MPAs.

Managers were asked to define the principal threat facing their MPA and these were subdivided by region (figure 3.6). Threats were then classified as originating inside the MPA (60%) or outside the MPA (40%). Particularly prevalent were poaching and coastal development, which accounted for almost half of all the responses. Threats which originated inside the MPA were poaching (28% of responses), tourist impact (12%) unsustainable use (11%), lack of enforcement (5.5%) and corruption or conflict (3.5%). Those which originated far away included coastal development (19%), pollution (12%) and bleaching or climate change (9%). In terms of regional patterns, MPAs in Asia were threatened most by poaching, whereas in the Americas, coastal development, pollution and tourist impact were all major threats. African and Pacific MPAs were similarly threatened, by poaching, unsustainable use and coastal development. Interestingly, coral bleaching was not seen as the major threat in and MPAs in the Pacific and Africa and only 15% in Asia and the Americas. Corruption was also not seen as a major threat, neither was pollution, expect in 23% of American MPAs.

The majority of actions the managers could use to ameliorate the threat facing the MPA were either unsuitable (22%) or of limited effectiveness (46%), compared to 32% which were targeted and potentially effective against this threat (based on the respondent's open ended answer to how they were addressing the principal threat).

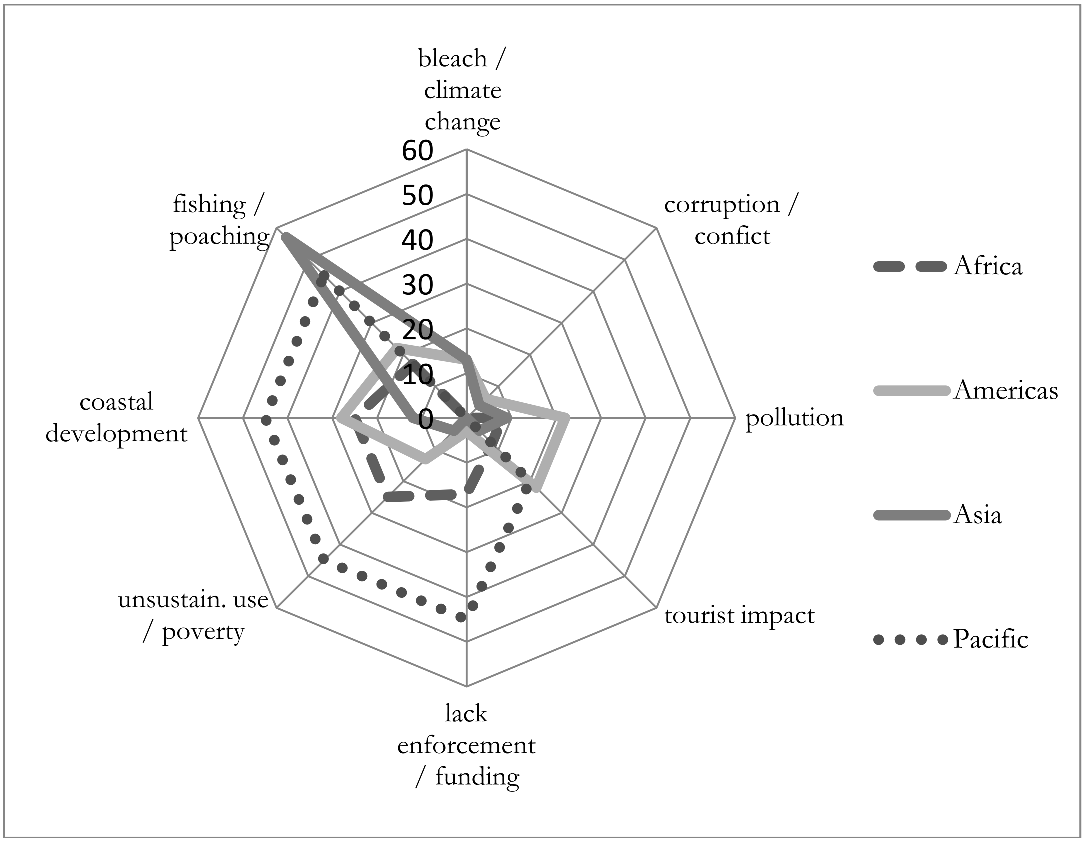


Figure 3.5 Responses to open ended question on main threat facing each MPA. Scale is from 0-100% of MPAs.

In terms of internal threats, 40% of respondents had seen damage to coral caused by visitors. MPAs which reported no major tourist damage had a significantly lower mean annual visitor pressure of just under 40,000 tourists per km² and those who reported coral damage from visitors had over 120,000 tourists per km² ($z = -2.633$, $n=62$, $p = 0.009$). Respondents estimated a mean detection rate of 39.8% of illegal activities, although 12% had no detection and 5% reported 99% detection. Of those activities that were detected, a mean of 48% were actually punished (this ranged from 0 to 100%), meaning that overall only 19% of infractions that occurred were punished. Funding per km² explained only 16% of the variation in proportion of illegal activities punished ($F=9.7$, $df=1$, $p=0.003$) and 65% of the variation in staff per unit area ($F=97$, $df=1$, $p=0.000$).

Other destructive uses of marine ecosystems include mangrove clearance, aquaculture and trawling. In terms of the destructive uses inside the MPA, it was possible to distinguish between MPAs that have remained fairly stable since they were established and those who had been able to reduce occurrence (figure 3.7). However, this was compared to outside (figure 3.8), 39% of MPAs are mirroring areas outside their boundaries, 25% have out-performed outside by one activity and 35% have outperformed by one activity or more. This is also reflected in the fact that while most MPAs had overseen the cessation of a mean of 2.5 destructive uses (SD=2.27) inside their boundaries, the areas outside had also seen an average of 1.5 destructive activities decrease (SD=1.44). MPAs with some NGO management had reduced significantly more activities over time (z=-2.40, n=60, p=0.016) as those with multiple management (z=-2.19, n=60, p=0.029).

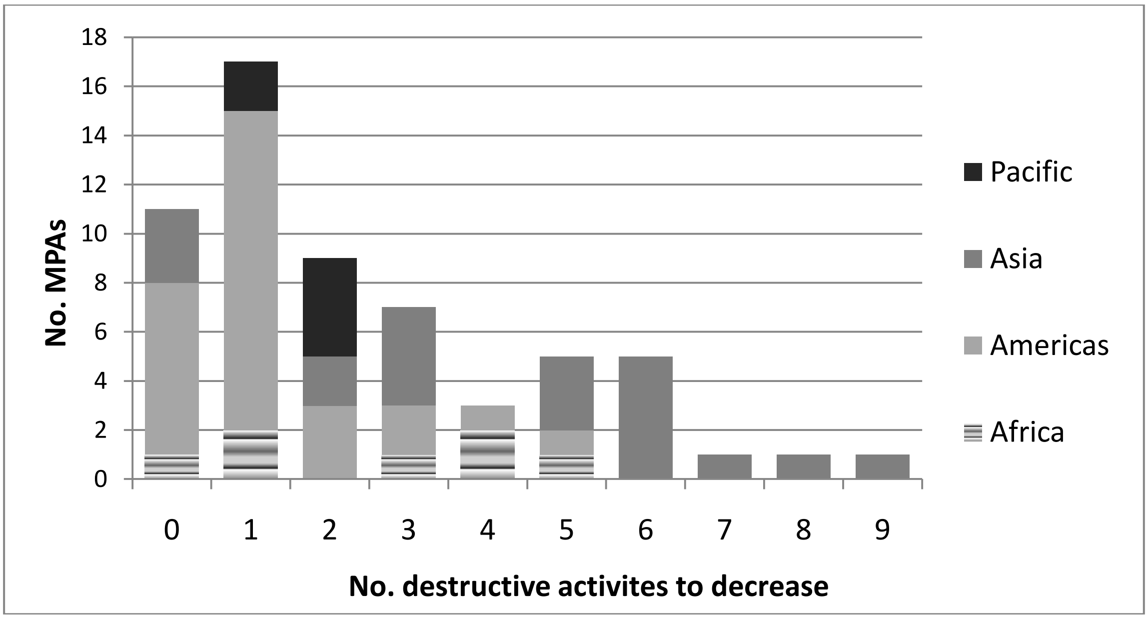


Figure 3.6 Changes in the destructive activities occurring in the MPA, since it was designated.

It is notable that all the MPAs that decreased six or more destructive uses inside their boundaries and the three that had outperformed outside conditions by 6 and 8 activities are in Asia, although Asian MPAs also show the most variation in performance, followed by American MPAs. All MPAs in Africa had also been able to outperform outside conditions, in contrast to Pacific MPAs who were largely mirroring outside events.

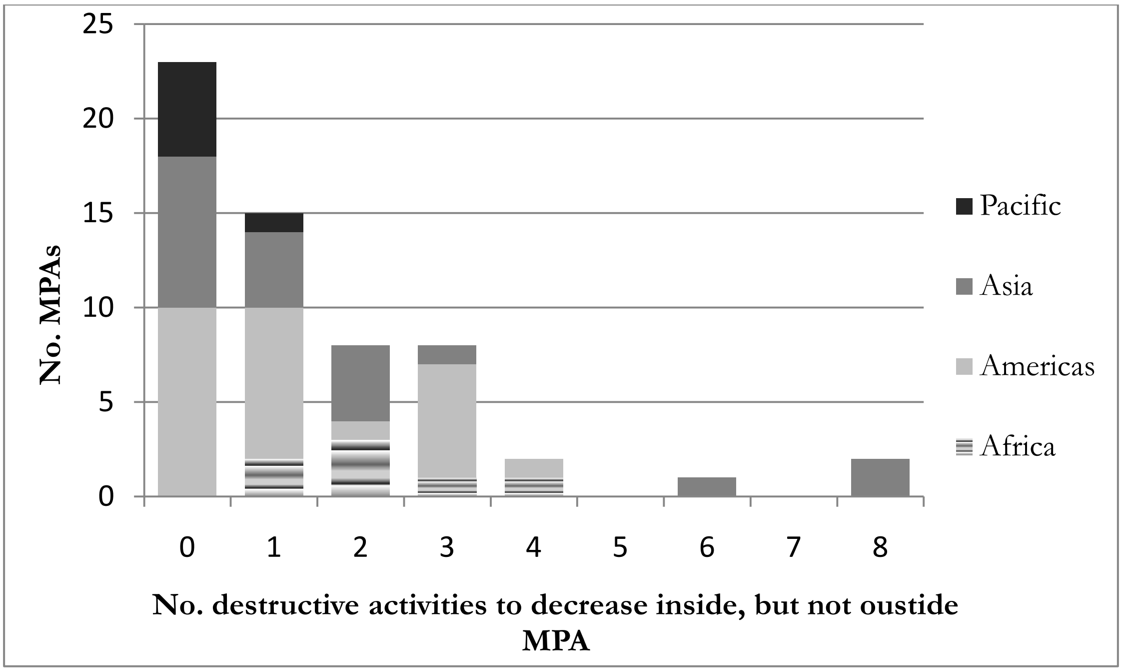


Figure 3.7 Changes in the destructive activities occurring in the MPA, compared to outside the MPA.

The analysis of user coral damage showed that MPAs in the Americas, those MPAs whose primary aim is focused towards tourism and had a greater proportion of jobs related to tourism are sustaining more coral damage from visitors and users (table 3.3). Those conducting education, with fisher compensation and those who provided mooring buoys had sustained less visitor coral damage.

MPAs whose main threat originated inside the MPA were less likely to have been established to preserve habitat quality, to be found in developing countries, and to be either recently established or old and to punish a small proportion of offenses. Finally MPAs facing a greater number of large-scale threats were larger and better staffed, which could be in response to the increased requirements for conservation and more likely to be located in Asia or the Americas. These highly stressed areas were also more likely to have received GEF funding and have used funds raised for community projects, rather than management costs or government departments. On the other hand, MPAs managed by NGOs and which had banned more activities had fewer threats inside their boundaries.

Table 3.3. Summary table of regressions to understand variables associated with threats inside sample MPAs. See appendices 3.9-3.11 for full regressions. (+) denotes a positive co-efficient and (–) a negative co-efficient.

	Coral damage by users Logit	**Main threat inside MPA Logit**	**No. threats inside MPA OLS regression**
Significant variables (sign of co-efficient)	Tourism aim (+) % jobs in tourism (+) In Americas (+) Fisher comp (-) Education (-) Mooring buoys (-)	Developing country (+) Age (-) Age ^{2} (+) % illegal act. detected (-) Primary aim habitat CN (-)	In Asia (+) In Americas (+) Size (+) No. staff (+) NGO managed (-) GEF funding (+) No banned act (-) % funds to community (+)
(N) Adj R^2	(49) 38%	(56) 41%.	(55) 40%

3.4.5 Ecological outcomes.

Coral cover estimates were not available at scales smaller than the country average. 5% of the coral cover estimates used here originated from expert opinion, 22% from monitoring data and 73% from a one-off study. Nevertheless, the comparison of live coral cover inside the MPA to the country average (figure 3.9) revealed that MPAs contain habitats which contain on average 7.6% more live coral cover than the national average. This was highly variable however, depending on the MPA (median=1.75%, n=62, SD=23.2%, range= -22% to +77%).

Many respondents (24%) were not able to report the initial coral cover estimates. This was especially true for older MPAs. However, for those for which it was known, coral cover had on average remained fairly stable over time within MPAs and showed less variability than the spatial coral cover estimates. The mean change since designation was -0.23%, with less variable than the spatial coral cover estimates (median =0.2%, n=50, SD=12.2, range =-34 to +33%). Overall, 66% of the MPAs had maintained or improved their live coral cover, but some MPAs have had large losses, for example, two MPAs in Belize had seen over 30% loss, over 12 and 24 years. In contrast, Siete Pecados, a 50km² MPA in the Philippines, reported a 30% increase in live coral cover in the 5 years since it was established, which seems inflated. If estimates of coral cover change were compared to respondent to perceptions of habitat change, then while 93% of respondents perceived that their MPAs had maintained or improved habitat, only 66% of MPAs seem to have achieved this given the reported current and initial coral cover estimates, although these results were not statistically different (chi^2=1.39, n=49, df=2, p=0.499), which suggested that perceived habitat changes were similar to those calculated from coral cover estimates.

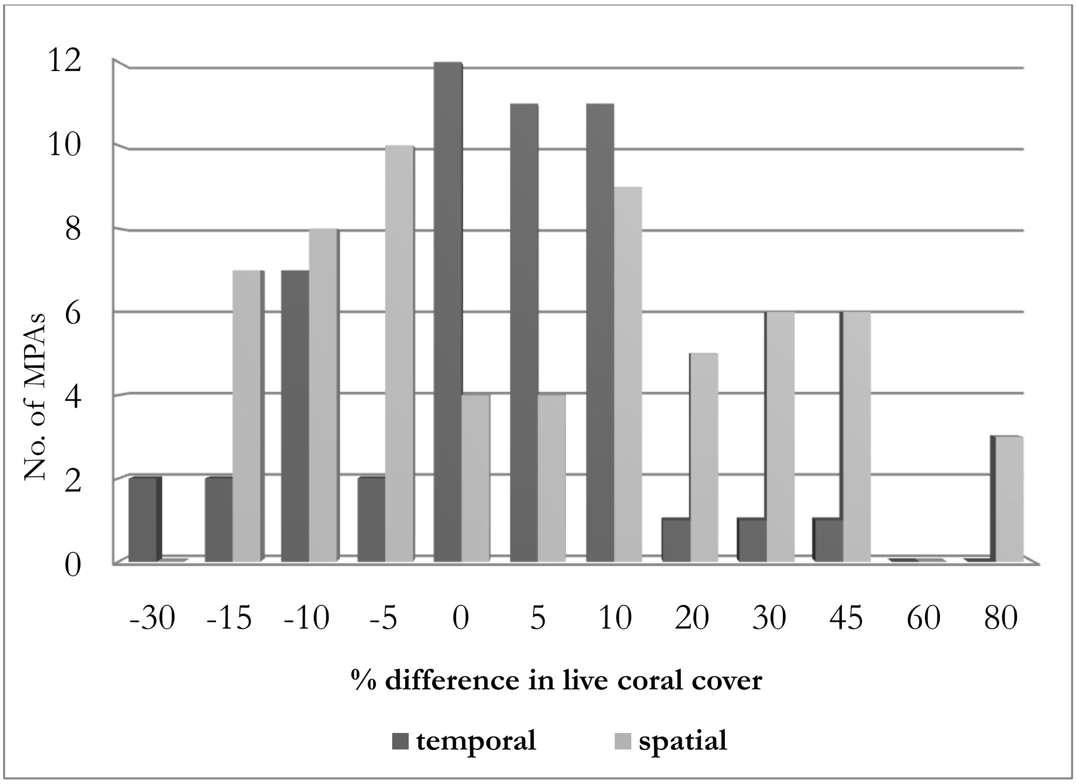


Figure 3.8 Comparisons of live coral cover at each MPA compared to cover when the MPA was established (temporal) and to the country average (spatial). Source of country average is (Wilkinson, 2004).

Since many MPAs may had been placed in areas which had unusually healthy ecosystems to begin with, coral cover should be analysed both temporally and spatially. Temporal variation (years since designation) explained 20% of the spatial variation in live coral cover (f=12.2, df=1, n=50, p=0.001) and in general, when one is favourable, so is the other. Spatial variation was much greater than temporal variation, which is in part due to the crudeness of the national data.

MPA age explained only 6.5% of the variation in coral cover changes since MPA establishment (F=4.32, n=50, df=1, p=0.043), but was not a significant predictor of spatial differences. Whilst no-take areas were not a significant determinant of spatial coral comparisons (t= -0.007, n=62, p =0.995), they did have an effect on changes in live coral cover over time at the 10% level (t=-1.82, n=50, p = 0.075), increasing the mean change from -3.98% to +2.3%. There was stronger evidence that having community management has a significant positive impact on the change in live coral cover over time (t = -3.294, n=50, p=0.002). The mean change was -5.17% in MPAs without community management and +5.2% in MPAs with community management. This is despite the fact that community managed MPAs are much more likely to be in high (less stringent) IUCN categories (chi^2=8.89, n=63, df=1, p=0.003) and less likely to be part of a reserve network (chi^2 =3.34, n=63, df=1, p= 0.068).

Questions related to perceived ecological changes showed that species conservation improved in 72% of MPAs and remained the same in 25%. Fisheries were reported to have improved in 66%, remained the same in 23% and worsened in 11%, so that fisheries showed the least improvement of the 6 changes assessed. Fishing benefits of MPAs should result in fishers congregating on the edge of no-take areas. 19% of MPAs reported frequent fishers "fishing the line" and the 52% saw this sometimes. Few respondents were aware of fisheries changes and even fewer what was occurring outside the MPA. The majority of respondents (69%) thought that the number of fishers had decreased inside the MPA and 28% thought that it had increased. 56% thought the numbers fishing had increased in the vicinity of the MPA, compared to 22% who thought they had stayed the same and 22% who thought they had decreased.

3.4.6 Socio-economic outcomes.

Respondents were asked how a variety of perceived social aspects have changed as a direct result of the MPA since it was designated. Education and research were reported to have improved in 82% of MPAs, local economic development to have improved in only 55% and cultural heritage to have stayed the same in 59% of MPAs. Most respondents did not think that MPA related tourism had resulted in local cultural erosion (79%). However, 50% thought that it had increased user conflict and 26% saw no change. Changes in conflict are affected by management type (chi^2 =13.8, n =66, df =2, p =0.031). Government managed MPAs had higher levels of conflict than the average and similar conflict scores to NGO managed areas, whilst multiply managed areas performed slightly better than average and community MPAs had reduced conflict the most. Conflict resolution initiatives were also associated with decreases in conflict (chi^2=16.5, n=66, df=2, p=0.000).

The majority of respondents (85%) felt that the MPA had increased tourist visitation in the area (11% felt it had not affected it). The MPAs supported a mean number of 69 businesses (SD=131) and 727 jobs (SD=1490, max =6740). Of these, an average of 51% jobs supported were in the tourism industry, 46% were fishers and 3% were MPA staff. If the area under management is taken into account, MPAs supported an average of 291 jobs km^{-2}. However this figure is unduly affected by two outliers, with Waialea bay in Hawaii and Resexmar in Brazil supporting more than 1000 jobs km^{-2}. Indeed the majority of MPAs support relatively few jobs km^{-2} (23% support 0.3 jobs km^{-2} or less) and without these outliers, the average number of jobs supported is 123 km^{-2}. Jobs supported in tourism were equivalent to a median of one job per 54 tourists, although this was highly variable.

Whilst 45% reported the MPA increasing local wealth, 55% reported increased local employment benefits. Respondents estimated the proportion of jobs that went to local people, with a mean of 82% of jobs being retained by the local communities. Five MPAs had less than 50% and 24% had 100% of jobs going to local people. This suggested there is minimal immigration into these areas. Of the three major employment types, fishing was where the least leakage occurs, as 84% of jobs were retained by locals, compared to 77% of management jobs and 75% of tourism jobs. As a result of increased tourism, respondents reported increased availability of goods in 22% and increased prices in 34% of MPAs. Respondents were not able to give indications on changes to fisher search costs and congestion.

3.4.7 Temporal aspects of change.

The number of years since MPA designation explained 8.5% of the variation in change in live coral cover since MPA designation (f =4.32, df =1, n=50, p =0.043). Older MPAs had seen larger declines in live coral cover than more recent ones. Whereas MPAs up to 10 years old had mean positive changes, those older than 12 had seen losses in coral cover (appendix 3.8).

As figure 3.10 shows, visual inspection of various changes inside the MPA seemed to demonstrate a pattern in terms of the age group of the MPA. None of the mean scores by age group were less than 0, indicating that changes were positive for MPAs generally. Initially, there seemed to be an increase in the quality of these attributes, which then fell for MPAs that were 11-20 years old and then increased for MPAs over 21 years old. Exceptions were compliance, fisheries and habitat quality, which seemed to decrease with older MPAs, with some improvement in the oldest MPAs. Perceived success varied according to the age category (chi^2=15.9, n=64, df=3, p=0.069). There was also a significant relationship between change in fisheries and age group (chi^2=13.4, n=63, df=2, p=0.037).

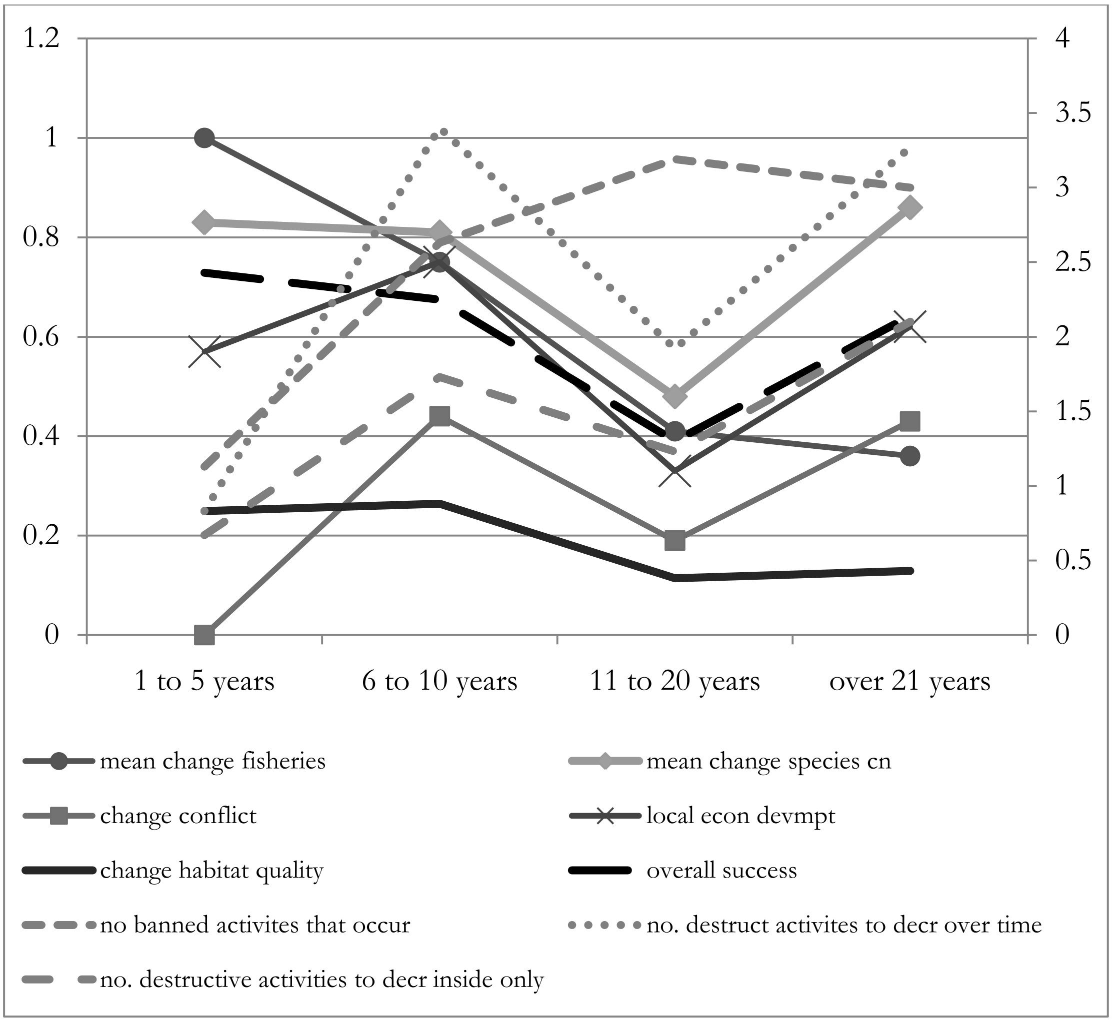


Figure 3.9 Mean scores for outcomes by MPA age group. Changes scores score lie between -1 and 1 on the primary axis are denoted by solid lines. Attributes could scored from 0 to 4+ are shown on the secondary axis are denoted by dotted lines.

3.4.8 Effects of no-take area and MPA size on Outcomes.

Surprisingly, few perceived outcomes are dependent on MPA or no-take area size. Only two variables showed significant effects associated with size category, change in fisheries (chi^2=11.12, n=65, df=3, p=0.085) and performance in terms of reducing destructive activities (chi-sq=28.7, n=64, df=5, p=0.052). Unexpectedly, the smallest size class of MPAs (0-25km^2) were reported to have seen the most improvement in fisheries (which could be due to ease of enforcement), whereas MPAs 151 - 1000km^2 in area produced the most additional success in terms of reducing destructive activities compared to outside. Also, the size of the no-take area was linked to the aim achievement, with no-take areas of 0.1-10km^2 and over 500km^2 having the greatest achievement of aims.

In contrast, having any size of no-take area influenced a large range of outcomes and success measures in these MPAs (table 3.4). No-take areas are seen to be associated with better detection of infringements, reduction in destructive activities, lower coral damage from tourists, better increases in education or research and more increase in wealth, employment and jobs.

Table 3.4. Success variables which vary significantly for MPA with and without no-take areas.

Variable	Mean value (no no-take)	Mean value (w. no-take)	Z value	p-value
No. of destructive activities to decrease over time	2	2.7	-2.04	0.038
No. of activities decrease compared to outside	1	1.7	-1.67	0.094
% of illegal activities that are detected	27.4%	48.5%	-2.51	0.012
Coral damage from tourists (dummy)	54%	30%	1.846	0.065
Change in quality of education / research	0.7	0.9	-2.02	0.043
Increase in wealth due to MPA	31%	55%	-2.02	0.044
Increase in employment due to MPA	38%	65%	-2.22	0.026
Total number jobs supported	213	1039	-2.17	0.030

3.4.9 **Regional patterns**.

MPAs within LDCs were younger (a mean of 12 years) than those in MDCs, which had mean of 23 years (f=11.4, df=1, n=65, p= 0.001). No take areas were significantly smaller in LDCs with a mean of 504km^2 compared to 8,877 km^2 in MDC (f=3.5, df=1, n=62, p= 0.067). LDC MPAs received a mean of 8,480 visitors per km^2 compared to 333,393 for MDCs (f=6.7, df=1, n=54, p=0.013). LDCs had greater perceived fisheries improvement chi2=13.7, n=64, df=2, p=0.001) and had further decreased the number of destructive activities compared to outside the MPA by 1.5 activities more than MDCs (f=6.7, df=1, n=60, p=0.012).

Several MPA features and outcomes varied significantly between regions (table 3.5). African MPAs were less likely to have been set up to increase tourism and had relatively low visitation rates. However they had the greatest importance for subsistence fishing and had retained the most jobs locally. They had budgets over ten times greater than the sample's median budgets, but they only retained 17% of them for management costs. They tended to protect high quality coral and had maintained it since inception (an average of 11 years). MPAs in Africa and the Pacific reported 4 large threats or fewer, although the main threat was inside the MPA for 88% of these. African MPAs had reduced between 0 and 5 destructive activities, with a mean of 0.6 destructive activities, of which 2.14 were continuing outside their boundaries.

American MPAs were predominately under government control (rarely community managed). Their budgets were small, but they retained 96% for management costs. They showed the most negative trends in coral cover since establishment (over a mean of 15 years), but these were still better than trends outside the MPAs. Most have reduced zero or one activity and faced relatively poor compliance and a mean of 3.2 large threats per MPA, with 25% having over 5 large scale threats. Half of the main threats were external and therefore beyond the control of management. All of the MPAs in the Americas reported at least one large scale threat, usually cyclones and hurricanes. American MPAs were the least important in terms of subsistence fishing and retained fewest jobs locally.

Asian MPAs were more focused towards tourism and 60% were in part community managed. They had relatively small management budgets and retained only 30% for management costs. However, they had increased coral cover by 5.31%, the greatest increase of all the regions (over a mean of 14 years) and were situated in areas with 7.5% better coral cover than the national average. Asian MPAs showed a large variation in terms of decreasing destructive uses, with 8 reducing 5 activities or more, but they had reduced a mean on 4.25 destructive activities, with over half of these also less commonplace outside MPAs. They faced the highest number of threats (33% had over 5 large scale threats) and the lowest compliance. One MPA in Vietnam had 8 large scale threats occurring inside its boundaries, including cyclones, large scale development, chemical pollution and war. They were seen as important for subsistence use and had high visitation levels.

Finally Pacific MPAs were often community managed. Their budgets were highly skewed by the inclusion of 2 MPAs with enormous visitation rates and budgets, Hanuma bay and Waieia bay in Hawaii, however, they had been able to retain 99% of their budgets for management costs. MPAs contained much greater coral cover than the national average and had seen increases in coral cover, despite being a mean of only 19 years old. All but one MPA in the Pacific report decreased destructive activities outside the MPA, similar to inside it. They had the highest levels of compliance and a low number of threats. They had high visitation rates, but are still important locally for subsistence fishing.

Table 3.5. Variables which differ significantly between regions. *** =p<0.001, **=p<0.05, *=p<0.01. N=66 unless otherwise stated.

Variable (number MPAs)	Africa (n=10)	Americas (n=20)	Asia (n=30)	Pacific (n=6)	Test for differences
Primary aim tourism	0%	7%	35%	0%	Chi^2 =11.5, p= 0.009***
Multiple mngt aims	0%	17%	0%	33%	Chi^2 = 7.99, p=0.046**
Government managed	80%	93%	90%	50%	Chi^2 = 8.55, p=0.036**
Community managed	50%	30%	60%	70%	Chi^2 =7.14, p=0.068*
Current budget / km2	190,424	11,713	18,326	2,263,601	F= 3.78, p= 0.016**
Management budget / km2	33,144	11,192	6,502	2,252,814	F=3.58, p=0.020**
Temp change coral cover	0.29	-5.61	5.31	3.5	F=2.99, p=0.040**
Spatial comparison coral	6.13	2.36	7.48	33.9	F=3.42 , p=0.023**
No destructive activities to decrease	2.57	1.56	4.25	1.67	F=10.2, p=0.000***
No. decreased compared to outside	2.14	1.23	1.85	0.17	F=8.07, p=0.045**
No. banned activities occurring	1.5	2.4	3.4	1.3	F=5.42, p=0.003***
No large threats inside	1.6	3.2	3.8	1.8	Chi^2 =31.2, p=0.006***
Main threat inside MPA	88%	52%	84%	67%	Chi^2 =7.2, p= 0.066*
No. visitors per km^2 per year	1,364	5,843	13,288	728,603	F=8.42, df=3, n=54, p=0.066*
Rank subsistence fishing	0.7	2.1	1.3	1.2	Chi^2 =2.45, n=62, p=0.57
Proportion jobs to local people	93%	73%	85%	90%	F=2.68. df=3, n=45n, p=16.4

3.4.10 Proportion of MPAs fulfilling key criteria for success.

If those aspects that are highlighted in the literature as critical for effective coral reef management are used as criteria for success, it is possible to assess how many MPAs meet these criteria and hence how much of the total managed area is effectively protected (table 3.6). Some of the criteria were met by the large majority of MPAs, including being over 5 years old, having one or more members of local staff and a set up budget, being greater than $5km^2$, having a management plan and less than 10 fishers per km^2. Those which were fulfilled by less than half the MPAs include having strict protective regulations (IUCN category), having no banned activities occurring, having at least one member of staff per km^2, or a no-take area which is likely to be large enough to encompass movements of key species. If no-take areas were seen as a requirement for MPA effectiveness, then only 22% of all this managed area would be included. Although 63% of the MPAs had budgets greater than

US$1000/km², this encompassed only 9% of the managed area. Similarly, while 52% of MPAs had less than 100 tourists per km², this covered only 13% of the total area. Fortunately, the majority of managed area fell within MPAs that were over 5 years old, were over 20km² in area, had a management plan and reasonably low fishing pressure. Importantly, although 66% of the MPAs had either maintained or improved coral cover, this only covered 20% of the total managed area. If 4 criteria are required, to include MPAs with any sort of no-take area, over 5 years old, designated as IUCN IV or lower throughout the MPA, this encompassed 15% of the samples MPAs and only 2% of the area under management.

Table 3.6. Percentage and Area of MPAs which fulfil possible Evaluation Criteria. Based on criteria suggested in Hughes et al., (2007), Vilayleck & Andrefouet (2006), Davis and Tisdell (1995), Sale et al., (2005), Storms et al., (2005), Boersma & Parrish (1999) and White et al., (2005b).

	Possible MPA Criteria	**% of MPAs**	**% of MPA Area**
MPA features	Have no-take area	61%	92%
	More than 5 years old	89%	98%
	IUCN category II or stricter	17%	8%
	IUCN category IV or stricter	34%	9%
	If MPA size > 20km²	62%	99%
	If no-take area >2km²	39%	22%
	If no-take area >5km²	35%	21%
Management	Part of wider coastal management	42%	84%
	Have active fisheries management	50%	34%
	One staff member per km²	20%	2%
	Had an initial set up budget	70%	44%
	Minimum annual budget of US$1000/ km²/yr	63%	9%
Uses and threats	< 10 fishers per km²	75%	96%
	< 100 tourists per km2	52%	13%
	No mangrove extraction occurs	68%	n/a
	Commercial fishing never occurs	20%	n/a
	No coral mining / destructive fishing occurs	82%	n/a
	No banned activities occur	20%	n/a
	Better coral cover than national average	53%	43%
	Maintained or improved live coral cover	66%	20%

3.5 Discussion.

MPA assessments are often hampered by the focus on small sets of ecological variables, the cost and effort needed for quantitative data collection, the lack of temporal comparisons, the focus on management inputs (based on the assumption that these produce the expected outcomes) and the lack of control sites (Holtzman et al., 2009; Willis et al., 2003). The large number of effectiveness evaluation methodologies also limits comparison between MPAs. Ideally MPAs would be assessed by directly comparing changes over time in ecological, economic and social factors inside and near their boundaries, compared to changes over the same time period in equivalent ecosystems and communities that do not benefit from MPAs, using replicated field surveys of habitats and households. This study is not intended to replace such studies in individual MPAs, which are essential to elucidate link between real and expected outcomes of MPAs and how these relate to management aims and conservation outcomes. However, the expense involved in carrying out such surveys at a large enough number of MPAs to enable quantitative comparative analyses is prohibitive. This research is exceptional as it contains the largest number of coral reef MPAs to be assessed using a single methodology.

This study focused instead on evaluating a range of factors that have been linked to MPA effectiveness in the literature. This necessitated reliance on coarse perceptions of changes and limited the outcomes that could be evaluated quantitatively. For example, it was not possible to look for ecological changes related to population structures, recruitment, biomass exportation, spawning, ecosystem resilience, biodiversity, etc. Similarly outcomes such as food and employment security, representation of minority groups, number of conflicts per year, susceptibility to environmental shocks, profitability of fisheries etc, were not included. These outcomes should result from successful MPAs (Pelletier et al., 2005). Similarly, it was not possible to gauge the frequency or quality of management actions undertaken. However, it is rarely possible to take into account every variable which may play a role in MPA effectiveness (Halls et al., 2002). Such information is rarely collected, which is demonstrated by the fact that despite many MPAs allowing fishing, almost no respondents were able to answer basic questions related to fisheries health. Instead this approach has been limited to assessing outcomes that respondents are able to judge based on their knowledge of each MPA.

Experts are an invaluable resource and are increasingly used for global assessments for coral reef status and other assessments e.g. (Tupper et al., 2008a; Wilkinson, 2008). Limitations of this approach include the fact that scoring will be less reliable than long term monitoring or academic studies, as it is usually qualitative and reliant on subjective perceptions, where the knowledge base of the respondent may vary significantly (Hockings, 2003). However methods involving quantitative monitoring data differ in methodology applied and in data quality and are also subject to measurement error and require interpretation during their analysis. Furthermore, responses of MPA managers are likely to be based on years of field experience and may better capture the realities and complexities of the MPA than any monitoring program (Hockings, 2003).

This study has gathered detailed information on a large range of factors at a large number of MPAs, by utilising expert knowledge of both the MPA itself and the ecological and social context in which it operates, at a relatively low cost. It is important to evaluate MPAs in the context of a wider subset of ecological and social contexts and regionally, since many additional confounding factors will also determine outcomes.

The MPAs included in this analysis cover 7% of all coral reef MPAs and more in terms of area. Globally, reefs are estimated to cover 527,072km^2 (Tupper et al., 2008b), but the areas in this study total 641,047km^2 of marine habitat, indicating that other habitats, such as mangroves and sea-grass beds are also included in these MPAs. This sample was also likely to be biased towards better funded and more actively managed MPAs, so results here may have constitute the best case scenario. This dataset included a wide range of MPA types and features, whose spread across IUCN categories and regions was not significantly different from the global total population of MPAs, suggesting that this information was broadly representative of MPAs in general. As a result, this constitutes an adequate dataset to make cautious inferences about MPAs generally. Nevertheless I acknowledge the limitations of expert opinion as this is likely to be somewhat subjective and biased, which is why several types of respondents were included, beyond only management staff. The similarity of the answers for those MPAs which had duplicate answers from different respondents and the range of outcomes reported would suggest that this approach is not fatally flawed, although there was evidence of bias in a few parameters, which will be further explored in the next chapter.

The basic approach of using expert information to assess which MPAs fulfil necessary criteria, as done by Mora el al., (2006a) is a quick and cheap way to make inferences about key evaluation criteria. Both the number of MPAs and the relative area they represent should be calculated, as these often differ. Most of the criteria thought important for MPAs are fulfilled by over half the sample. Those which fare relatively poorly are related to the size of the no-take area, the provision of adequate regulation and compliance on potentially destructive uses such as fishing. When combinations of requirements are assessed, the proportion of MPAs with adequate provisions for conservation becomes much smaller. This approach is limited however by uncertainty in the literature about what general criteria are important, such as coral reef carrying capacity and the necessary reserve size and as such there is some subjectiveness in the choice of the level of each parameter used.

In terms of ecological outcomes, coral reef health is an appropriate test of MPA performance, given that it is the fundamental motivation for setting up most MPAs. This study has focused on live coral cover as MPAs vary widely in the quality and change in their coral cover, so these are good measures of habitat conservation. However, mean cover is difficult to estimate accurately. Moreover the large regional variability in patterns of coral cover makes demonstrating significant effects of management on coral cover extremely difficult. Similarly spatial comparisons used here are coarse grained and vary depending on the size of the country. Incorporating the scale of the spatial comparison (the area of reefs in each country), in the quality of the coral cover estimate (replication, size of study site) would be ideal, but these data were not available. Fortunately, only 5% of the coral cover estimates used here originated from expert opinion, rather than from monitoring data or a published study. The spatial comparison provides local context and so is essential in addition to the temporal comparison. Given the inaccuracies described above, a tentative inference can be made that 66% of the MPAs considered have maintained or increased coral cover, which constitutes a significant success in the context of the global decline in reef health (Wilkinson, 2008), although this represents only 20% of the area under management. The positive spatial coral cover comparison suggests that MPAs are located in areas benefitting from better than average coral cover. However, 24% of these MPAs have over 10% less live coral cover than the national average, which is cause for concern.

It was expected that the older the MPA, the more likely that reefs both inside and outside the MPA have experienced coral declines and losses, but age alone explains only 8% of the temporal changes in coral cover, indicating that other factors are also important. In addition, MPAs are reported to have a more positive impact on species conservation than on fisheries enhancement, although there is anecdotal evidence of spillover in 19% of the MPAs. Fishing impacts were difficult to test quantitatively using a measure that respondents are able to report on, which is surprising given the emphasis on fisheries benefits as key reasons for establishing MPAs (Alder et al., 2002). MPAs with lower coral cover than the national average had higher budgets, which was unexpected, although the direction of this causation is unclear this could be due to the requirement for greater funds to increase coral cover.

The equitable distribution of costs and benefits MPAs generate is an important concern (Corbera et al., 2007; Webb et al., 2004). Local communities have been shown to benefit widely from these MPAs, in terms of recreational use, income, education and economic development. Tourism was a key element of these benefits for many of these MPAs (it accounts for over 5-% of jobs supported through the MPA). Fortunately most of these jobs were retained locally and there is little evidence of indirect costs, such as immigration, although coral damage is occurring. Local communities suffered relatively few OCs, as although commercial fishing was banned in several MPAs, it was rarely banned throughout the area and there was anecdotal evidence of spillover in a few MPAs. In addition, subsistence fishing and traditional hunting of species occured widely, which may also undermine management. Finally, funding was frequently used for local community projects, including those that were designed to compensate local costs (e.g. alternative livelihood schemes) or increase local representation. Only 39% small portion of these funds originated from national governments overall, less so in LDCs.

Of most concern in terms of social impacts was the reporting that conflict between stakeholders had increased in half of the MPAs, which is contrary to what was expected (Kelleher et al., 1995). This could undermine MPA effectiveness, as local support is critical for compliance (Pomeroy et al., 2007). This may be a sign of perceived inequity (Christie, 2004). More research is needed to see if this was because of uneven employment and wealth benefits, lack of engagement of certain stakeholder groups or lack of compensation for marginalised fishers.

There were several MPA features which cause significant changes in MPA outcomes. In terms of temporal changes, a pattern emerged that while MPAs may have some immediate benefits, these declined and then increased in MPAs older than 20 years, which is similar to what was predicted by Syms and Carr (2001). Many of the MPAs here were too young to have achieved their full impact, especially in terms of ecological changes, which should be taken into account. Having a no-take area was a significant determinant in more outcomes than the MPA age. There was evidence that it helped to reduce destructive activities including visitor damage to coral, aided illegal activity detection and was associated with increased wealth and employment benefits. Larger no-take areas produced greater fisheries benefits, as was expected (Roberts & Hawkins, 2000).

Regional location also explained much of the variation in more aims, management groups, budgets and outcomes. However, those MPAs with strong performance over time were not always the same as those who had out-performed outside conditions, underscoring the need for counterfactual comparisons in evaluations.

These MPAs are highly threatened, especially by coral bleaching and hurricanes as well as sedimentation and pollution, yet only 42% of the MPAs are part of wider coastal management, which is cause for concern, as these could undermine management efforts. This is reflected in the fact that the evaluation of the potential efficacy of the solution offered to the main threat at each MPA showed than only in a third of MPAs was this solution targeted and likely to reduce the threat. More emphasis needs to be placed on reducing these threats on a regional basis, as relying on MPAs to conserve coral reefs, whilst allowing these threats to remain will not safeguard these habitats in the long term, even though management may increase resilience. These results support the contention that the present number and impact of MPAs on threats alone is insufficient for coral reef conservation (Allison et al., 1998).

Enforcement and punishment of illegal activities are disappointing in many MPAs (Byers & Noonburg, 2007; Jameson et al., 2002). The link between funding, staff numbers and illegal activity punishment demonstrated here suggests that an increase in funding is a good way to increase compliance. Therefore providing MPAs with resources to increase enforcement could have a strong impact on MPA effectiveness. Additional funding could also enable increased use of fisher compensation, education and mooring buoys which were shown to reduce coral damage from users, as it is not helpful to reduce impacts from fishing only to increase impacts from other users, such as tourists.

Some MPAs were indeed fulfilling objectives related to conservation of habitat quality, improvement of local community welfare and reduction of threats. However this was by no means universal. In contrary to what has been observed previously (Christie, 2004), socio-economic benefits were more commonplace than ecological improvements, although continued conflict remained a widespread issue. The principal aim of the MPA has no significant relationship to the achievement of the required outcome, however targeted management actions (such as fisheries, species or conflict resolution) did have significant impacts. Therefore simply designating an MPA and specifying an aim is not enough, resources need to be made available to ensure active management effort, which is likely to require, but not be limited to, increased funds (Balmford et al., 2004; Francis et al., 2002; Gravestock et al., 2008).

MPAs were funded to a large extent by international organisations and tourists, who gained directly from recreation and support of non-use values, as well as indirectly from support of ecosystem services beyond the boundaries of the MPA. Thus MPAs can be seen as a transfer of wealth in return for support of these services. Ineffective MPAs will incur significant opportunity costs for donor funding. To increase the impact of conservation funds, effectiveness should be assessed. Investigating the number of threats inside MPAs and the decrease in destructive activities shows large differences in impacts between MPAs. However, almost 40% of these were mirroring what is going on outside the MPA. The most effective MPAs were those which show additionality, by outperforming outside conditions. If there were no destructive uses prior to establishment or are major threats within MPAs, or if they are not adding additional benefit compared to non-managed areas, this calls into question the value of an MPA in this area.

3.6 Recommendations.

Further research is needed to develop indicators of fisheries impacts of MPAs. The creation of a database of coral quality monitoring and one-off studies in areas would be highly beneficial, to aid future adaptive management, by gauging the impact of management actions on coral quality, in the context of nearby reefs. Further research needs to look into the temporal aspects of MPA benefits, as time lags will occur for different types of impacts, but these remain poorly understood.

Regional differences were evident in both MPA features and in terms of outcomes, as did the distinction between MPAs located in LDCs and MDCs and there was also evidence of temporal patterns. Although MDCS had lower budgets, this could be due to the relatively lower costs of inputs. Similarly, larger MPAs are likely to benefit from returns to scale in management investments. Since these factors will often be confounded with one-another, drivers of performance needs to be explored together, taking into account non-linearities and interactions, which is the focus of the next chapter.

Investigating Drivers of Successful Ecological and Socio-economic Performance in Coral Reef MPAs.

4.1 Introduction and Rationale.

MPAs continue to be the most favoured coral reef management tools (Christie & White, 2007). However, there exists an increasing need for the evaluation and understanding of the effectiveness of MPAs operating globally (Lani et al., 2003). MPA research has principally focused on demonstrating single ecological outcomes, especially fisheries benefits e.g. (Ervin, 2003), despite the relative expense of such studies (Holtzman et al., 2009). Other research has looked at gauging effectiveness but limited to MPAs of a similar management type or region e.g. (McClanahan et al., 2005a). However, the success of an MPA depends on the interaction between biological, social and governance factors (Hudina, 2006), meaning that the narrow focus on a specific MPA outcome is limited in terms of elucidating the link between different facets of success and the drivers of overall success. This may because few studies have objectively and simultaneously examined the types of MPAs that are most effective in conserving reef resources and the socioeconomic factors responsible for effective conservation (McClanahan et al, 2006). The relative dearth of quantitative research into socio-economic outcomes and their link to MPA performance is surprising, given that these are likely to be critical for MPA success (Christie, 2004; Mascia, 2004; Pelletier et al., 2005). Yet analysing both the environmental and social dimensions of MPA performance is essential as it provides a basis for adaptive management (Pomeroy et al., 2007).

Expectations are placed on MPAs to protect marine biodiversity and ecosystem function, to reduce poverty, and to provide for healthier coastal communities with a strong foundation for economic growth (Lani et al., 2003). Indeed, it is the ability of MPAs to provide habitat, fisheries and socio-economic benefits simultaneously (Sanchirico et al., 2002), which is a key reason why they are advocated (Halpern, 2003). However, the demonstration of MPAs simultaneous ecological and social benefits remains controversial (Agardy et al., 2003; Gjertsen, 2005). There is little quantitative research to determine the extent to which different successful outcomes are coupled at MPAs. There is also disagreement as to what constitutes MPA success. MPAs that meet narrowly defined biological goals are often touted as successful, even if they are failures in the context of social evaluations due to issues such as user conflict which can undermine long term success (Christie, 2004). Therefore, there is an increasing interest in the development and use of an adequately comprehensive but not exhaustive set of indicators that measure the socio-economic, ecological and institutional outcomes from the management process associated with MPAs (Lani et al., 2003) and a need to understand how these different facets of success relate to one-another.

Research has documented large variation in quality of MPAs, but the large majority of MPAs are failing to meet their aims (Jameson et al., 2002; McClanahan, 1999; Mora et al., 2006a). While 40 coral reef MPAs are created each year, they are rarely adequately managed, so that the vast majority of reefs inside MPAs remain threatened (Mora et al., 2006a). As yet there are no compelling reasons for this variation in MPA performance (Holtzman et al., 2009). The absence of credible evaluations of effectiveness is not peculiar to marine protected areas (Kareiva, 2006). In general, conservation science has a poor record of critical examination of whether its projects deliver their objectives (McClanahan et al., 2005a). Nevertheless, research has demonstrated or hypothesized which MPA features and management actions facilitate ecological and socio-economic success. Testing the hypotheses generated from these studies on a global scale is critical to improving the performance of coral reef MPAs. For example, most PA funding strategies now include mechanisms to raise and allocate funds or generate other benefits for adjacent communities. The extent to which these alter outcomes has not been tested on a wide scale. Performance evaluation of conservation impact and value is now seen as a top priority in order to assess and adapt management needs for protected areas (Lani et al., 2003). This should be done by developing performance criteria which are relevant, efficient and available enough to enable quantitative analysis (Pelletier et al., 2005).

Evaluation of MPA management effectiveness can serve multiple audiences, including donor agencies, policy makers, management teams, and conservation and development non-governmental organizations (Lani et al., 2003). As a result, there are increasing requirements to demonstrate effectiveness at MPAs, so that spending is targeted to only highly effective management interventions, which have demonstrated impacts (Hockings et al., 2000). This information is critical, since funding for MPAs is scarce (Balmford et al., 2004) and donor investment in any conservation strategy entails potentially significant opportunity costs. Poor evaluation could divert funds and effort away from those areas which could achieve most conservation impact. Further research is needed to assess the impact of the source and level of funding for management on outcomes (Holtzman et al., 2009). Finite funding must not be wasted on management strategies that do not produce conservation and therefore jeopardize valuable resources and undermine support for MPAs as a management tool.

This study used a dataset based on expert knowledge of globally representative sample of MPAs in 33 countries for a large range of factors, including MPA features, management actions and the ecological, socio-economic and national context. This dataset has the advantage of being large enough to allow quantitative analysis of MPAs, having substantial variation in outcomes, inputs, and contexts, and applying a standardised approach to all the MPAs assessed. Indeed, this sample is the largest set of coral reef MPAs to be assessed with a single methodology. Thus this provides a unique opportunity to investigate the links between and the drivers of different facets of MPA performance. This research was not intended to replace detailed studies which look at direct drivers of MPA success and failure at individual MPAs. Each location had a unique social and ecological context the influences MPA design, implementation and impact, which makes it challenging to transfer lessons between MPAs (Pomeroy et al., 2007). However, in the context of widespread management failure and the aim for a large global network of MPAs by 2012 (Balmford et al., 2004), it is vital to pursue a comprehensive understanding of MPA success on a global level (Gravestock et al., 2008; Lani et al., 2003).

The majority of MPA studies have looked at single or a few MPAs and have looked at the causes of changes in ecological features of habitats and species which are directly related to MPA goals, or MPAs of a similar type or in a similar region. This is wise as it controls for a variety of factors that differ between MPAs with different goals and in different countries, which are likely to have a strong impact on MPA performance. However, it is precisely this variability which I wish to utilise by taking a global perspective for MPAs, for one type of habitat: coral reef ecosystems. By analysing different facets of success individually and in combination, I acknowledge the multiplicity of MPA goals, the different perceptions of what constitutes success, which may be determined by institutional affiliation (Axford et al., 2008), the ability of MPAs to achieve some positive outcomes without meeting others (Christie, 2004) and the interaction between all these variables which leads to confounding. Thus by explicitly incorporating both endogenous and exogenous aspects of a heterogeneous set of MPAs, I hope to tease apart the relative importance of MPA features, management actions and contextual factors.

See also sections 2.2.2 and 2.2.6 for background to this section.

4.2 Aims and Objectives

This study has three aims. Firstly to identify an adequately comprehensive set of performance indicators related to MPA success, using as far as possible spatial and temporal comparisons to provide counterfactuals. This will enable recommendations to be made about the metrics that broad scale management effectiveness evaluations should use. Secondly, I wish to understand the link between different elements of ecological and socio-economic success at MPAs. Specifically I am interested in understanding correlates of respondents' perception of success and whether different types of success re-enforce one-another or are mutually exclusive. Finally, I test which explanatory variables, including physical and governance features, management actions and local contexts, are associated with the different types of successful outcomes and overall respondent perceptions of success. This will enable testing of hypotheses about the relative importance of different MPA features and management actions in determining success in a variety of contexts. This will allow me to make recommendations which identify the most important factors enabling successful outcomes for MPAs and therefore to make recommendations on how to maximise the conservation impact of scarce donor funding.

4.3 Methodology

The initial dataset included 27 performance related variables, which could be indicative of different facets of success at MPAs. These were taken from the dataset described in chapter 3. First this list was reduced to a set of measures that could reasonably be determined at a large number of MPAs and which characterised MPA impacts related to aims, threats, social, economic and ecological impacts without any redundancy. If variables were highly correlated (over 0.75), one variable was discarded. Preference was given to variables that had data from more respondents, as well as those variables which had more variation, as this would increase statistical power to detect and explore differences in performance (Pelletier et al., 2005). Those variables which recorded changes were also chosen above those that simply described current states. This resulted in a final set of 13 variables related to success (table 4.1). These related to 6 areas; ecological outcomes (4 measures), social (1) and economic outcomes (2), threat reduction (3), goal achievement (2) and overall success (1).

A number of bivariate and multivariate methods were employed to elucidate the links between the performance measures and to clarify components of perceived success. These included Spearman rank correlations, analysis of variance, chi-squared tests, principal components analysis (PCA), and cluster analysis. A correlation matrix was generated to examine the direction and strength of association between performance measures, using Spearman rank correlations, as in Bruner et al., (2001). PCA was used to understand which success variables were related to one-another. Those components with loadings over 0.3 were noted. No attempt was made to aggregate performance scores into a single composite measure, as the PCA, bivariate and multivariate results suggested that successful outcomes were often not coupled. In addition, the survey already contained a question relating to general MPA performance, which the correlations showed was a good gauge of several of the success measures (but not all). The analysis of correlations between outcomes enabled a further reduction in the number of dependent variables needing to be analysed to understand variation in their performance.

Since the aim was to assess the impacts of several aspects, including endogenous and exogenous factors, multiple regression was used to explore these factors for each performance indicator. The majority of potentially significant explanatory variables were gleaned from the surveys. These variables had been included in the survey, based on hypotheses from previous research. Some of these were direct responses to the survey questions e.g. number of zones in the MPA. Others were calculated indirectly from responses, e.g. the difference between the regulations and occurrence of specific actions based on yes and no responses, which was summarised by a single number. The aim of the MPA should determine many features. In chapter 3, indicators measured suggested that many MPAs are achieving increased tourism and economic benefits and that habitat and fisheries conservation were less ubiquitously realised. Therefore, aims were also included in the regressions.

Finally, a small number of variables were taken from other sources: national level statistics and the percentage of reefs at risk. National contextual variables included the gross domestic product (GDP per capita), the human development index (from 2005) and the population growth rate (from 2006), from the CIA fact-book with the same year was used for each variable (CIA, 2007), as in Holtzman et al., (2009). In addition, the reefs at risk estimates for each country for year, which have not been published for all countries, but were assessed for most, were used to create two variables, (a) the percentage of reefs at high risk and (b) the percentage at high and threatened risk in 1998 (Burke et al., 1998).

Data quality variables were also included in the analysis, since the coral cover data were of three types with varying degrees of accuracy. A small proportion was expert opinion, which was assumed to be the least reliable, some data were from one-off studies and some were long-term monitoring data, which was assumed to be the most reliable. Similarly, it was important to test for the impact of respondent affiliation, since respondents that are directly involved in MPA management have a vested interest in showing their areas to be effective and can show self-reporting bias (Bhagwat et al., 2001; Mascia, 2000).

This process resulted in a large number of potentially significant variables, in seven categories (see appendix 4.1 for full list);

- MPA attributes e.g. age, size, number zones, management type
- Management activities e.g. compensation, alternative livelihood schemes, fisheries management, monitoring and education
- financial aspects e.g. level and source of funding, spending
- socio-economic context e.g. number businesses, local use, fishing and visitor pressure
- threats e.g. number of threats inside MPA, coral damage from tourists, main threat originates outside
- national features e.g. human development index, GDP per capita
- respondent / data quality variables e.g. respondent affiliation, coral cover estimate source.

The underlying model which was being tested was;

$$\text{Eq. 1} \quad P = f\,(At, Mng, Fin, Thr, Ctx, Nt, Sv) + e.$$

Where P = performance, At = MPA attributes, Mng = management actions, Fin = financial aspects, Thr = local threats, Ctx = local context, Nt = national context, Sv = survey variables, e = error.

The distribution of the performance indicator data determined the type of regression analysis used. Ordinary least squares regression was used for normally distributed and continuous data e.g. coral cover comparisons. If Shaprio-Wilks tests for normality were passed, transformed variables were then regressed using ordinary least squares. Logistic regression was used for binomial data, such as increased wealth as a result of the MPA. Ordinal variables were explored with ordered logistic regressions. Finally, those variables with a negative binomial distribution were analysed with a negative binomial regression, e.g. number of large scale threats inside compared to outside. For right skewed data, such as of destructive activities to decrease, right skewed data were transformed by using the natural log of the number +1.

Non-linear relationships were explored for several variables, such as MPA age, size, no-take area size and budgets. In addition, interactions were explored between variables with a priori likelihood of being inter-related e.g. MPA age and size, the number of staff and the MPA budget, and tourist and fishing pressure.

Initially, a model with a few potential explanatory variables was developed, based on those variables which had been demonstrated in previous research to affect that type of performance (see table 4.1), as well as variables which emerged as important in chapter 3. Variables that were non-significant (with p-values greater than 10%) were removed and another variable added using a stepwise procedure. This was important, as over-parametised models needed to be avoided, especially for relatively small sample sizes. Successive models were compared against each-other using analysis of variance. This process was repeated, until a final minimal acceptable model was reached, where removal of any variable did not change model fit significantly. For each model, model assumptions were tested such as normally distributed errors and homoscedasticity and those which did not passed under-went variable transformation or required the correction of standard errors.

4.4 Results.

4.4.1 Performance indicators for Coral Reef MPAs.

The list of variables related to success was reduced to 13 variables (table 1). The final set of variables included seven outcome variables, three threat related variables, two variables related to goals and one to overall success. As discussed in the previous chapter, coral cover changes over time averaged around 0%, although some MPAs had suffered large losses. Spatial comparisons were even more variable, but these MPAs contained in general better coral cover than the country average. Species conservation had been improved in 72% of MPAs, fisheries in 66%. Stakeholder conflict had increased in most MPAs, despite the fact that these MPAs had increased wealth in almost half of the sample MPAs. The jobs supported were highly skewed by a few MPAs with large number of jobs supported, with a median of 2.2 jobs per km^2. Threat related variables were highly variable, and temporal and spatial comparisons showed different trends. Banned activities were shown to occur in many MPAs. General success was perceived as having occurred more often than achievement of primary aim of the MPA.

Table 4.1. MPA performance indicators for ecological, social and economic outcomes, as well as threats, achievement of goals and perceived success. See appendix 4.2 for detail on coding for each measure.

Outcome	Measures gleaned from questionnaire	Min	Max	Mean	Median	SD
Ecological	Change in live coral cover since established	-34%	33%	-0.23	0.2	12.2
	Live coral cover compared to country average	-23%	77%	7.6	1.75	23.2
	Perceived changes in fisheries	-1	1	0.55	1	0.67
	Perceived changes in species conservation	-1	1	0.69	1	0.53
Social	Perceived change in stakeholder conflict	-1	1	0.26	0.5	0.8
Economic	Perceived greater wealth for local communities as a result of MPA	0	1	0.46	0	0.5
	Estimated Number jobs supported per km^2	0	2460	123	2.2	443
Threats	Number of destructive activities that have decreased inside the MPA over time	0	9	2.5	2	2.3
	Difference between number of large scale threats inside and outside MPA	-8	4	0.03	0	1.9
	Number of destructive activities to stay the same / decreased inside, but not outside MPA	0	8	1.4	1	1.8
Goals	Number of banned activities occurring	0	10	2.7	2	1.9
	Perceived extent of primary aim achieved	0	3	2.7	2	1.9
Manager Opinion	Perceived success of the MPA in general	0	3	1.9	2	1

4.4.2 Validity of measures.

I investigated the accuracy of reporting by comparing results given by different respondents for the same MPA and found that a high level of congruence (chapter 3). Where more than one indicator has been used to measure similar outcomes by triangulation, these can be compared, as a basic assessment of validity of data gleaned from expert perceptions. Most relevant was the comparison of reported changes in coral cover from monitoring and one-off studies and perceived changes in habitat quality; which were highly correlated (f=3.41, df=2, R^2=13%, p=0.041). Those MPAs who had shown perceived improvements had a mean change of +2.9% in live coral cover compared to those with no perceived improvement, which had a mean of -6.8%. If these comparisons are grouped by MPA age category, these two data show very similar results (figure 4.1).

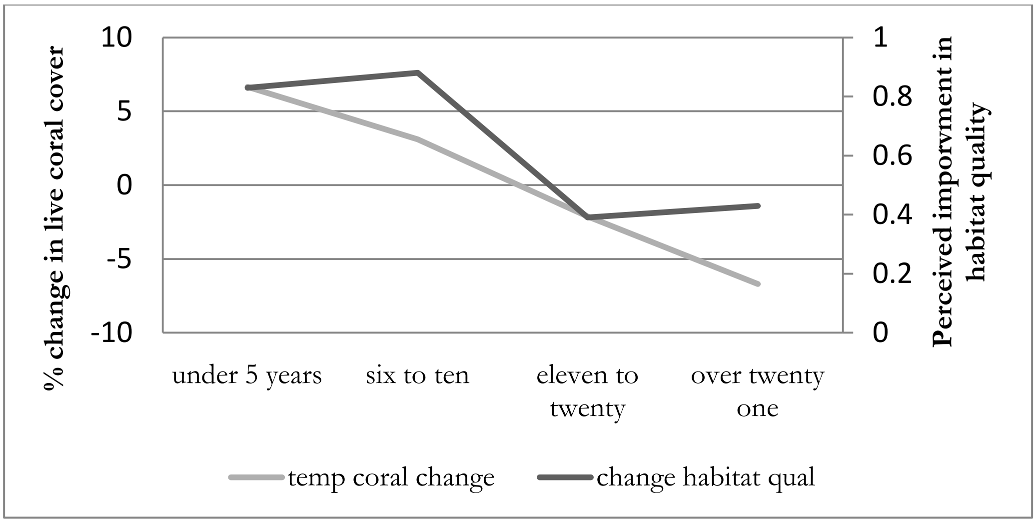


Figure 4.1. Comparison of mean coral cover change since establishment and perceived habitat quality changes, by MPA year group.

Perceived increases in employment were weakly related to both number of jobs supported (f=3.43, n=66, df=1, R^2=6%, p=0.07) and jobs per km² (f=3.05, n=50, df=1, R^2=5%, p=0.086). Those areas with which reported increased employment supported a mean of 37 jobs per km² compared to 236 per km² for those with no increased employment.

The indicator which was used to look for evidence of spill-over (fishing the line) was of limited use, since many respondents did not provide this information. However, (anecdotal) evidence of spill-over was highly correlated with perceived change in fisheries (chi^2=11.0, n=60, df=2, p=0.027), which supports the validity of these measures through triangulation. Spillover was also correlated with changes species conservation, which will often be aimed at a commercial fish species (Pearson chi^2=9.6, n=58, df=2, p=0.047).

4.3.3 Relationships between successful outcomes

Figure 4.2 shows the mean perceived changes for MPAs in various performance related outcomes. Conflict reduction had been achieved much less frequently than the other outcomes and education had been achieved the most. These results suggested that most MPAs often achieve improvements in areas such as education and ecological improvements, but less in socio-economic outcomes and relatively few decrease conflict. This indicated that improvements in some outcomes are not always coupled with improvements in others.

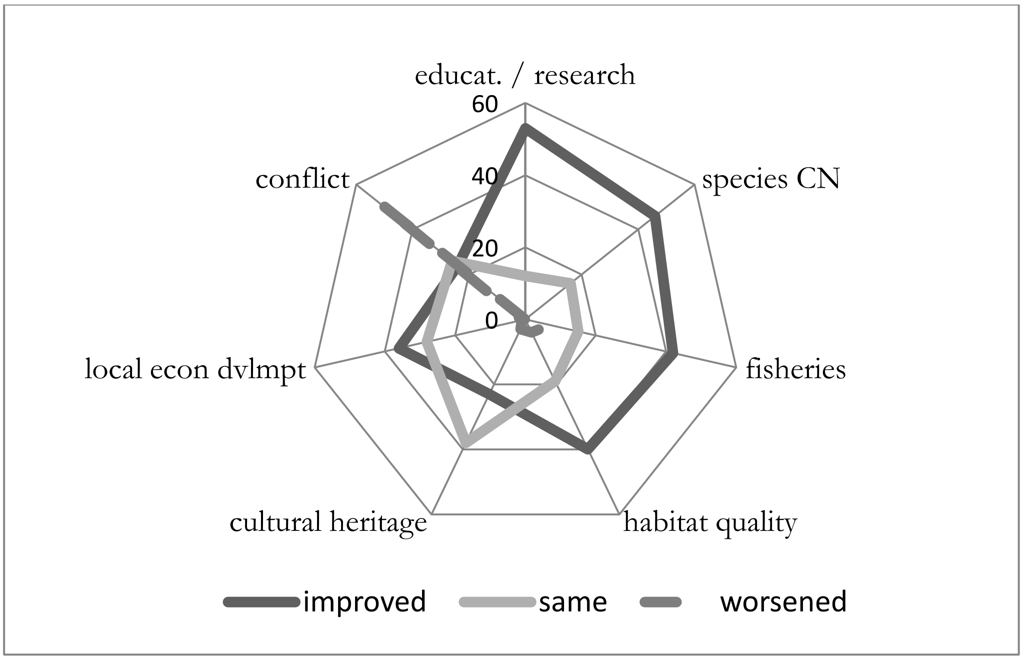


Figure 4.2. Mean scores for changes in performance related outcomes.

The first three components of the principal components analysis (pca) explained 60% of the variation in the success variables (table 4.2). This analysis suggested that changes in species and fisheries conservation were related to increased wealth and employment, as well as overall success and achievement of aims (component one). Both temporal improvements in coral cover (component 2) and improvements in species conservation (component 3) were linked to perceptions of enforcement of unsustainable uses and reduction in threats, but not to each other. Spatial comparisons of coral cover and changes in conflict were not significantly linked to any other indicators. There was also no link between threat reduction or habitat quality changes and socio-economic improvements.

Table 4.2. Principal Components Analysis for Performance Indicators.

Variable	Component 1	Component 2	Component 3
Temporal change in live coral cover	0.204	0.328	0.237
Spatial comparison in coral coral	0.276	0.167	0.256
Change in fisheries	0.337	0.045	-0.252
Change in species conservation	0.346	-0.142	-0.371
No. banned activities to occur	0.089	0.210	0.493
No. destructive activities to decrease	-0.147	0.583	0.016
No. activities to decr compared to outside MPA	0.019	0.489	-0.421
No. threats compared to outside	-0.084	0.351	-0.330
Change in conflict	-0.118	-0.150	0.215
Increase in wealth	0.372	0.128	0.145
Increase in employment	0.321	0.143	0.232
Extent primary aim achieved	0.434	-0.074	-0.009
Overall perceived success	0.430	-0.168	-0.157
Percentage of variance explained	**31**	**15**	**14**

Spatial comparisons were more variable than temporal changes, as was be expected (figure 4.2). Where MPAs had improved coral cover over time, positive spatial comparisons would be expected, as these areas would outperform unprotected habitats. If a large proportion of the variation in coral cover changes over time at a site was explained by spatial comparisons, this would suggest that MPAs are mirroring trends in coral cover in most countries. Spatial comparisons explained 20.2% of the variation in coral cover changes (f=12.2, n=50, df=1, p=0.001). This suggested that factors beyond simply the general national trends were also affecting coral cover, which is likely to be due a large part to the presence and management of MPAs in these areas. These were therefore explored further.

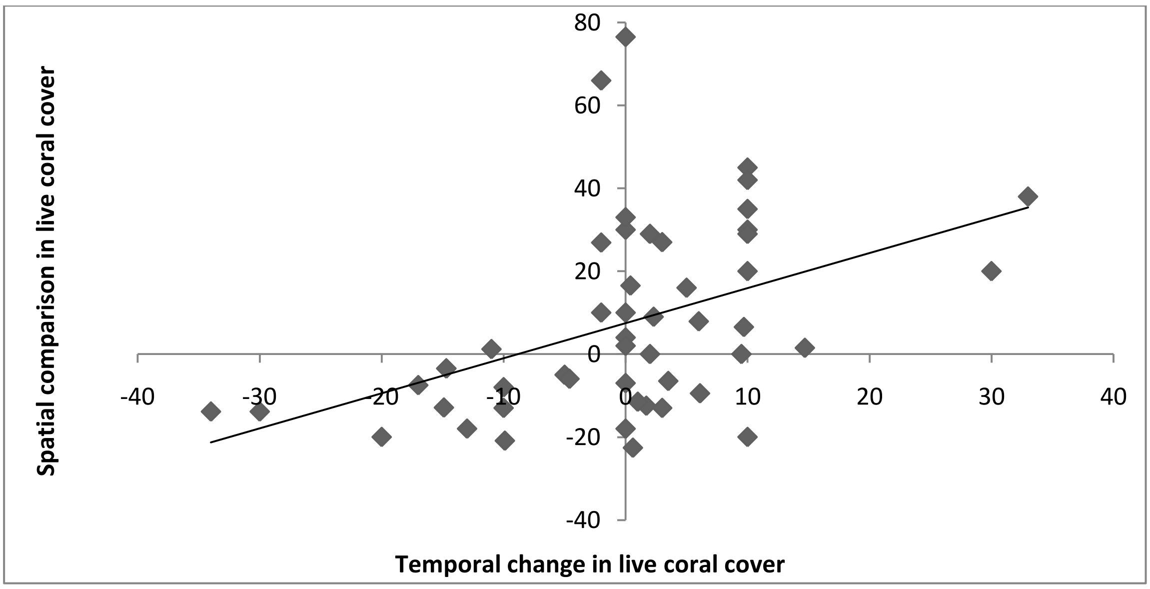


Figure 4.3. The relationship between spatial and temporal live coral cover comparisons.

Perceived success was correlated with seven other measures (table 4.3). This meant that this variable alone was a useful summary of many changes in the MPA, but that it did not relate to all outcomes. Changes in MPA threats, temporal coral cover comparisons, conflict and jobs supported were not correlated with this measure, so it cannot be solely relied on to measure performance. Extent of achievement of aims was also weakly correlated with coral cover changes, which was expected since the most common aims for MPAs are habitat focused. This suggested that despite the fact that perceptions of general success and aim were highly correlated (Spearman's Rho=0.784, n=66, p=0.000), respondents distinguished between these two measures in terms of habitat changes, which were not perceived as necessary for overall success.

In terms of the other performance indicators, which outcomes were often coupled is informative. This enabled associations between outcomes to be examined. It also showed which variables were highly related and unlikely to provide distinct information in terms of investigating drivers of performance. Temporal and spatial changes in coral cover were significantly correlated with one-other, but Rho < 0.5 (table 4.3). Temporal improvements in coral cover were correlated with reduced threats inside the MPA compared to outside, as well as the number of destructive activities that have been decreased, as might be expected. Good coral cover compared to national average (spatial comparisons) were linked to species, reduced threats and economic improvements. Improved jobs and employment were frequently coupled with endangered species and fisheries improvements. Other correlations differed between species and fisheries changes, which suggested these were being distinguished by respondents. In terms of the number of banned activities that occur, these were correlated with decreasing destructive activities over time and compared to outside, but not in the expected direction, unlike its correlation with species conservation and achieving aims. Interestingly, changes in conflict were not correlated with any other outcomes.

Further tests were done to explore significant relationships between variables. Interestingly, whilst temporal changes were not significantly related to perceived success, positive spatial comparisons were (f=2.26, df=3, R^2=10.5%, p=0.09), and also with the extent of achievement of primary aim (f=3.2, df=3, R^2=14.2%, p=0.03). This suggested that respondents were judging areas inside the MPA compared to those outside, more than changes over time. Variations in the extent of achievement of achievement of the primary aim (appendix 4.4) were explained by improved coral cover, species conservation and increased wealth (F=26.3, def=1, R^2=23%, p=0.000). Conflict showed no links to other performance indicators previously, suggesting that its causes may differ between MPAs. A logit regression of performance measures linked to improvement in conflict (appendix 4.4) suggested that this was related to improvements in species conservation, threat reductions compared to outside the MPA and number of jobs supported (Lr chi^2=12.6, df=1. R^2=0.194, p=0.006).

Table 4.3. Spearman rank correlation coefficient matrix for success variables. N=66. Only variables with p values < 0.01 are reported.

	Achievement of primary aim	Temporal coral cover change	Spatial coral cover comp.	Change fisheries	Change Species conserv.	Diff in threats inside/ outside	No destruct. Active. decrease	No. to decr compared to outside	No banned active. occuring	Change conflict	Increase wealth	Increase employment	Tot jobs supported/ km²
Overall success	0.784 ***		0.312 **	0.641 ***	0.663 ***				-0.277 **		0.493 **	0.406 ***	
Achievement of primary aim	-	0.262 *	0.334 **	0.548 ***	0.622 ***				-0.247 *		0.493 ***	0.392 **	
Temporal coral cover change	0.262 *	-	0.473 ***			0.392 **	0.288 **						
Spatial coral cover comp.	0.334 **	0.473 ***	-		0.219 *	0.212 *					0.248 *	0.247 *	
Change fisheries				-	0.582 ***	0.233*					0.451 ***	0.331 ***	0.227 *
Change species conserv.	0.663 ***		0.219 *	0.582 ***	-				-0.239 *		0.297 **	0.260 **	0.227 *
Diff in threats inside/ outside		0.392 ***	0.212 *	0.244 *		-					0.219 *		
No. destruct. act to decr		0.289 **					-	0.399 ***	0.405 ***				
No. to decr compared to outside							0.399 ***	-	0.293 **				
No banned act to occur	-0.247 *				-0.239 *		0.405 ***	0.293 **	-				
Change in conflict										-			
Increased wealth	0.493 ***		0.248*	0.451 ***	0.297 **	0.219 *					-	0.711 ***	
Increased employment	0.392 **		0.247*	0.331 ***	0.260 **						0.711 ***	-	

4.4.4 Drivers of selected performance measures.

Perceived success and achievement of aim were correlated with many other outcomes, therefore they are important measures to determine drivers higher performance in these areas (table 4.3). Six other performance measures were not highly correlated with one-another and not well represented by the aim and success indicators and thus represent distinct facets of MPA success. The regressions for each of the eight measures are summarised in table 4.4 and given in full in the appendices 4.5 to 4.8. These are discussed in turn.

4.4.4.1 Overall measures.

MPA features which had a significant positive relationship with the extent to which the MPA's primary aim had been achieved (an ordinal variable) were MPAs which had more zones and were larger, although there ws an interaction between their age and size, meaning that larger size was not associated with more successful outcomes for all MPAs (table 4.4). MPAs with multiple aims had fulfilled their aims less than those established principally to increase tourism. This is consistent with the widespread reporting of MPAs increasing tourism and tourism related employment (chapter 3). Management actions contributing to aim achievement included community benefit sharing and development initiatives. MPAs which had banned more activities inside the MPA were having better success at fulfilling their aims, which was probably due to curtailment of damaging activities, especially as greater staff numbers were also significant, which would be expected to increase the number of critical management actions, including enforcing regulations. MPAs facing more large scale threats inside their boundaries (such as large scale development or pollution) had met their aims less, as had those in nations where a high percentage of the reefs were threatened, as would be expected. However there was a positive link between the national gross domestic product per capita (GDP pc) and having achieved aims, suggesting that being situated in more affluent areas was a positive influence, over and above the budget size.

The number of zones, being in a country with a higher GDP pc and with fewer reefs at risk was associated with perceived success. However, overall perceptions of success were largely associated with different variables from aim achievement, suggesting again that respondents did distinguish between these aspects. In particular, three aspects of funding were associated with success, but not with achievement of aims. One related to the level of funding per km^2 protected and the other the percentage of funding which was raised from on-site donations.

Both these would be expected to increase the autonomy of management and funds available for interventions. Conversely those MPAs which returned more of their funds to the government were less successful. MPAs which had affiliated community institutions were associated with more success, as were those who punished a greater proportion of illegal activity. Asian MPAs were also perceived as having greater success. Unexpectedly, smaller no-takes were associated with more success, which may have been due to less opportunity costs, as a result of better enforcement or more focus towards tourism.

4.4.4.2 Socio-economic performance

MPAs had increased local wealth more in developing countries, where resource dependence and poverty may be high. Sites with less restrictions on extraction (IUCN category) and smaller no-take areas had increased wealth, which is likely to be because they had limited extraction levels less (table 4.4). Those which were set up with multiple management aims were less likely to and those with a formal management plan were more likely to have produced increases in wealth. MPAs with active fisheries management and higher detection rates had overseen greater increases in wealth, which would be expected due to positive impacts on fisheries and coral quality for tourism. Finally, MPAs in the Pacific have had positive impacts on local community wealth.

Conflict was perceived as having been reduced more frequently in MPAs which are community managed, which is 44% of the sample population. It was also reduced in areas which had benefitted the community through alternative livelihood schemes and those who have received more of their funding from international organizations, which would be expected to increase support. Sites which were located in countries with a high proportion of reefs at risk had less conflict, which was likely to be due to the fact that there was an awareness of the need for protection. Similarly, MPAs with larger no-take areas and who experienced fewer large scale threats inside their boundaries had less conflict, which could have been due to the greater protection large no-take areas afford. No-take areas might be expected to increase conflict in newer areas, but age was not a significant determinant.

Table 4.4. Summary of Regressions to Determine Significant Endogenous and Exogenous Variables Related to MPA Performance. This summarises the final models (available in full in appendixes 4.3 -4.6) to explain variation for each of the final 8 success variables, organized by type of input. + denotes a positive co-efficient, - a negative co-efficient. The number of symbols denotes the p-value (e.g. +=p<0.1, ++=p<0.05, +++=p<0.01).

	Achievement of Primary Aim	Perceived MPA success	Increase in wealth	Conflict has decreased	Temporal change coral	Improvement in fisheries	No destruct. activities to decr	No. threats compared to outside
MPA features	No. zones +++ Age Size (km2) ++ Age * size - -	No. zones ++ No take area - -	No take area - Low IUCN cat -	Size no-take ++ Community managed +	No. zones ++ No. staff - - - Age - - - Multiple mngt- - -	No-take area - -	Age +++ Size (km2) ++ Age * size - - - Size no-take +++ Mooring buoys +++	Age^2 - - - Size no-take +++
Region		In Asia ++	Pacific +		Asia+++	Americas -	Asia +++	
Aims	Tourism aim ++ Multiple aims - - -		Multiple aims -					
+Management actions	Staff per km^2 +++ Benefit sharing project(s) +++ Development initiative(s) +++ No. banned activities +++	% illegal activities punished ++ Community institution(s) ++	Fisheries mngt + No activities banned - Mngt plan + % illegal activities detected ++	Alternative livelihood project +	Mngt plan+++ Fisher compens.+++	Compensation+ % illegal activities detected+ Community institutions + No regulated activities +	Freq. research / monitoring - - -	% illegal activities punished ++ Staff per km^2 +++ Fisheries mngt +++
Financial		% funding returned to government - - % funding from donations ++ Funding per km^2 +		% funds from intl. organizations++	% funds used for mngt costs ++		Intl conservation grant +++	(Funding per km^2)^2 - - - % funds used for mngt costs +++
Threats / uses	No. threats inside MPA - -			No. threats inside - -	No. threats inside - - - Rank subsist. fishing - -	No. threats inside - -	Rank commercial fishing ++	Rank commercial fishing - -
Local context						Increased tourism +		
National context	GDP pc ppp +++ % reefs high risk - - -	GDP pc ppp + % reefs high risk - -	LDC ++	% reefs high risk++	Coastal zone mngt + +	Human develt. index +	% Reefs at risk +++	Coastal zone mngt - -
Survey variables								NGO employee +++

4.4.4.3 Ecological performance

Older MPAs have had greater losses in coral cover, which was expected, given global declines in habitat quality (table 4.4). Asian MPAs and those which had formal management plans report greater increases in coral cover. MPAs which were co-managed had also seen a greater decline, which was not expected, although there was evidence that coral declines were associated with greater conflict at MPAs (chapter 3). Similarly, more staff was unexpectedly associated with coral quality declines, although this may be in response to those declines and a great need for active management. Those MPAs which had spent a greater proportion of funds on active management and that compensated fishers for negative impacts of designation had overseen better coral quality changes, as was expected. Those MPAs which were still used predominately by local communities predominately for subsistence fishing (rather than recreation or other uses) and who had more large scale threats inside had also experienced greater declines in coral cover as both fishing and large scale threats were expected to negatively impact habitat quality. Those that were located in areas that are part of a wider coastal zone management strategy had less loss of coral cover. This was likely to be due to CZM management reducing the number of outside stressors acting on these reefs.

Fisheries improvements had been achieved in MPAs with compensation payments, affiliated community institutions and those which had increased employment locally, which would be expected, as these are likely to increase support and compliance in terms of fisheries regulations. MPAs in countries with a higher human development index were more likely to generate fisheries benefits, which could be due to a lesser extent of poverty and a lesser reliance on natural resources. Those that regulated more uses and had greater detection had also improved fisheries, as expected, as poaching undermines fisheries benefits. MPAs in the Americas reported seeing more declines in fisheries, as did MPAs which suffer from a greater number of large scale threats inside their boundaries. Finally, those MPAs with larger no-take areas reported fewer fisheries improvements, which may be due to the short term opportunity costs these areas initially generate. Conversely, MPAs where tourism has increased showed more fisheries improvements, which may be linked to the accessibility of new sources of income, which decreases reliance on fishing.

4.4.4.4 Threat reduction performance

Destructive activities had decreased more in MPAs which were older and larger, although these variables interacted, so that the least impact had been felt in MPAs of intermediate size and age (table 4.4). Areas with larger no take areas had also decreased the number of destructive activities, as would be expected, since many of these relate to fishing (see chapter 3). MPAs situated in developing countries and those in Asia which were found in countries with a greater proportion of reefs at risk. Mooring buoys also had had a positive impact in this regard, which is likely to be related to their ability to reduce coral damage from tourists (see previous chapter). Funding from an international conservation grant had also enabled reduction in destructive use. However MPAs who reported frequent research and monitoring efforts had decreased these uses less, perhaps because effort had been drawn away from enforcement. Lower importance for the area within the MPA as a commercial fishing area had also reduced the number of destructive uses.

MPAs with fewer threats inside compared to outside were better staffed, punished a greater proportion of illegal activities and had larger no-take areas, as was expected. Budget per area showed a non-linear relationship to this outcome, which could be related to return to scale, as smaller MPAs are more expensive to run per area or related to budgets not being spent active management. Indeed MPAs which spent a greater proportion of funding on active management had also had more impact of threats. Those MPAs that faced relatively fewer large scale threats were more likely to have active fisheries management and had less importance as commercial fishing sites for locals, suggesting that fishing contributes to perceived threats in MPAs. Coastal zone management also reduced the difference between the impact of the MPA on the number of threats inside and outside its boundaries, as would be expected since it would reduce threats in the wider area. This was the only variable where respondent affiliation had a significant relationship to a reported outcomes. NGO staff are more likely to report reduction of impact of the number of large scale threats that other respondents.

4.4.5 Comparison between performance measure drivers

Table 4.4 also allowed us to compare common and distinct patterns in terms of significant explanatory factors for all the measures of success. MPA features and management actions were extremely important in predicting performance, in particular MPA size, age and no-take areas, which often interacted with one-another. Management actions emerged as important relate to MPA regulations, enforcement as well as community projects, such as alternative livelihoods schemes. Financial variables which emerged as important related more to sources and spending of funds, than of absolute levels of funding. Threats in inside the MPA, as well as the % of reefs at risk in the past, as use for fishing also occurred often, as was expected. Local contextual factors were minimal, compared to national contextual factors (such as level of economic development), but this may have been due to the smaller number of local contextual variables available for inclusion. In terms of the survey variables, only affiliation with an NGO was significant, for a single measure.

Those variables which were significant in the expected direction (table 4.5) were zoning, community management, American and Pacific MPAs, those with multiple aims, having a management plan, visitor pressure, fisheries management, the number of staff, the level of enforcement and the number of large scale threats. Community related variables; namely institutions associated with management, incentive initiatives and compensation also had positive effects as expected.

Those variables which were significant in the opposite direct expected included co-management, strict IUCN category, those MPAs located in Asia, level of monitoring effort, being in a LDC. Several variables also showed mixed results on MPA performance; the existence or size of the no-take area, the MPA age, number of banned activities, fishing pressure, coastal zone management and the % reefs at risk.

Variables which did not emerge as significant, but might have been expected to be included: the proportion of the MPA which was no-take, the interaction between the no-take area size and age, as well as government or NGO management, the absolute numbers of staff or budgets, MPA aims (apart from tourism), world heritage status, staff training or technical support, conflict resolution, being part of an MPA or monitoring network, education, management effectiveness monitoring, visitor and fisher pressure and the interaction between them, proportion of jobs related to tourism or retained locally, tourist sports fishing activity, the set-up budget, percentage funding from revenues or used for community projects, respondent affiliation and data quality for coral cover estimates.

Table 4.5 Comparison of Significant predictors of MPA performance against hypotheses from previous research. Previous research was collected which qualitatively or quantitatively assessed factors associated with MPA management effectiveness. These were used to build hypotheses in the first column about which MPA features, actions and contexts were expected to be positively (+), negatively (-) or non-linearly related (Q) to MPA performance (table 2.2). The observed relationship between these explanatory variables and the performance measures is given in the second column. The number of symbols indicates the number of times a significant relationship was demonstrated. NA denotes the fact that no relationship was detected.

	Aspect	Expected direction of relationship	Observed relationship
MPA features	MPA size	Q / +	+ +
	Existence or size of no-take area	+	+ ++, - -
	Age	Q / +	+ , - , Q
	Low IUCN number (strict regulations)	+	-
	Zoning: conflict	-	+ ++
	Community managed	+?	+
	Government managed	-?	NA
	Multiple (co) management	+	-
	Part of physical or monitoring network of MPAs	+	NA
Region	Americas, Asia	-	Asia + + + Americas –
	Pacific	+	+
Aims	Multiple aims	-	- -
Management actions	Existence management plan	+	+ +
	No. staff / level activity	+	+ +
	Staff training	+	NA
	No. regulations or bans on potentially destructive activities	+	++, -
	% activities detected and/or enforced	+	+ + + +
	Community involvement and/or consultation	+	?
	Community institutions	+	+ +
	Creating local community incentives	+	+ + +
	Environmental education and outreach programs	+	NA
	Conflict resolution mechanisms	+	NA
	Social and ecological research and monitoring	+	-
	Management effectiveness evaluation	+	NA
	Technical supervision / advice	+	NA
	Compensation to groups suffering user costs	+	+ +
Financial	MPA funding (absolute / per area / for active management costs)	+	+ + +, Q
	Facilities, equipment and infrastructure	+	?
	% funding from user fees	+ / -	NA
	% funding to local community projects	+	NA
Threats / uses	No. threats inside or outside	-	- - - -
	Number of fishers / fishing pressure	-	+, - -
	Number of visitors/ visitor pressure	+ / -	+
National context	Coastal zone management beyond MPA	+	+, -
	Fisheries management	+	+ +
	Less developed country (LDC)	-	+
	Human development index (HDI)	+	+
	% reefs at risk	+ / -	+ +, - -
Survey variables	Respondent is part of management staff		NA

4.5 Discussion.

The models developed for performance (table 4.4) were able to explain at least 67% of the variation in each performance measure, which suggested many of the drivers of performance had been incorporated into this analysis. The lack of survey variables emerging as significant in the regression analyses also suggested that bias is minimal. The results showed that perceived success was linked to coral cover compared to outside the MPA, species and fisheries changes, compliance and economic benefits. Thus MPAs can be perceived as successful despite limited reduction in threats or increased coral cover improvements and conflict. Often, this is justified, as they are nevertheless improving these aspects compared to outside the MPA. Perception of achievement of aims was similar, but also incorporated temporal changes in coral cover, which makes sense in the context of habitat conservation as the predominant goals for MPAs (Francis et al., 2002; McClanahan et al., 2006). Nevertheless, the drivers of these two measures were largely different, with funding concerns important for overall success and threats and the original aim as solely important for fulfilment of aims. This suggested that both measures should be included in MPA evaluations, as they are distinct.

Unexpectedly, the relationship between increased employment and number of jobs was negative. This was likely to be because changes in employment are not the same as the number of jobs available, but this could also suggest that these measures are inaccurate. It is also possible that since it was not defined, respondents could have interpreted the necessary link between the MPA and the jobs differently, limiting the usefulness of this metric. Further clarification of metrics which are more prone to individual interpretation is recommended in future research using expert knowledge. Also trends, as were often employed in this analysis are easier to evaluate than more detailed metrics such as number of jobs.

Only one of the correlations between performance measures other than overall success and aim achievement was above 0.5. This points to the fact that MPAs that perform well in some areas do not often perform well in others (Christie, 2004; Pomeroy et al., 2007). This validates the approach of not using a composite indicator of success (Hudina, 2006; Holtzman et al., 2008), and suggests that trade-offs need to be made in terms of prioritising management aims (Hicks et al., 2009). However, results suggested that MPAs that have achieved fisheries and endangered species improvements also often increased local economic welfare. In addition, MPAs with reduced threats and destructive activities were often able to achieve better habitat improvements (Allison et al., 1998; Burke et al., 1998; Wilkinson, 2006).

The previous chapter identified age, having a no-take area, region and to a lesser extent size as having significant effects on many outcomes for this sample of MPAs, using bi-variate analyses. The conclusion of the importance of no-take areas in increasing MPA performance remains here, despite other significant variables having demonstrated importance. Furthermore, some of the impacts of no-take areas were also likely to be absorbed by the number of zones, as any MPA with a no-take area has at least two zones and the mean number of zones is only 2.1. The number of threats inside the MPA had an important impact on half the performance indicators. Whilst larger MPAs had more threats, those with larger no-take areas had fewer, so this makes a case for having a relatively large proportion of an MPA as no-take. Conflict resolution was an activity that had a significant relationship to reduced conflict when bi-variate analyses were used (chapter 3), but did not emerge as significant here when other contextual and management variables are included.

MPA age was significant in three of the eight regressions, and has positive, negative and non-linear links to these outcomes (Claudet & Pelletier, 2004; Leverington et al., 2008). Thus age has a complex effect on MPA performance, and different impacts of different facets of performance (Syms & Carr, 2001). Other aspects of MPA features, including governance and size, appeared to be important in determining benefits. MPA size had also relatively limited effects on a small number of measures, but larger MPAs performed better each time and size interacts with age. In the previous chapter, regions emerged as having a strong impact on performance, however this was less true here, once other variables had been taken into account. This validated using regressions to look at the combinations of many aspects on MPA performance. No-take areas were demonstrated to have important impacts on performance. However, much of their impact could be masked by the number of zones, which was also significant.

Only Asia emerged in three regressions as having out-performed other regions, which is surprising, given the high level of coral damage and the destructive uses that had occurred there, which have meant that 37% of corals are effectively dead and 47% of the remaining corals are at high risk (Wilkinson, 2004) and that Asian MPAs have more threats within their boundaries (chapter 3). However, since this research emphasises additionality (through comparison with counterfactuals), it is exactly the MPAs that outperformed their surroundings that would emerge most succesful, as has been stressed by other authors e.g. (Salafsky et al., 2001).

This research enabled us to infer which factors seemed to be important in determining MPA performance and could help to increase resilience of coral reef habitat in the context of future stressors. Community managed areas were more successful at reducing conflict, but in general, no specific governance type was associated with improved outcomes. This is because the best management body at a given site is likely to depend on the context, including the institutional capacity, the nature of threats and local values and norms (Christie & White, 2007). Similarly, MPA aims seemed to have no bearing on their performance, apart from those established to increase tourism. This meant that MPAs cannot necessarily be relied on to achieve conservation goals (Allison et al., 1998).

Management actions which were carried out at an MPA have a great deal of influence over outcomes, even in newly established MPAs. MPAs which detected and punished illegal activities produced better outcomes. Increasing enforcement was linked to decreased threats, which in turn was linked to improved habitat quality. Regulations for a large number of activities helped to improve certain outcomes. Since many of these were established in management plans or in the IUCN designation, these variables may be related. Benefits to community members, in terms of projects that increase community welfare, that provide alternative sources of income other than fishing and which compensate those who lose out as a result of MPAs, emerged as an extremely important determinant of MPA performance, as have been emphasized by other terrestrial research and to a lesser extent MPAs (Leverington et al., 2008; Mascia, 2004; Pollnac et al., 2001a; Pomeroy et al., 2007; Tupper et al., 2008a).

In terms of financial aspects, absolute funding was not significant, although funding per km^2 managed is for two of the performance measures. Spending and funding sources were more important than absolute levels of funding. MPAs that did not return funds to government and those spending on active management have most success. The percentage of funding was not significant, neither was spending on community projects, although these were related to community projects featured in management variables.

Variables which seemed to be only marginally significant, but may have been expected to be more significant included education (Browning et al., 2006; Christie & White, 2007; Mascia, 2000; Tupper et al., 2008a) and frequent research and monitoring (Kelleher, 1996; Leverington et al., 2008; Lundquist, 2005; Mascia, 2000; Tupper et al., 2008a). In addition, this research suggested that less effort and emphasis should be put on several aspects of MPAs commonly thought to be critical for success; the set-up budget, management effectiveness monitoring, monitoring and inclusion in networks, partnering with international organisations, staff training, low fishing pressure and low or high levels of tourist visitation. This is not to say however that these will not have beneficial effects at some MPAs, as these are process-type activities that are not expected to directly impact performance, but are nevertheless valuable.

Contextual factors did also affect MPA outcomes. These included the level of local use for subsistence fishing which was positively correlated with performance, but the importance in terms of commercial fishing had the opposite relationship. Active fisheries management beyond designation of a no-take area and coastal zone management will also improve MPA performance. A higher GDP in the MPA's host country is related to, improved overall success, although there is more opportunity to improve local levels of wealth for MPAs in developing countries. Overall, it was the interaction of contextual factors, MPA features and management that determined performance, yet the most importance must be placed on endogenous factors. This is encouraging, as these are factors that management can affect, given appropriate financial and technical resources.

The approach of using expert opinion to gather information on a range of performance indicators was cost effective, but also dependent on the level of knowledge of the respondent. However, most respondents familiar with a site are expected to know whether conflict has significantly increased, decreased or stayed the same. This means that this method is also limited to information that is commonly known about MPAs and excludes finer scale information about habitat and fisheries effects, which necessitate expensive on-site research.

Other potential problems with this analysis which need to be considered include the difficulty of teasing apart causation and correlation e.g. number of staff and decreasing coral cover over time. Many variables are also likely to show endogenity, however, this would be expected to be more problematic in a time-series analysis. The research would have been strengthened by a greater sample size and a greater number of responses for each MPA to help validate responses.

Factors that were not able to thought to be accurately assessed using expert surveys, but might be expected to have an impact on performance include factors related to the choice of locations where the MPA was situated, border demarcation, the level of stakeholder consultation, historical rates of use and visitation, the level of participation of local communities in management, management infrastructure, perceived equity of costs and benefits generated by the MPA, the level of technical assistance and success of community and development projects.

4.6 Recommendations.

This research has important implications for MPA establishment and management. MPAs with multiple goals are unlikely to fulfil all of these goals simultaneously. MPAs need to be established that have features that are likely to produce the main aim of that MPA. MPAs work most effectively when combined with coastal zone management and active fisheries management. They should be as large as possible, with at least two zones (one being a no-take area). However, no-take areas should not be established without community consultation. Benefits cannot be expected to materialise straight away and stake-holders should be warned of this. This is especially true for threat reduction and coral cover changes and aim achievement. MPAs should be able to keep monies raised on site for active management costs. Funding should be targeted to both enforcement and projects that benefit community members, especially where opportunity costs have been severe.

Future research should be undertaken, which uses the 13 performance measures here, on a larger scale. A five point scale could be used for perceived temporal changes in outcomes, instead of a three point scale, to increase the quality of information. This would enable more information as to the magnitude of effects of various inputs. Validation could be achieved by using at least 5 responses for each MPA (from respondents with different affiliations). These performance measures, which focus on changes over time and spatial comparisons should be regularly assessed at MPAs, using data from monitoring, as a tool for adaptive management over time and to help demonstrate efficacy to donors or to highlight areas of concern. Further research is needed to explore the temporal aspects of MPA performance as well as research to understand the causes of conflict, which was a common problem at these MPAs.

Visitor and Non Visitor Values for the Gladden Spit Marine Reserve.

5.1 Introduction and Rationale.

Much coastal tourism depends to some extent on the quality of the reefs (Casey, 2006). Indeed, many MPAs have been set up with tourist benefits specifically in mind (Pendleton, 1995), often because tourism will bring financial benefits for local businesses and the regional economy. Well managed and safeguarded ecosystems are expected to provide a range of values for visitors and non-visitors (non-users). Users may benefit from a suite of recreational activities, including underwater photography, diving or snorkelling, environmental education and wildlife interactions. Non-users may benefit simply from knowing that these areas exist and will remain for future generations or visits or indirectly through ecosystem service provision (Dixon & Sherman, 1991). Ecosystem management can also promote conditions such as large numbers of fish, which increase recreational values (Williams & Polunin, 2000).

Unfortunately, many MPAs are hampered by lack of funding (Alder, 1996; Depondt & Green, 2006) and cannot hope to achieve their goals unless they can become self financing (McClanahan, 1999), especially as government and donor funding is rarely viable over long time frames (Baral, 2008). Only 15.7% of the MPAs surveyed by Balmford et al., (2004), reported that current funding was sufficient for effective conservation and many MPAs are without any operating budgets (Mora et al., 2006a). This underfunding stems in part from a lack of knowledge and underestimation of the values they generate, which constrains their ability to raise funding (Mohamed, 2007). Tourist related revenues can be used to supply some of these funding needs (Dupondt & Green, 2006; Emerton et al., 2006; Green & Donnelly, 2003), if information is available on the types and magnitudes of values that different types of tourists have and their preferences in terms of funding mechanisms.

A comprehensive recreational value meta-analysis of coral reef has found that recreational values are highly variable and more studies are still needed to measure tourist recreational values (Brander et al., 2007). Better understanding of tourist values could help revenue raising and decision-making in several ways, including making a case for increased government funding for MPAs (Mohamed, 2007). Demand estimation can enable entrance fees to be set at a level that creates the desired visitation level or maximises the total funds collected. There have also been few published studies of protected area entrance fees (Baral, 2008). Setting inappropriately low fees can encourage excessive tourism levels which can directly harm wildlife and ecosystems, as was seen in Samadai Reef (Sarhan et al., 2004). Few places have taken full advantage of the consumer surpluses generated by charging or increasing fees to a level that maximises revenues (Dupondt & Green, 2006) or controls visitor numbers. To the best of my knowledge, there has been no research using CVM to value specific marine wildlife interactions in MPAs. Instead there has been a focus on valuing the whole visit or dive experience as a bundle (Brander et al., 2007). Without information on demand for each experience, fee setting could become a rather arbitrary process, which did not raise the revenues hoped.

An estimate of tourist value also acts as a benchmark for donors in terms of whether the value generated is worthy of continued or further investment. It is therefore a potentially powerful awareness and revenue raising tool for park managers. Decision makers can use these results in cost benefit analyses of future scenarios or policy plans. Furthermore, tourist value estimates can also be used as part of claims assessments, when damage occurs to ecosystems within marine reserves which can be compared with those at other sites. This information then becomes invaluable to make decisions regarding prioritisation of funding or management effort.

Similarly, there is little understanding of how ubiquitous non-use values are for people who will not visit MPAs and reefs (non-visitors) and how they compare to visitor values. Since only 30% of the total economic value is typically reflected in the published resource value estimate, welfare benefits could be being miscalculated due to improper costing (Balasubramanian et al., 2003). If non-use values are significant and widely held, even small values could generate large sums of money for conservation in aggregate. Indeed research by Spurgeon et al., (2004) has suggested that non-use values for reef ecosystems may dwarf use values. Little is known as to whether use and non-use values are driven by the same experiences, attitudes or socio-demographic factors for MPAs in Belize and elsewhere. This is useful information for government or international organisations wishing to support the provision of public values for ecosystem and MPA related resources.

See also sections 2.4.2, 2.5.2 and 2.5.7 for background to this section.

5.2 Aims and Objectives.

This paper investigates gross values and consumer surpluses associated with a range of experiences and existence and bequest values for both reserve visitors and non-visitors at a case study reserve, the Gladden Spit Marine Reserve (GSMR). CVM, a stated preference approach, was used to measure respondent willingness to pay (WTP) for various benefits. Sequential hypothetical markets were used, to differentiate between use values, wildlife interaction and non-use values for visitors to the reserve. Non-visitor WTP is also estimated and its drivers explored, in relation to a specific revenue raising mechanism and over respondent lifetime. This enables a comparison of the relative magnitude of the different values. This in conjunction with demand estimation can inform revenue raising efforts and an understanding of how factors such as attitudes, awareness and socio-economic variables influence these values. Values will also be estimate will also be used for the overall economic valuation for the reserve.

Objectives of this research were to;

- measure visitor welfare and consumer surplus for three MPA-related goods; (a) visitor values associated with a day trip to the reserve, (b) a whale shark trip inside the reserve and (c) additional donations related to non-use values
- to estimate two non-use values of local tourists who were not visiting the reserve; (a) non-user values associated with compulsory taxation for visitors to Belize (policy valuation) and (b) the overall lifetime non-user values for this reserve
- explore impacts of sequential hypothetical questions and survey specific attributes and to investigate non-visitor motivations and decision-making
- better understand drivers and motivations of visitor and non-visitor values
- make recommendations for setting fee levels and fund raising from tourists

5.3 Methodology

5.3.1 Survey design

Visitor and non-visitor surveys were necessary to measure reserve related values. CVM was chosen as a flexible method, which could be applied to measure both use and non-use values. The aim of research was to discern an overall figure for the many values held by respondents for the park under current circumstances, rather than explore the effects of various reserve attributes on these values, making CVM preferred to choice modelling. The precision of CVM to elicit these values would also be aided by existing markets for reserve entrance fees, donations and environmental departure taxes already exist, which would reduce the hypothetical bias associated with the valuation scenario (Bateman et al., 2002).

Since the property rights did not lie with the visitors, willingness to pay (WTP) was used (Garrod & Willis, 2000). Where costs exist, such as entrance fees, WTP can be used to calculate visitor CS, by deducting entrance fees paid from WTP. Focus groups were used to shape plausible payment vehicles and bid ranges and intervals, and to gain some insight into tourist holiday profiles and expectations, previous experiences in protected areas, opinions about entrance fees and environmental taxes and their knowledge of marine environmental issues. However, the payment card format was used (where categories of payments are presented visually), instead of the recommended referendum format (Arrow, 1986), due to the relatively small sample size for each type of survey. Carson et al., (2000) suggest that payment cards only produce a weak dependence on the amounts used in the card. Payment cards were designed, where the bids increased from small to larger intervals, which is a less extreme application of the exponential incremental bids advised by Rowe et al., (1996).

The visitor survey was designed to elicit three values (see appendix 5.1 for full transcript);

- WTP for a daily reserve entrance fee (WTPA)
- WTP for a whale shark tour trip (WTPB)
- WTP for a non-visit related donation (WTPC).

Since fees were stressed to be additional to tour operator and other costs, only entrance fee bid were elicited. Additional questions included pertained to experiences inside the reserve, activities undertaken and attitudes towards the quality of the experience. Payment cards for WTPA and WTPB started at the current entrance fee. The donation was used to measure lifetime non-use values associated with the reserve. The payment card for WTPC had the greatest range in values starting from zero. Since the order of the questions was likely to invoke relational or anchoring bias in the next question, the order was rotated for different respondents. If two responses were given, the mid-point was noted and if the highest category was given, a specific bid was sought. Whilst the donation vehicle is undesirable since it is not incentive compatible (Carson & Groves, 2007), it was the only plausible vehicle which could be used for visitors, but not related to visitation. Garrod and Willis (2000) advise that the most important criterion for the payment method is that it is believable. In addition, pilot surveys elicited significant number of protest responses when a taxation vehicle was used in addition to entrance fees.

The non-visitor survey was designed to solicit an exit tax revenue-raising vehicle for the MPA, for tourists coming to Placencia, in addition to current exit fees, which already include an environmental tax (see appendix 5.1 for full transcript). Currently existing payment vehicles were chosen to minimize the hypothetical bias, and a taxation vehicle was used for the non-visitor survey, which is less susceptible to strategic behaviour (Arrow et al., 1993). Those with zero bids were asked if their answers would have differed with voluntary payments and asked to give a bid, to help with the interpretation of these zero bids as legitimate or protest bids. Additional motivational and survey related questions were included, since they refer to aspects that may affect WTP responses and should provide insight into the processes involved in choosing bids. These included certainty estimates, which can inform estimates of individual and aggregate WTP bids, by reducing hypothetical bias. In addition, respondents were asked how they had decided on their bid amounts (qualitative response) and how they thought their bids compared to other tourists in the region, to ascertain whether or not they are considering others in their response. This was important given that there is some debate as to whether, given collective payments, respondents consider other people, rather than state their own maximum WTP in their response (Wiser, 2003). Respondents were also asked if they had previously heard of the reserve or the whale shark trips there, to assess the level of previous information, which Whitehead et al., (1995) suggest will influence WTP significantly and perhaps reduce variance and increase the validity of responses.

All scenarios included some description of the likely outcome, if funds were not increased. However, this could not be very detailed or quantitative, due to the lack of current understanding of these ecological processes. Both positive and negative information was included to help respondents understand both the unique attributes of the case study sites and how it was similar to many others reserves. This helped to remind respondents of substitute sites and emphasized that this survey was only concerned with one MPA (Bateman et al., 2002; Whitehead & Blomquist, 1991). Both valuation scenarios provided information on reserve attributes, economic and ecological benefits, management actions and aims and described the shortfall of available funds. A map of the reserve was also used, with photos of the islands and many of the species found within the reserve. A large amount of detail about the reserve was provided to reduce some of the variation which results from difficultly in valuing unfamiliar goods and increase the validity of the responses (Cummings et al., 1986).

The final surveys had 5 sets of questions; (a) respondent socio-demographic variable, (b) trip profiles, expectations, experiences, (c) reserve background information, the scenario, the payment cards and WTP bid elicitations in US$, (d) follow-up questions relating to bid decisions and motivations and (e) environmental attitudes / awareness; related to reserves and conservation. Tourist holiday characteristics, reserve experiences and motivations and socio-demographic variables, were included, as these have been shown to be predictors of WTP e.g. in (Adams et al., 2008; Togridou et al., 2006).

5.3.2 Sampling

Approximately 85% of people approached agreed to do surveys, indicating low non-response bias. The interviewer dressed in a similar manner each day, to avoid interviewer responses being influenced by the appearance of the interviewer, which was confirmed in Bateman and Mawby (2004). The same interviewer carried out all surveys, to ensure the delivery of the questions and other contextual issues varied as little as possible. By starting in a different location in the village and walking around each day, tourists were approached in all areas of the village and the resorts at different times. Interviews were conducted in the village, at the airstrip, at the reserve and between dives on dive boats. Tourists were initially approached and asked if they had visited the reserve to determine which survey should be used. They were then given some information about the survey, how long it was expected to take and asked if they would be willing to participate. Tourists were also regularly interviewed at the airstrip, as they had sufficient time to respond and it was less hot. If there were quite a few tourists, every third one walked past was approached. If they refused, the person next to them was approached. During weeks were there were few tourists, everyone was asked.

5.3.3 Implementation

Twenty pilots were carried out on members of survey population (Spash, 2000; Yeo, 1998). Detailed follow up questions investigated survey length, reactions to scenarios, payment cards with different scales and visual information, interviewer style of questioning (speed, attitude) and any concerns respondents felt e.g. for level of information provided, unclear wording, ensuring confidentiality, etc. Particular attention was focused on the hypothetical scenario e.g. impact of different management.

The samples were split between self completed and personal interview (face to face), to increase sample size (table 5.1). Face-to-face surveys require significant investment of time, but offer advantages of increased response rate, and increased survey quality, as the respondents were each read the valuation scenario (Arrow et al., 1993). Face to face surveys took approximately 15 minutes per respondent.

Non-visitor values related to this MPA could be significant and extend internationally. Non-use value magnitude is likely to decrease with increasing distance from the site, which has been demonstrated in various empirical studies e.g. (Pate & Loomis, 1997). It was decided that the most appropriate group to survey were tourists coming to the village. Given the relatively modest sample size that was feasible, given the time and effort available, it was felt that this was the largest group that a representative sample could be taken of and therefore values aggregated for.

Table 5.1 Implementation of the tourist surveys.

	Visitor	Non-visitor
Total number surveys	302	282
% face to face	77%	51%
Dates implemented	9 weeks. March to May (52%) and October to November 2007	8 weeks. October to December 2007
Locations carried out	54% at local airport 20.5% at whale shark zone 14% elsewhere in reserve 11.3% in / near the village	62% at local airport 38% in /near the village

5.3.4 WTP estimation.

Respondent demographic, trip characteristics and attitudinal responses were explored and analysed using Intercooled Stata 8 and "R" statistical software for all tourist responses. One bid, which was larger than 30 standard deviations away from the mean bid (excluding protests), was excluded to remain as conservative as possible. Data were cleaned, with qualitative and quantitative answers coded as dummy variables where necessary. Protest votes, where respondents gave a zero bid as a result of the scenario used, despite holding values, were identified using respondent answers as to why they were not WTP anything (Bateman et al., 2002).

For the non-user survey only, the follow up question on a donation provided extra information, which proved useful when identifying zero bids and protest bids, which resulted in some changes in interpretation from the usual method of simply asking why respondents would not pay. Those with zero bids for the tax and positive WTP for the donation question were interpreted as protest responses. Inconsistent or incomplete were treated as zero responses. Responses were coded and interpreted as conservatively as possible. For example, where tourists did not say how many times they would return to Belize, it was assumed that they would not return.

Mean and median WTP bids were calculated for all values, once protest bids had been removed. Where respondents gave 2 groups, the mid-point was used. For visitors, whale shark bids and donation bids were added together to calculate total WTP for visitors to the reserve. Visitor CS was calculated using equation 1 (after Mathieu et al., (2003)) and non-visitor lifetime values using equation 2.

Equation 1

Aggregate Consumer Surplus = (mean tourist WTP – entrance /departure fee) * number of tourists in 2007.

Equation 2

Aggregate non-visitor non-use values = (mean per holiday WTP * expected number trips to Belize) * estimated no. visitors to Placencia in 2007.

WTP estimates were made for pooled data, plus for each of the survey treatments, based on stated values. T-tests and Mann-Whitney tests were used for parametric and non-parametric data respectively, to look for differences both between visitors and non-visitors, and the samples of people tested with the two types of surveys.

5.3.5 Econometric analysis

Shapiro-Wilk test of normality were carried out on WTP distributions. Those which were not normally distributed had right skews, which were corrected using log WTP+0.01, which produced normally distributed distributions. The full set of possible variables to explore were examined and those that correlated over 0.75 were combined or deleted, so the final data set did not contain any variables that were highly correlated. In addition, where variables were suspected to interact, new interaction variables were created. For example, for the non-visitor survey, interactions between income and age, type of survey and gender (to see if the interviewer had different effects on different sexes of respondents) and type of survey and airport were incorporated into the econometric analysis.

Econometric analyses were performed in Intercooled Stata 8, to generate parameter estimates for linear functions of model variables. Payment card data should be analyzed using interval regression, as the true WTP is thought to lie between the value given and the next value up (Bateman et al, 2002). Parametric interval regression methods were developed for payment card data by Cameron and Huppert (1989), who note that the wider the payment card intervals, the greater the chance of bias if interval regression is not used. Various studies have however used tobit or logit models for payment card data, due to the large number of zero values or because the WTP distribution is not parametric (Lindsay et al., 1992). These methods assume that the impacts of independent variables are homogeneous along the entire WTP distribution, which is inadequate if these variables influence parameters outside of the mean (Koenker & Bassett, 1978).

Interval regression was carried out with robust standards errors, with the stated values as the lower bound and the next level up in the payment card as the higher bound, as is appropriate for payment card surveys (Bateman et al., 2002). The interval regressions used a core set of attributes which economic theory and previous empirical studies predict should influence WTP and would therefore be important to test for theoretical validity (the core model). Such determinants of WTP values on WTP data, should include aspects such as expected number of total trips and substitute sties, as would be predicted by economic theory (Mitchell and Carson, 1989) and rights based beliefs about animals and ecosystems (Spash, 2002).

Various other attributes which may be related to stated values e.g. trip attributes, attitudes and environmental knowledge were tested in the model, to see if they had significant explanatory power. These provided insight into the motivations of values held by respondents for marine reserves. Income, education and environmental group membership were always included in the all models (the core model), as they should be a strong predictor of WTP. For the user survey, the order of the questions was included as an explanatory variable. Those variables that did not produce covariates significant at the 10% level were dropped using stepwise backward selection, checking that removal of any variable did not adversely affect model fit, until the final model was produced. Post-estimation statistics confirmed that model selection was correct and that the parametric assumptions had been met, including constant variance and normally distributed errors.

An OLS model was also used for comparison, both with the missing variables and as many surveys had one or two missing responses, with the missing values were replaced with mean values for each variable, to see if this would produce different results. OLS models have been used for other coral reef contingent valuation studies where zero bids are not an issue e.g. (Ngazy et al., 2004). As the donation bid analysis (WTPC) contained few zero bids, the low number of zero bids meant that probit analyses (with WTP as a binary variable) were of limited use.

The underlying models that were implicit in these analyses for the user and non-user surveys are given in equation 3 and 4 respectively;

Equation 3. $$\text{Log (WTP)} = f\,(Sd, Tr, Mr, At) + e$$

Equation 4. $$\text{WTP} = f\,(Sd, Tr, Dc, At) + e$$

Where Sd = socio-demographic variables, Tr = trip characteristics, Mr = reserve experience, Dc = decision attributes, At = attitudes and e = error.

O'Garra and Mourato (2007) apply quantile regressions (QR) to understand the determinants of WTP along the WTP distribution. The resulting co-efficients gave the marginal change in WTP given a marginal change in the independent variable, for some percentage of the conditional WTP distribution. Quantile regression further benefits from being robust to outliers and right skews (Koenker & Hallock, 2001), which are a particular feature of WTP studies and can be used to reveal non-linearities and other threshold effects (O'Garra and Mourato, 2007). QR is an alternative to classifying respondents into political or attitudinal groups and then analysing WTP determinants for each group, which some studies do. Analysing the data using several models and then comparing the results is a useful way to test how robust results are to distributional assumptions and to identify non-linear relationships (O'Garra and Mourato, 2007). Therefore, models were also run using quantile regressions for range of quantiles from 5% to 90%, to enable some understanding of how different variables are influence different places along the stated WTP spectrum.

5.4 Results.

Here results are presented from both the visitor and non-visitor surveys in terms of the trip characteristics, socio-demographic characteristics, attitudes, tourist economic values, econometric results and finally the aggregate values. Visitor and non visitor results are discussed separately where they differ which is in terms of experience inside the reserve, the decision-making process for the values elicited and the scenario used.

5.4.1 Respondent Socio-demographic profile.

A variety of socio-demographic factors which were hypothesized to be important were collected during the survey. These are summarized in appendix 5.3, wherever possible with the same information from a national level survey to enable a cursory comparison of tourists to Belize and tourists to Placencia. The large majority (72%) of respondents came from the United States, followed by Canada (10%), the UK and Scandinavia. They were very highly educated, with 93% having done degrees and almost a third having done post-graduate qualifications. There was a large range of ages. Respondents were also very wealthy, with a quarter earning over US$120,000 per annum after tax and only 5% earning less than US$15,000 per year. The majority of respondents were not members of environmental groups and 56% had no dive qualifications. Data from a national level CSO study for visitors to all parts of Belize, were used to test sample representativeness against tourists to Belize. These data were not available for many of the key variables, however, they suggests that the sex ratios, ages and home countries are similar (BTB, 2008).

The income of visitors and non-visitors was significantly different ($n = 503$, $z=-4.59$, $p = 0.000$), with visitors having a mean income of US$108,713 and non-visitors of US$87,518. However, age, education and the numbers of tourists coming from the US were also not significantly different. Visitors were more likely to be qualified divers ($n = 565$, $z = -5.82$, $p= 0.000$). The majority of both visitors and non visitors did not belong to one environmental group (mean of 0.9 groups) and visitors did not belong to significantly more groups than non-visitors.

5.4.2 Respondent trips to Belize.

Respondents were asked why they had chosen Belize to visit rather than another country. The most popular answers were the marine environment (including diving) given by 16% of all tourists, the culture/atmosphere (12%) and the beaches by 11%. Other responses related to visiting eco-tourist trips, the weather and the less developed coastline. Overall, a third of responses related to the marine resources in Belize. Non-visitors referred more to ruins and the local culture and atmosphere and visitors to the whale sharks, which were one of the main reasons for choosing Belize for 14% of visitors. Visitors and non visitors did not differ significantly in terms of the marine environment as a key motivation for coming to Belize, but visitors were more likely to have come to Placencia for the diving or a whale shark trip than non-visitors ($n=570$, $z = 2.30$, $p = 0.022$). Respondent reasons for choosing Placencia within Belize were broadly similar (appendix 5.4). Overall 51% of responses referred to a marine aspect such as sailing, beaches, diving or fishing. Visitors to the reserve showed marked preference to sailing and whale sharks, which accounted for 15 and 19% of their responses respectively.

In terms of their trip characteristics (table 5.2), visitors to the marine reserve spent the same number of nights in Belize (11-12 days) and Placencia (6-7 days) as non-visitors. Around 18% of tourists had purchased hotel or sailing packages. These were similar to the CSO study results which found that 24% of tourists are return visitors, the average length of stay in Belize was 8.2 nights, 60% of visitors dived in Belize and 15% purchased pre-paid packages (CSO, 2006). Those who stayed for long periods of time often have holiday homes or relatives in Belize. However, they differed in the number of times they had come to Belize, with reserve visitors having come to Belize significantly more often. Visitors had also during this trip, done more dive expeditions (5 rather than 3) and visited more marine reserves (1.8 rather than 1.2 for non-visitors). In general, 31% of the snorkel trips that reserve visitors had done were inside marine reserves.

Table 5.2. Summary of respondent trip attributes.

	Visitor (n=302)			Non- visitor (n= 280)			Comparison visitor & non-visitor
Variables	Mean	SD	Range	Mean	SD	Range	Z statistic (p value)
Times to Belize	2.4	3.5	0 - 36	1.75	2.72	0 -25	-5.11 (0.000)
Nights in Belize	12.7	16.7	1 - 180	10.6	8.84	0-100	-0.17 (0.868)
Nights Placencia	7.2	13.3	0 - 120	5.2	6.14	0 - 95	-1.19 (0.233)
# dive/snorkel trips	4.9	6.8	0 - 100	2.3	3.1	0-30	-10.3 (0.000)
# marine reserves visited	1.8	1.9	0 - 10	1.2	2.0	0-20	-6.73 (0.000)

5.4.3Respondent conservation attitudes

When questioned about costs associated with the marine reserve, 68% of respondents said there were none and 28% mentioned one. Concerns as to the negative impacts of tourism were a commonly referenced cost of reserves, as were the impacts of restrictions and regulations on tourists, local people and fishers. Other concerns related to poor or expensive management and conflict.

When asked about the benefits that marine reserves provide, respondents frequently referred to the experiences visitors had, plus indirect economic impacts due to revenues raised and increased local tourism. Only a third mentioned ecological benefits of protection and 22% conservation of the ecosystems or endangered species. For all respondents, 42% referred to non extractive values such as recreation, 28% to indirect use values and a quarter or respondents extractive use values such as fishing. Only 1.4% referred to non-use values. While non visitors described a mean of 3 beneficiaries, visitors unexpectedly only mentioned 1.5 ($z = 8.64$, $p = 0.000$). Respondents who had positive values for the marine reserve were asked what they would most want to use the funds for (appendix 5.5). Education and awareness was the most popular choice (25%), followed by enforcement (19%), whale shark conservation (16%) and monitoring / research (14%).

Levels of concern about the health of the reefs were high, with 39% of respondents saying they were extremely concerned and less than 1% not at all (appendix 5.5). Concern did not differ between the visitors and non-visitors. 42% of respondents expressed very strong beliefs in rights of wildlife to exist, with visitors expressing stronger rights based preferences than non visitors to the reserve ($z = 12.42$, $p = 0.000$). Respondents felt that tourists (73%), the government (60%), international organizations (34%) and the local community or business (26%) should pay for the costs of this reserve. Only 22% said that multiple parties should pay.

5.4.4 Visitor experiences and values

5.4.4.1 Experiences inside the reserve

Visitors had carried out a mean of 1.3 activities (SD=0.7, range = 0 – 4) over a mean of 1.8 trips (SD=3.3, range = 0-50), indicating repeat trips for some visitors. 21% had dived, 49% had snorkeled, 7% had gone fishing and 8% kayaking. Whale shark trips were carried out by 39% of respondents. 28% of visitors had seen whale sharks and 58% saw a large charismatic species, such as a shark, turtle or dolphin during their trip. Most people recalled three things they had seen (maximum was 9 species), although only 15% of respondents mentioned coral. 65% of the 114 people who had gone to the reserve specifically to see whale sharks had seen them (28% of all reserve visitors). 46% rated the quality of their experience at GSMR as excellent, 38% as good, 9% as average and 1% as poor. Only 6% of respondents were sure they would not return to reserve, compared to 26% who were not sure and 68% who thought it was likely.

37% of respondents did not know what the trip to GSMR had cost them. Trip costs were highly variable, but a mean cost was US$127 per person (SD=263), with a maximum of US$3500 for one person who had specially charted a boat. While 63% of people knew there was some kind of entrance fee for the reserve, 64% of visitors did not know the price. This was partly due to the fact that the fee was included in the total package cost for day-trippers. In contrast, sailing boats were asked to pay and received stubs, so were more likely to know what the fee was. 23% of respondents knew the correct cost (US$10 per person) and 12% underestimated the cost.

5.4.4.2 Willingness to pay for the Gladden Spit Marine reserve for three scenarios

Since entrance fees already exist as a market and are familiar to respondents, they are therefore not expected to elicit protest bids, although there could be concerns as to the body collecting the fees or in the use of the funds. As all the respondents had been to the reserve, and paid US$10 or US$15 entry fees, these were the minimum bids possible (which they were informed prior to the WTP question). Follow-up questions were not asked for each bid, so protest responses for entrance fee questions were not possible to identify. Using donations as a payment vehicle was expected to produce more protest bids. For the donation question however, there were 27 zero bids (5.3% of all responses). 59% of these zero bids were identified as protest bids, related to mistrusting donation solicitation, poor management or adequate funds already being available. Legitimate zero responses were associated with lack of interest unless associated with visiting, not being able to afford a donation, preferring other causes and living elsewhere. A summary of lowest bids is given in Table 5.3.

Table 5.3. Low and protest WTP bids for the three valuation scenarios.

WTP question (value lowest bid)	No. responses in lowest category	% responses in lowest category	No. identified as protest bids
Entrance (US$10)	51	17	NA
Entrance + whale shark (US$15)	33	11	NA
Conservation donation (US$0)	27	9	16 bids

In total, three values were elicited, including non-use values with and without protests (table 5.4). Mean values were higher than median values, due to right skews in the WTP distributions. Since there were relatively few protest bids, these had only a US$3 impact on non-use WTP. Mean WTP for entry into the reserve was US$24, which is US$14 above the current fee. Since only one of the respondents mentioned ticket cost as a disadvantage of reserves, this is not unexpected. The chance of seeing whale sharks increased WTP by US$14.6, indicating that visitors have high values for these animals. The whale shark entrance fee bid is also US$23.60 higher than the current US$15 fee. There was some variation in respondents who had no interest in whale sharks, those who would pay a little more and some whose bids were extremely high; "whale shark enthusiasts". The non-use values are almost twice those associated with reserve and whale shark visits and were the most variable. This was expected due to the incentive incompatibility of donation solicitation, which results from hypothetical bias and free-riding (Carson & Groves, 2007).

The mean tourist has a total WTP of just under US$108.5. This is similar to the mean reserve visitation cost, which for those who knew what they had paid was US$127 (equivalent to 0.12% of the mean respondent income). Mean WTP for reserve entry for face to face respondents were US$25.2 for entry and US$40.60 for whale shark trips and US$69.3 for donations, compared to US$20.2, US$31.5 and US$54.8 for self completed responses.

Table 5.4. Visitor WTP for the Reserve in US$.

Estimated WTP	N	Min	Max	Mean	Median	Mode
Reserve entry	297	10	100	24.1	20	20
Reserve entry + whale sharks	297	15	200	38.6	30	50
Additional donation (with protests)	297	0	500	66.2	50	50
Additional donation (without protests)	281	0	500	69.9	50	50
Total visitor WTP	297	15	700	108.5	100	100

In order to understand WTP motivations, respondents were asked why they were WTP anything (figure 5.1). Ecological benefits were the most common answer (70% of responses). Future benefits were also important. Most responses referred to some aspect of management for conservation. However, 24% suggested it was a moral duty and 22% a good cause. A few respondents also mentioned using the reserve as a way to support local livelihoods, although this was not as important as conservation impacts.

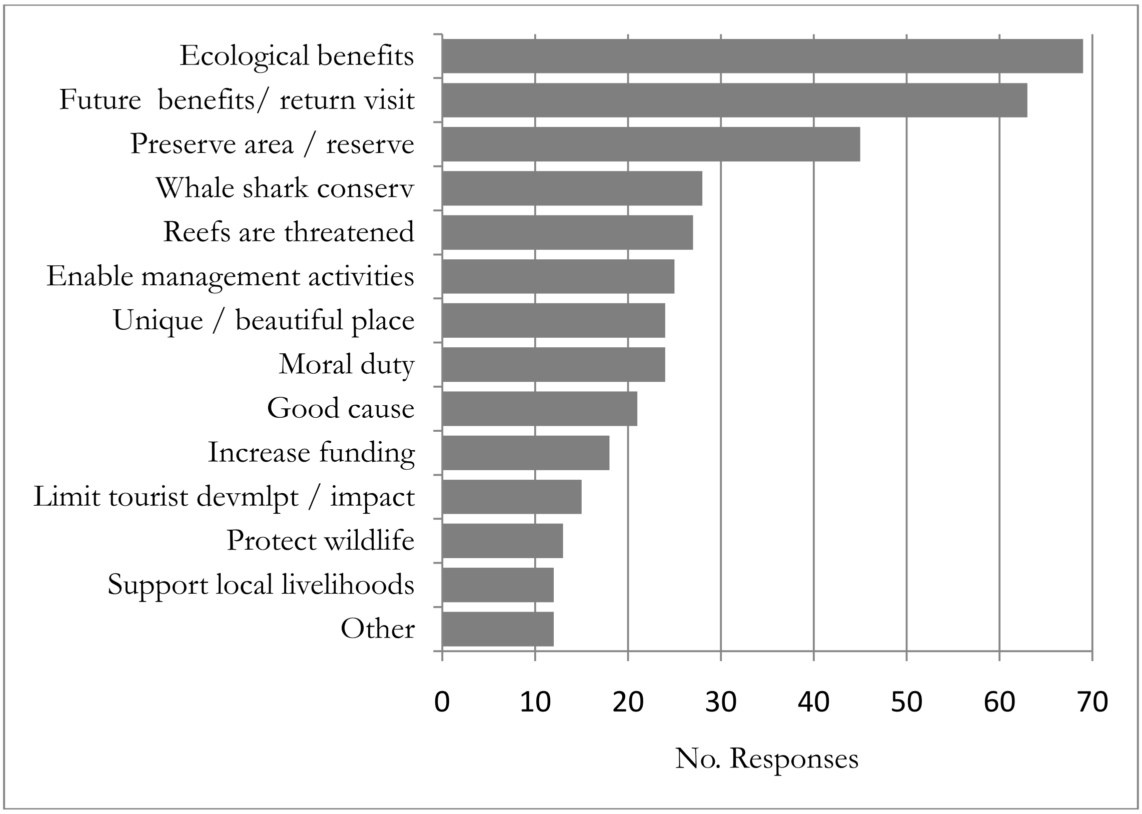


Figure 5.1. Visitor reasons for positive responses.

5.4.4.3 Econometric analysis

Several of the variables collected in the tourist survey were expected to explain some proportion of the variation in WTP bids (table 5.5). These variables fell into the categories of (a) respondent socio-demographic variables, (b) trip characteristics, (c) reserve visitation, (d) survey variables and (e) respondent attitudes. All analyses were done with both OLS and interval regression models and these are presented in table 5.6 and are discussed in turn. For all the WTP values, the core model contained income, education and environmental group membership. Variables which had been expected to be important in some or all of the values, but which were not, included respondent age, gender, number of times to Belize, marine motivation for choosing Belize and seeing a whale shark or lots of charismatic species such as turtles during the visit. Self completed surveys had more incomplete responses, so these were more likely to be excluded from the econometric analysis.

Table 5.5. Description of the explanatory variables.

Variable	Description
Income	Continuous: Median of income group per individual after tax
Education	Dummy: If they have a degree level qualification. 1=yes, 0= no.
Env group member	Dummy: If they belong to an environmental group. 1=yes, 0= no.
Expert diver	Dummy: If they have advanced or higher dive qualifications. 1=yes, 0= no.
Nights Placencia	Continuous: Number of nights respondent is spending in Placencia on this trip
No. snorkel trips	Continuous: number of snorkel trips the respondent will do during the visit
No. reserves	Continuous: number of marine reserves the respondent will visit during the trip
Sailing	Dummy: are they on a sailing holiday; yes =1, 0 = no.
Whale shark motivation	Dummy: was seeing whale sharks given as a motivation for choosing Belize? 1=yes, 0= no.
High season	Where they surveyed in the high season (March-July)? 1=yes, 0= no.
No. visits made	Continuous: number of visits they have made in total to GSMR
Fishing in reserve	Dummy: did the respondent go sports fishing inside the reserve, 1=yes, 0= no.
Excellent trip	Did they rate the quality of their trip at the reserve as excellent? 1=yes, 0= no.
Will return	Do respondents plan to go to the reserve in the future? Yes = 1, maybe = 0, no = 0.
Estimated entrance fee	Continuous: the fee that respondents thought was charged for reserve entry. Not sure = 0.
Type survey	Dummy: Was the survey face to face (yes = 1) or self completed (yes = 0).
Surveyed in reserve	Dummy: was the survey done inside the reserve, yes =1, 0 = no.
Question last	Was this the third valuation question to be asked? yes =1, 0 = no.
No. things seen	Continuous: Number of species mentioned in response to open ended question about what they saw during their reserve visit
Concern reef	Continuous: Response to: how concerned are you on a scale of 1 to 10 about the state of the reefs in Belize?
Strong lexico prefs	Dummy: High The extent to which they agree with the statement "animals and ecosystems have a right to exist, which cannot be traded against economic considerations". Not at all = 0, completely = 4.
Global benefits	Dummy: Respondents mentioned global benefits generated by marine reserves. Yes =1, 0 = no.
No. benefits from reserves	Continuous: Number given in response to open ended question about the benefits reserves generate
Non users should pay	Dummy: outside NGOs and governments given as people who should fund reserves, 1= yes 0= no.
Government should pay	Dummy: government given as people who should fund reserves, 1= yes 0= no.

For the entrance fee analysis, income was positively correlated with WTP at the 10% level, environmental group membership was not, which is unusual. Tourists who stayed longer in Placencia had higher WTP, but those who were on sailing trips, those who had done more snorkel trips and those who had visited the reserve more frequently had lower values. This is what would be expected, due to higher costs already incurred for marine activities. People who fished in the reserve had lower values, this could be due to high costs associated with this activity or since there is often seen to be a conflict of interest between marine reserves and fishers. People who rated the environmental quality as excellent, who planned to return In the future, those who had high levels of concern for the reef health and those who thought reserves generated global benefits had, as expected higher WTP. Those who thought non-users should contribute to reserve costs had lower bids. Ordering effects were evident as those who were asked their WTP for entrance fees last had higher bids than those who were asked first or second. Overall, the explanatory power of this model (R^2 = 22%) was adequate to assume that many of the important determinants of this values. Variables which had been expected to be important for entrance fee bids, but which were not, included being a keen diver, the estimated cost of the entrance fee, the number of reserves they had visited and the number of kinds of activities they had done inside the reserve.

The whale shark entrance fee models explained 27% of the variation in these values. Many of the same variables were important, although income, which was unexpectedly insignificant, which could be because some users hold extremely high values for whale sharks. Those who had visited more marine reserves were willing to pay more, as were those who had come to Belize specifically because of the whale sharks, or during the whale shark season. This value was the most sensitive to survey related factors, including the type of survey, the location of the survey and the order of the questions. Those surveyed face to face and inside the reserve had higher values. In contrast to the entrance fee question, asking for a bid last produced lower values. This might be expected, as respondents have just been reminded of other costs they could incur associated with the GSMR. Those who thought the government should fund reserves gave lower values, as was expected.

The donation value elicitation question was affected by different variables. Income had a significantly positive correlation only for the interval regression and environmental group membership only for the OLS model. Expert divers had higher non-use values, as did whale shark visitors, those with strong rights based preferences for wildlife and those who thought reserves generated many type of benefits. Again, being asked this question last led to lower bids. Those who estimated higher entrance fees for the reserves had higher bids, which could be due to a relational bias. Again, the explanatory power of the model was adequate (19%), although non-use related bids were the most variable.

To investigate why the type of survey produced different results for the whale shark entrance fee, I examined differences between these populations. Respondents did not differ in terms of age, education, sex or income, nor in times visiting Belize, the number of nights in Belize and Placencia. Key differences related to both location of survey and season, as all the self completed surveys were done during the low season and all at the airport. Self completed respondents had a different order of questions, had made more snorkel trips during their visit (they completed surveys on leaving the village) and were more likely to have done a whale shark trip and to have seen a charismatic species at the reserve than those interviewed face to face.

Quantile regressions were used to understand the way that these variables relate to WTP across the lower, middle and upper ranges of the WTP bids (table 5.7). These were done for all values, but produced broadly similar results, therefore only those associated with entrance fees are shown here. The interval regression is repeated to aid comparison. Income has a patchy effect on the various quantiles, being significant for the 25% and 75% quantiles. Environmental group membership is important for those with WTP in the top 5%. The number of nights spent in the village is more important for lower values, as is the respondent being on a sailing holiday. The number of visits made is important for all but the bottom quantile, where costs are smaller, so are less of a problem for repeat visits. Fishing exerts a strong negative effect on high WTP bids, as does the attitude that non-users should also pay for marine reserves. Respondents who thought the reserve was in an excellent condition had higher WTP at the median quantile and those who planned to return at the middle and higher ranges. In contrast, the order of the valuation question seemed to affect lower values more, which was also true for the opinion that reserves generate global benefits. Concern for reef health was important for all but the bottom quantile, in increasing bid values. Overall variables related to trip characteristics and the survey instrument were more important at middle and lower values and those associated with reserve visits and attitudes at middle and higher values.

Table 5.6. Econometric analyses for the three visitor values, using OLS and interval regression models. Co-efficients for each variable are followed by p-values in parentheses. *** =p<0.001, **=p<0.05, *=p<0.01.

Variable type	Variable name	Log WTP entrance	Log WTP entrance	Log WTP entrance & whale shark	Log WTP entrance & whale shark	Log WTP Addit. Donation	Log WTP Addit. Donation
Model		**OLS**	**Interval**	**OLS**	**Interval**	**OLS**	**Interval**
Constant		1.137 ***	1.203 ***	0.955 ***	1.028 ***	1.152 ***	1.361 ***
Respondent socio-demographic variables	Income	0.000044 (0.077)*	0.000043 (0.062)*	0.000014 (0.595)	0.00002 (0.664)	0.00005 (0.553)	0.00015 (0.010)**
	Education	0.0096 (0.772)	0.0075 (0.808)	0.0039 (0.917)	0.0001 (0.997)	0.0216 (0.831)	0.127 (0.830)
	Member env group	-0.0063 (0.186)	-0.0074 (0.141)	0.0145 (0.147)	-0.0844 (0.134)	0.0397 (0.051)*	0.0211 (0.205)
	Expert diver	NA	NA	NA	NA	0.204 (0.004)***	0.1126 (0.020)**
Trip characteristics	Nights in Placencia	0.002 (0.001)***	0.0017 (0.002)***	0.0026 (0.004)***	0.0026 (0.002)***	NA	NA
	No. snorkel trips	-0.006 (0.092)*	-0.0054 (0.102)	-0.0103 (0.011)**	-0.0101 (0.008)***	NA	NA
	No. reserves	NA	NA	0.053 (0.000)***	0.0521 (0.000)***	NA	NA
	Sailing	-0.0722 (0.030)**	-0.074 (0.013)**	NA	NA	NA	NA
	Whale shark motivation	NA	NA	0.0982 (0.019)**	0.0956 (0.016)**	0.136 (0.082)*	0.0567 (0.314)
Reserve visitation	High season	NA	NA	0.111 (0.006)***	0.108 (0.004)***	NA	NA
	No. visits made	-0.0179 (0.000)***	-0.168 (0.000)***	NA	NA	NA	NA
	Fishing in reserve	-0.0917 (0.034)**	-0.0849 (0.021)**	-0.145 (0.004)***	-0.132 (0.005)***	NA	NA
	Excellent trip	0.0648 (0.025)**	0.0631 (0.017)**	0.058 (0.040)**	0.053 (0.046)**	0.136 (0.085)*	0.0843 (0.077)*
	Will return	0.0484 (0.084)*	0.0428 (0.096)*	NA	NA	0.261 (0.014)**	0.1503 (0.005)***
	Estimated entrance fee	NA	NA	NA	NA	0.0083 (0.061)*	0.0062 (0.058)*
Survey variables	Type survey	NA	NA	0.205 (0.001)***	0.1956 (0.001)***	NA	NA
	Surveyed in reserve	NA	NA	0.063 (0.041)**	0.0622 (0.033)**	NA	NA
	Question asked last	0.0999 (0.007)***	0.0945 (0.007)***	-0.092 (0.041)**	-0.0844 (0.044)**	-0.284 (0.001)***	-0.137 (0.008)***
Attitudinal variables	Concern for reef	0.0177 (0.004)***	0.0168 (0.003)***	0.0197 (0.003)***	0.0184 (0.003)***	NA	NA
	Strong lexico prefs	NA	NA	NA	NA	0.211 (0.014)**	0.142 (0.004)***
	Global benefits	0.0527 (0.046)**	0.0469 (0.058)*	NA	NA	NA	NA
	No. reserve benefits	NA	NA	NA	NA	0.0853 (0.009)***	0.052 (0.022)**
	Nonusers should pay	-0.055 (0.043)**	-0.0564 (0.026)**	NA	NA	NA	NA
	Government should pay	NA	NA	-0.062 (0.038)**	-0.059 (0.036)**	NA	NA
Model parameters		N: 222 F-stat 4.76 p = 0.000 R-sq 22%	N: 222 Chi^2 = 64.4 p = 0.000	N: 221 F-stat 5.76 p = 0.000 R-sq 27.1%	N=221 Chi^2 = 87.2 P = 0.000	N: 217 F-stat 2.96 p = 0.001 R-sq 19%	N=216 Wald Chi^2 59.4 p = 0.000

Table 5.7. Quantile regressions for the entrance fee values of reserve visitors.
Co-efficients for each variable are followed by p-values in parentheses. *** =p<0.001, **=p<0.05, *=p<0.01.

Variable type	Variable name	Log WTP entrance	Log WTP entrance	Log WTP entrance	Log WTP entrance	Log WTP entrance	Log WTP entrance
Model		Interval	5% Quantile	25% Quantile	50% Quantile	75% Quantile	95% Quantile
Constant		1.203 (0.000)***	0.806 (0.000)***	1.005 (0.000)***	1.203 (0.000)***	1.198 (0.000)***	1.045 (0.000)***
Respondent socio-demographic variables	Income	0.000043 (0.062)*	0.00007 (0.186)	0.00005 (0.056)*	0.00002 (0.343)	0.00006 (0.084)*	0.00006 (0.633)
	Education	0.0075 (0.808)	0.0348 (0.651)	-0,024 (0.462)	0.0033 (0.916)	0.035 (0.502)	0.065 (0.679)
	Member env group	-0.0074 (0.141)	0.0105 (0.273)	-0.0076 (0.432)	-0.011 (0.185)	-0.0116 (0.182)	-0.046 (0.014)**
Trip characteristics	Nights in Placencia	0.0017 (0.002)***	0.0033 (0.056)*	0.00216 (0.001)***	0.00165 (0.076)*	0.0009 (0.487)	0.0009 (0.575)
	No. snorkel trips	-0.0054 (0.102)	-0.006 (0.379)	-0.0017 (0.685)	-0.005 (0.145)	-0.0045 (0.393)	-0.0051 (0.706)
	Sailing	-0.074 (0.013)**	0.0414 (0.533)	-0.105 (0.006)***	-0.0797 (0.023)**	-0.0985 (0.068)*	-0.050 (0.770)
Reserve visitation	No. visits made	-0.168 (0.000)***	-0.006 (0.411)	-0.0122 (0.018)**	-0.022 (0.000)***	-0.0252 (0.006)***	-0.0344 (0.051)*
	Fishing in reserve	-0.0849 (0.021)**	-0.0309 (0.538)	-0.0775 (0.158)	-0.0321 (0.502)	-0.095 (0.203)	-0.301 (0.014)**
	Excellent trip	0.0631 (0.017)**	0.0509 (0.522)	0.017 (0.532)	0.0628 (0.017)**	0.064 (0.131)	0.141 (0.352)
	Will return	0.0428 (0.096)*	0.047 (0.470)	0.034 (0.264)	0.0511 (0.065)*	0.0879 (0.056)*	0.129 (0.411)
Survey variables	Question asked last	0.0945 (0.007)***	0.178 (0.000)***	0.0836 (0.041)**	0.0497 (0.174)	0.0962 (0.090)*	0.2001 (0.357)
Attitudinal variables	Concern for reef	0.0168 (0.003)***	0.006 (0.628)	0.0253 (0.001)***	0.0166 (0.010)**	0.0191 (0.051)*	0.0512 (0.065)*
	Global benefits	0.0469 (0.058)*	0.1098 (0.098)*	0.0105 (0.716)	0.0159 (0.537)	0.0284 (0.491)	0.158 (0.224)
	Nonusers should pay	-0.0564 (0.026)**	-0.026 (0.707)	-0.0148 (0.618)	-0.0274 (0.301)	-0.0823 (0.048)**	-0.116 (0.443)
Model parameters		N: 222 Wald Chi^2 64.4 Prob>chi2 0.000	N = 222 Pseudo R^2 = 9%	N = 222 Pseudo R^2 = 11%	N = 222 Pseudo R^2 10 = %	N = 222 Pseudo R^2 13.4= %	N = 222 Pseudo R^2 22= %

5.4.5 Non-visitor experience and values.

5.4.5.1 Reserve knowledge and future trips.

Although 70% of respondents were familiar with the whale sharks that visit the reserve, only 35% had heard of the GSMR. The majority of non-visitors (58%) did not plan to return to Belize, although 28.4% were considering doing so. Overall, 82% of non-visitors were never expecting to visit the reserve, these responses differed with the type of survey ($z= 11.9$, $n=222$, $p=0.000$), although it is not clear why. While 8% of face to face respondents might return to the reserve, 79% of the self completed responses agreed.

5.4.5.2 WTP values for exit fees to raise money for the reserve.

In total, 95% of non-visitors had positive WTP values. Of the 15 (5%) that gave zero bids to the exit fee question, 2.1 (n=6) were identified as protest responses and 1.5% as non-responses. Protest bids were separated from actual zero bids using both the answer to the follow up question, "why were you not willing to pay anything?" and to the donation question. Both the reasons given, the donation bids, the initial and final interpretations are given when provided in appendix 5.6. The use of the additional donation question resulted in reinterpretation of half the zero responses.

Non-user WTP values associated with a compulsory taxation for visitors to Belize (the policy valuation), are shown in table 11. The mean WTP for the taxation question, taking the given values was US$21.5 per person per trip to Belize. Removal of protest bids only increased the mean WTP by 46 cents, due to the low number of protest bids. These were significantly different for the different survey types ($n = 268$, $t = -2.75$, $p=0.0063$). The means in table 5.8 have been calculated using the actual bids respondents made. If means are recalculated, assuming that the real maximum WTP lies between the category stated and the next payment category, the mean WTP rises modestly to US$23.46, due to the high number of bids at the lower end, where the gaps between the categories are small.

In terms of expected number of visits, where respondents were unsure or did not answer, it was assumed they would not return to Belize, to be as conservative as possible. Only 34% of respondents expected not to return and 12% of respondents expected to return more than 10 times. Those who said every year were coded as 15, unless they owned a house in Belize, in which case they were coded as 20. The mean number of number of expected visits respondents expected to make to Belize was 3.9, but estimates ranged from 1 to 31.

WTP for taxation and lifetime WTP are given in table 5.8. Removing protest bids increased the average lifetime WTP from US$71.6 to US$74.1 per person. If voluntary donations were used to replace protest bids, this reduced the mean only slightly. Face to face respondents had a mean lifetime WTP of almost US$80 and self completed respondents of US$68, over US$12 difference per person. The distribution of lifetime WTP bids, shows a heavy right skew, which is typical for value estimates, with a mode of US$20 per person. The lifetime value is almost three times the policy value. This makes sense since respondents are seen to take their expected number of visits into account when stating their WTP.

Table 5.8. Summary statistics for taxation non-visitor WTP (no protests), based on the WTP elicited and estimated return visits.

Value	WTP	Mean	Median	Mode	SD	N
Single visit exit taxation	Mean all surveys	21.52	15	10	25.9	275
	Face to face	25.5	20	10	32.5	142
	Self completed	17.3	12	5	15.1	134
Lifetime exit taxation	Mean all surveys	74.1	40	20	108.3	277
	Face to face	79.83	39	10	126.8	142
	Self completed	68	40	20	84.4	134

To understand why face to face responses might produce higher results, differences between the sample of each type of survey were examined. Tourists who were interviewed face to face were significantly less likely to be a member of an environmental group (n=267, z=6.6, p=0.000), had significantly lower level of education (n=274, z =5.1, p =0.000) and were less concerned for the reef health in Belize (n=280, z= 4.8, p=0.000). Those doing self completed surveys were more likely to know about the current environmental departure tax (n=272, z=3.34, p =0.001), were much more likely to plan to visit GSMR in the future (n =279, z=11.97, p=0.000) and were less certain about their WTP responses (n =279, z=-5.3, p=0.000). All other variables, including those for the length of their trip, number of visits to Belize, number of snorkelling trips were not significantly different, neither were factors such as income, age, country of residence.

5.4.5.3 **Response related variables**.

In response to the question on how certain respondents were of their bids, the great majority said they were "extremely certain", with self completed responses being more certain. If bids are removed, unless respondents rated their certainty as 10, as has been suggest is minimise hypothetical bias, the WTP is virtually the same, despite losing 96 responses. It increases only marginally from US$21.52 to US$21.73, with a minor increase in the standard deviation, suggesting that this data truncation based on certainty is unnecessary.

Follow-up questions to explore why these non-visitors were willing to contribute were varied (figure 5.2). A third of the answers involved making sure the area remain unchanged; preservation, limiting tourist development and due to the untouched nature or beauty of the area. Some respondents felt like it was a good cause (10%) or even a moral duty (5%). A few responses were linked to specific benefits, including 10% for ecological benefits, 12.5% for future benefits, 6% for local community benefits and 4% of responses were linked to potential future respondent visits (option value). The whale sharks were specifically mentioned by 6% of respondents. Only 1% said they based their responses on the fact that reserves are a good idea or seem to work.

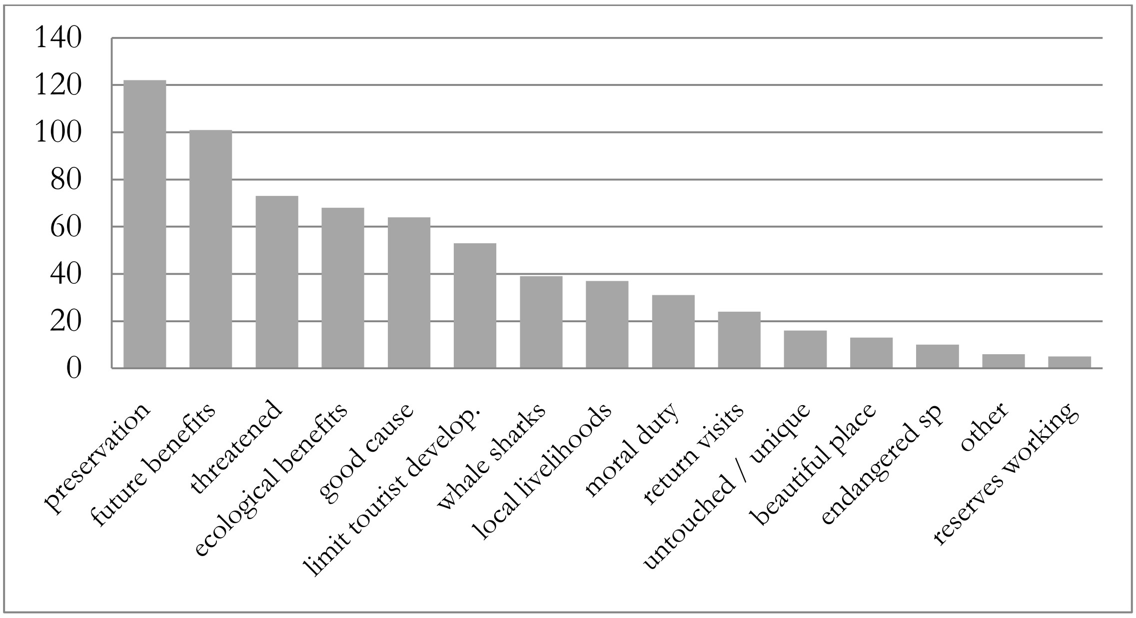


Figure 5.2. Why are non-visitors willing to pay anything?

Possible biases that could influence bid amounts include anchoring biases and expectations as to what others might be willing to pay. To account for possible anchoring biases, respondents were asked if they were aware that there was already an environmental tax which was collected as part of the airport departure fees. Almost 67% were not aware of this. For those who were, they were asked to say what they thought it cost. The majority of these thought that the tax was US$35-37.5. The rest of the responses were fairly evenly distributed among from US$2-70. The actual total departure fees are Bze$37.50 (US$15) of which Bze$7.50 (US$3.25) is the environmental fee. When asked how they expected their bid to compare to what others would be WTP, 44% thought it would be about the same, 18% their bid would be higher, 10% lower and 24% were not sure.

In terms of how respondents choose their bid amounts (figure 5.3), some responses were rather general, such as this is a "reasonable" amount (21%) and "I can easily afford this" (13%), "ballpark figure" (5%), this is a good cause (3%) or "this is my standard donation" (1%). Answers that included consideration of other people were "this is easily affordable for all tourists" (4%) and "any higher would deter visitors coming to Belize" (8%). Some responses were related to costs incurred either on the trip (6%), or the respondent income (5%). Responses linked to comparing this tax to other prices included "considering Belizean exit fees" (10%) and "based on entrance fees elsewhere" (5%). Answers which considered the total funds raised were "based on multiplying this figure by the number of people visiting Belize" (5%) and "given total amount raised, this should be enough to make a difference at this reserve (4%). Finally, some people explained why they would be hesitant to pay more than they had stated, as this is only for one reserve, they are not actually visiting the reserve and they are worried about corruption (3.5%, 3% and 2% respectively). These responses were summarized into categories which pooled similar answers, which are shown in figure 7.

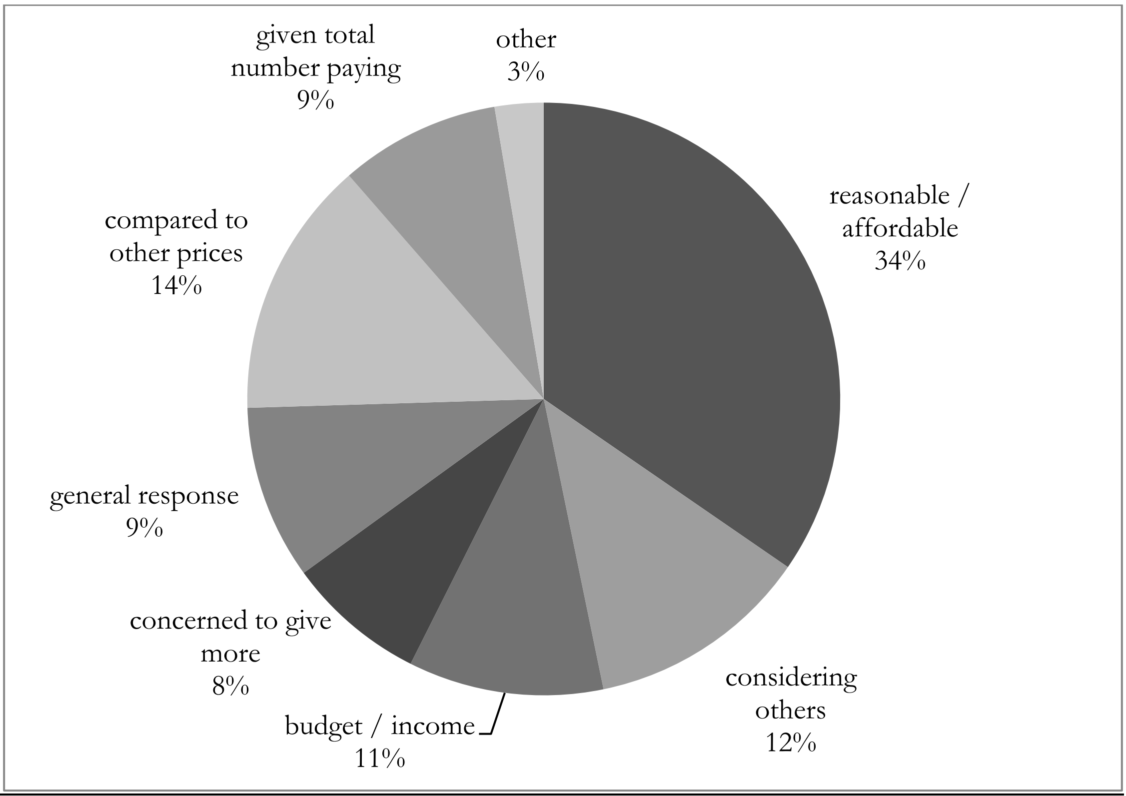


Figure 5.3. Summary of respondent choice for their WTP bid.

The distribution of the raw WTP bids is normally distributed, with few zero responses and a minor right skew, so the bids did not need to be transformed. The results for all the models fitted, including the ordinary least squares regression (OLS), the interval regression and the quantile regressions are shown in table 9. The core final model contained 12 variables (table 5.9), of which 4 were socio-demographic, 2 were related to current or future trips, 3 were related to response variables and 3 to environmental awareness and attitudes (see table 5.10). Where the OLS was run with missing variables replaced by mean values, the results were almost identical, with only minor changes to significance levels, therefore these results are not reported.

Table 5.9. Description of additional explanatory variables for non-visitor survey.

Variable	Description
Income	Continuous: Median of income group
Age	Continuous: Median of age group category
Env group member	Dummy: Are they a member of an environmental group? Yes = 1, No = 0.
Education	Dummy: have degree = 1, no degree = 0.
Nights Belize	Continuous: Number of nights respondent is spending in Belize on this trip
Total est visits	Continuous: Number of times respondent expects to return to Belize + 1
Plan to go	Dummy: Do respondents plan to go to the reserve in the future? Yes =1, maybe =1, no = 0.
Type survey	Dummy: Was the survey face to face (yes = 1) or self completed (yes = 0).
Type survey * airport	Interaction for airport survey response and if the survey was face to face or self completed.
Same as others	Dummy: Did they consider others in their response 1 = yes, 0 = no.
Heard wh sharks	Dummy: Had they heard of the whale sharks visiting this area? 1 = yes, 0 = no.
Concern reef	Continuous: Response to: how concerned are you on a scale of 1 to 10 about the state of the reefs in Belize?
Lexico prefs	Dummy: High The extent to which they agree with the statement "animals and ecosystems have a right to exist, which cannot be traded against economic considerations". Not at all = 0, completely = 4.

The interval regression produced almost identical results to the OLS, whose explanatory power was 22%. This could be due to the relatively small intervals between payment card responses, in the lower categories, where most of the bids fell. These models showed a positive co-efficient for income, which was highly significant and therefore provides evidence of theoretical validity. Another test of theoretical validity is the negative relationship between the total estimated visits and the WTP and the positive relationship between planning to return and WTP. People planning to return to Belize take this into account when they give their WTP bids, indicating that they are sensitive to the taxation scenario given. Those who answered that they might return were WTP US$5.53, which is the option value associated with the reserve. Age was significant and negatively correlated with WTP, as has also been found in other studies. Education was not significant. Environmental group membership was significant at the 10% level and positively correlated, as was expected.

In terms of survey related factors, both the type of survey and its interaction with the location it was done are significant. Face to face interviews at the airport produced the highest bids and there was an interaction between these factors. Those who thought that others would have the same WTP to pay as them, had significantly lower WTP than those who did not. Finally, as would be expected, people who had heard of the whale sharks in this area and therefore had greater previous knowledge had higher WTP, as did those who said they were more concerned about the health of the reefs in Belize and those who expressed rights-based preferences for marine life (lexico prefs).

Those variables that had no discernable effect on WTP and were therefore removed from the model, but could have been expected to affect WTP were; number of previous trips to Belize, nights in Belize, number of snorkelling trips in Belize, if they had gone on a trip to a reserve in Belize, dive level (as a proxy for reef experience), or the estimate of the current departure tax, certainty level associated with stated bid and the income -age interaction term. This was also true for several attitudinal variables including having heard of the reserve before and opinions about costs and benefits of these reserves.

The quantile regressions can be used to understand the way that these variables relate to WTP across the lower, middle and upper ranges of the WTP bids. Income becomes increasingly important at higher levels of the WTP spectrum, suggesting that higher incomes are more important in terms of determining high WTP. Age in contrast, had more of a depressing effect on the lower end of the WTP range. Environmental group membership is a good predictor of WTP for the 25% quantile, but not at others. Education remains insignificant at all quantiles.

Interestingly, those who planned to return to Belize were more likely to take this into account for high values. Those who planned to come back to the reserve were likely to take this into account for most of the values, but this was not true for those with very high values. Those considering others were reducing their bids at all levels but the lowest WTP, as whether others can afford to pay is less likely to affect low bids. Type survey was a marginally significant predictor of WTP at most levels, but not for the highest values. Its interaction with survey location was significant at many quantiles, but not the median quantile. In terms of awareness, none of the variables were significant at the lowest quantile, suggesting that other factors are motivating respondents with low WTP. Concern as to the reef health motivated those at 25% and median quantiles, but rights based views and having heard of the whale sharks were important several quantiles apart from the lower quantiles, suggesting patchy effects of different awareness variables.

Table 5.10. OLS, Interval and Quantile Regression Results for non-visitor Taxation WTP to support a marine reserve in Belize. *** =p<0.001, **=p<0.05, *=p<0.01.

Variable type	Variable	WTPtax	WTPtax	WTPtax	WTPtax	WTPtax	WTPtax	WTPtax
Model		**OLS**	**Interval**	**Q 10%**	**Q 25%**	**Q 50%**	**Q 75%**	**Q 90%**
	Constant	-17.021 0.073*	-16.938 0.083*	-4.448 0.261	-5.513 0.116	-10.63 0.182	-5.485 0.664	22.915 0.526
Respondent socio-demographic variables	Income	0.000087 0.003***	0.000094 0.002***	0.000006 0.677	0.000013 0.204	0.00004 0.077*	0.000109 0.001***	0.00012 0.011**
	Age	-0.3466 0.006***	-0.3688 0.004***	-0.1182 0.060*	-0.152 0.000***	-0.1139 0.203	-0.1561 0.232	-0.3198 0.109
	Env group member	7.122 0.078*	7.477 0.066*	2.202 0.330	3.677 0.005***	3.399 0.230	4.623 0.209	7.885 0.151
	Higher degree	5.969 0.164	6.079 0.160	1.577 0.444	1.565 0.210	0.1568 0.952	-0.087 0.980	-0.346 0.947
Trip characteristics	Total est visits	-0.9502 0.003***	-1.015 0.002***	0.056 0.730	-0.219 0.095*	-0.448 0.144	-1.025 0.027**	-1.057 0.018**
	Plan to go	10.578 0.009***	11.401 0.007***	3.120 0.063*	3.749 0.022**	8.158 0.026**	13.906 0.006***	12.191 0.109
Survey variables	Type survey	11.591 0.024**	12.268 0.022**	3.817 0.045**	4.210 0.032**	7.719 0.070*	9.949 0.094*	5.568 (0.764)
	Type survey * airport	10.833 0.006***	11.369 0.005***	4.396 0.051*	4.671 0.003***	4.217 0.220	7.700 0.075*	14.778 0.001***
	Same as others	-8.260 0.008***	-8.549 0.008***	-2.263 0.209	-4.179 0.000***	-4.079 0.094*	-7.414 0.022**	-10.304 0.029**
Attitudinal variables	Heard whale sharks	8.043 0.009***	8.454 0.008***	0.849 0.666	2.037 0.096*	3.859 0.143	10.659 0.002***	14.761 0.000***
	Concern reef	2.637 0.005***	2.778 0.004***	0.763 0.180	1.313 0.000***	1.948 0.010**	1.110 0.270	0.0236 0.987
	Lexico prefs	8.919 0.002***	9.611 0.001***	2.968 0.202	3.559 0.011**	2.237 0.466	8.247 0.046**	18.491 0.051*
Model parameters		N: 248 F-stat 2.62 Prob>F 0.003 R-sq 22%	N: 248 W Chi^2 32.48 Prob>chi2 0.0012	N: 248 Pseudo R^2: 8.8%	N: 248 Pseudo R^2: 9.4%	N: 248 Pseudo R^2: 8.2%	N: 248 Pseudo R^2: 9.3%	N: 248 Pseudo R^2: 17.7%

5.4.5.4 Aggregate values and revenue raising.

When comparing values per person for the reserve (figure 5.4), non-use values are the highest for visitors. For non-visitors, lifetime values are almost three times those for single trips. Overall, the visitors have higher values than non-visitors, but non-use values for visitors and non-visitors are almost the same.

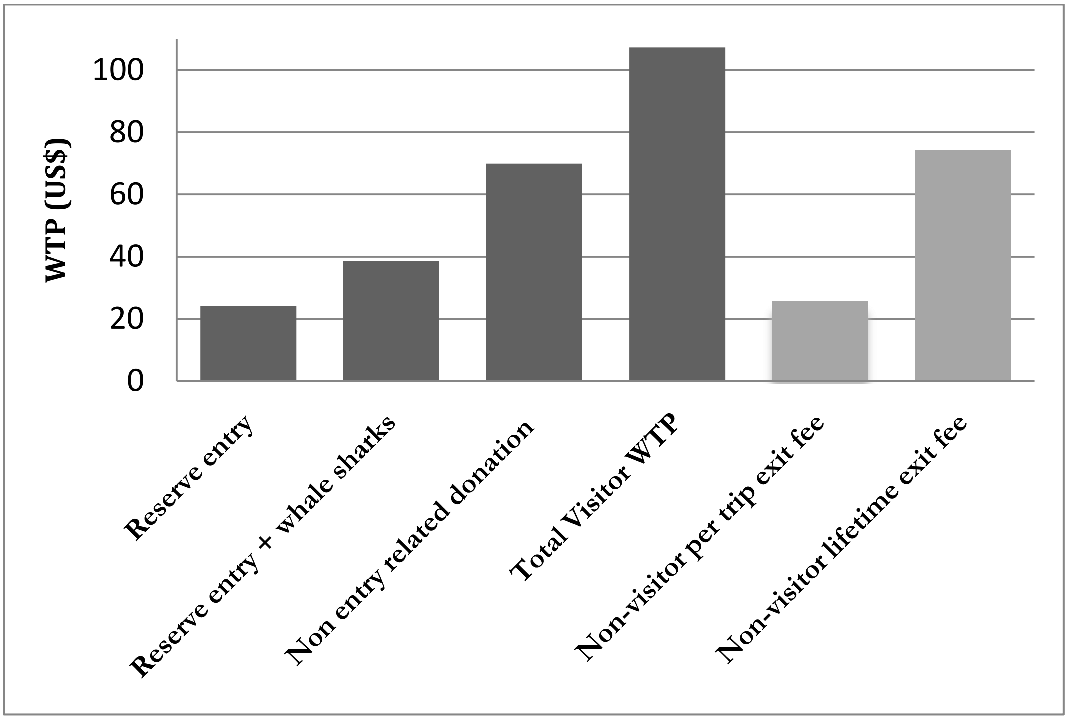


Figure 5.4. Mean WTP associated with different tourist values for the Gladden Spit Marine Reserve.

Estimates based on data provided by the Belize tourism board indicate that almost 40,000 international tourists visited this village in 2006. Since the number of visitors are known in terms of the reserve visitors for general trips, for whale shark trips (from ticket sales) and the number of tourists coming to Placencia each year, gross aggregate values can be estimated, which are of key importance as potential sources of revenue for the reserve.

The resulting estimates enable consideration of the magnitude of values held by tourists and are given in Table 5.11 and shown in Figure 5.5. The relative magnitude of the values changes. For example, due to the lower rate visitation rate, overall whale shark trips values are lower than those simply associated with the reserve. The importance of non-use values also quickly becomes clear. Non-use values associated with non-visitors are the largest overall value both per visit to Belize, but even more so over a lifetime, as seen in Figure 5.5.

Table 5.11. Consumer Surplus (CS) associated with Gladden Spit Marine Reserve. *1 Costs assumed to be negligible. *2 Estimate of visitors to Placencia, from the Belize tourism board. *3Current exit fee = 3.75 *4 mean number of expected trips = 3.9; so cost = 3.75* 3.9 visits. *5 this was taken by adding together WTP for whale shark/ reserve visits and non-entry related donations. NB difference in cost between normal and whale shark visit is US$5, so this is taken away from CS

Estimated WTP	Visitor / Non-visitor	N	Mean WTP	# people affected 2006	Gross value (US$)	Indiv. CS (US$)	Approx. Total CS US$
Reserve entry	Visitor	297	24.1	4221	101,726	14.1	59,516
Reserve entry + whale sharks	Visitor	297	38.6	2032	78,435	23.6	47,955
Whale shark related WTP (diff)	Visitor	297	14.5	2032	29,464	9.5	19,304
Non-entry donation (no protests)	Visitor	281	69.9	6253	437,085	69.9*1	437,085
Total visitor WTP*5	Visitor	297	107.3	6253	670,947	92.3	577,152
Non-visitor per trip exit fee	Non Visitor	275	25.5	39570*2	1,009,035	21.75 *3	860,648
Non-visitor lifetime exit fee	Non Visitor	277	74.1	39570*2	2,932,137	59.5*4	2,354,415

Lower estimates are taken from self completed surveys estimates and the upper estimate from face to face responses were used to look at ranges of aggregate values. For total visitor values, this means the aggregate gross value could range from just over US$540,000 to US$687,200. For non-visitors, the range is estimated from US$692,000 to US$1.02 million for the single visit taxation and US$2.7 – 3.2 million for the lifetime non visitor taxation.

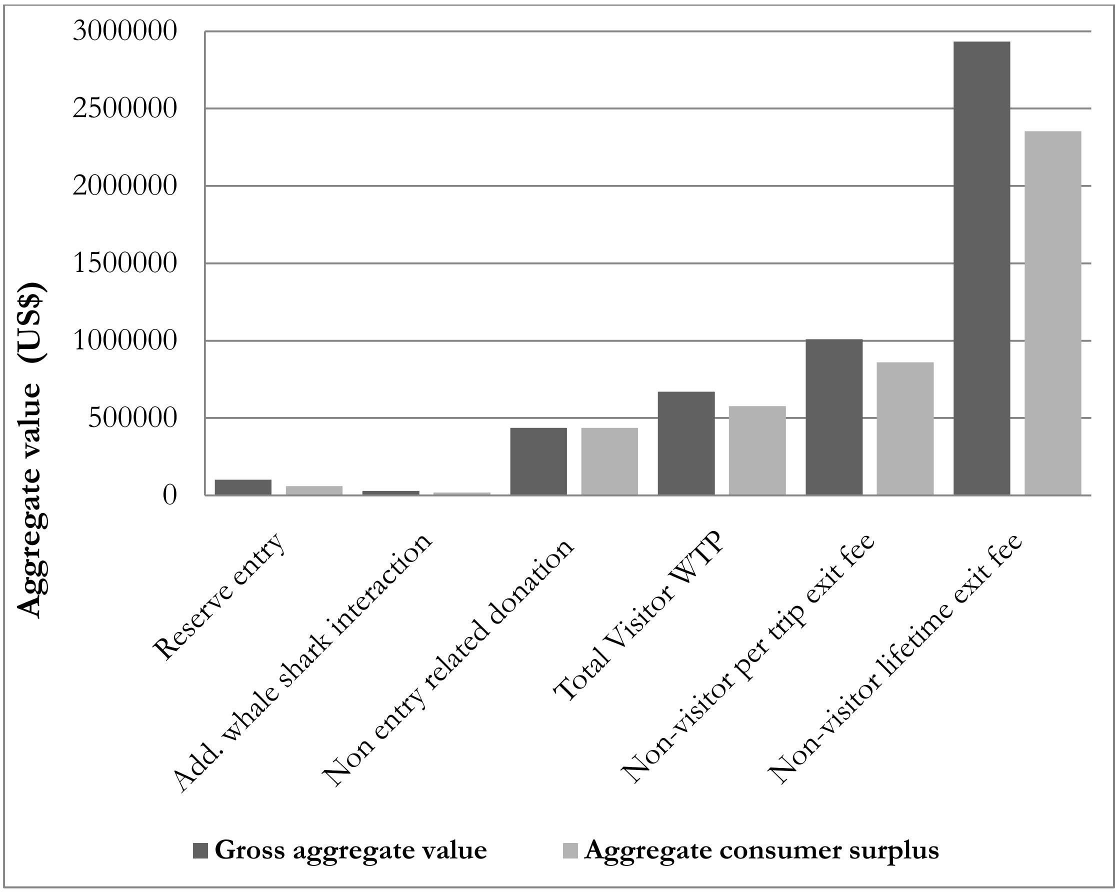


Figure 5.5. Gross and net tourist values associated with the Gladden Spit Marine Reserve from tourists coming to Placencia village.

These WTP results can be used to generate demand curves for the visitor entrance fees and the non-visitor exit fees. An exponential function provided the best fit for the entrance fee data (figure 5.6), and a linear one provided a best fit for the exit fee data. These estimates can be used to help fulfill various reserve criteria; namely access, financial sustainability and environmental sustainability (O'Garra & Mourato, 2007). Reefs are likely to have critical social and biological thresholds (Davis & Tisdell, 1995). Since environmental protection is a key element of an MPA, this demand estimation could be used to set fees at a level which would produce visitor numbers below the environmental carrying capacity. Alternatively, as with any recreational value there are likely to be a social carrying capacity, beyond which recreational values are diminished by congestion. This could be used to decide on appropriate fee levels. Other criteria include cost retrieval, either for the costs associated with collecting tickets or the management costs for the reserve, and profit maximization, which would enable financial independence and some level of financial security.

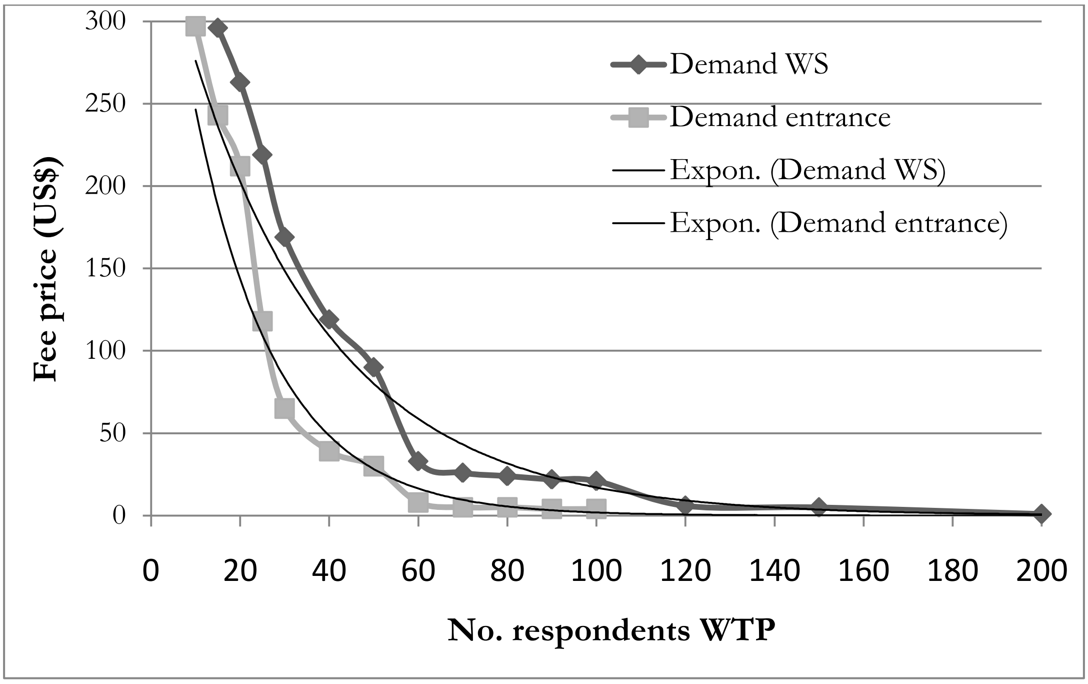


Figure 5.6. Exponential demand functions and actual data for entrance fees and whale shark fees.

The fee levels for each of these strategies (table 5.12) showed that if profit maximisation was the sole goal, entrance fees should be raised to US$24 per person per day, whale shark entrance fees to US$30 or airport exit fees to US$35. These would be paid by 50%, 55% and 26% of visitors. Even if maximum profits are taken, only US$88,903 would be raised, which would only cover the reserve's fuel costs. However, the full budget of the reserve could have been met if an exit fee of US$17.5 was added to the current exit fee, although only 45% of visitors would pay this. Standard costs are therefore well below cost recovery at this area.

Table 5.12. Pricing options for revenue raising at Gladden Spit Marine Reserve.
*[1] Airport exit fees refer to prices paid above current departure fees. *[2] In 2007, US$84,265 was spent on fuel, US$56,993 on boat maintenance and US$116,225 for ranger salaries, to enable patrols inside the reserve. If it was assumed that the rangers are necessary for reserve management and 50% these costs would be incurred, even if ticket collection was not done, since the need for patrolling would still exist, this generated a rough estimate of US$128,700 for ticket collection costs. *[3] Total reserve budget for 2007 was US$315,864.

Pricing option	**Entrance fee**		**Whale shark entrance**		**Airport exit fee*[1]**	
	Price (US$)	Revenues raised (US$)	Price (US$)	Revenues raised (US$)	Price (US$)	Revenues raised (US$)
Current policy	10	42,210	15	30480	0	0
Cover fee collection costs *[2]	n/a	n/a	n/a	n/a	3.75	130,116
Cover reserve mngt costs *[3]	n/a	n/a	n/a	n/a	17.5	310,063
Profit maximization	24	50,652	30	33,251	35	361,741

5.5 Discussion.

This research investigated tourist activities in Belize, attitudes and motivations for visits and marine reserve visitation linked to the case study site, the Gladden Spit Marine Reserve. Studies which establish baseline tourist values are vital to inform current and future decision making. This study is useful in demonstrating that tourists enjoy significant consumer surplus from reserve visitation and simply knowing the reserve is present. As expected, attitudes, trip motivations, experiences at the reserve and socio-economic variables such as income will impact these bids. GSMR is in many ways typical of other reserves in Belize, which may therefore be expected to elicit similar recreational non-extractive values. However, the special feature of predictable whale shark aggregations adds US$19,304 annually to the total visitor value.

Entrance fees and tour operator charges were tiny in comparison to most holiday costs, as was demonstrated by the number of people who did not know what they had paid for their trip. Visitors were shown enjoy large welfare gains associated with the reserve, and large consumer surpluses of US$14 for tourist trips and US$23 for whale shark trips. As many have had high quality experiences inside the reserve, often doing several activities and seeing charismatic species such as whale sharks, this was expected. Whale sharks are a highly valuable resource, since they are associated with an additional value of US$14.5 per visitor, or US$19,300 in aggregate in 2007. However, less than 25% of visitors would be WTP the US$100 for whale shark entry charge in Thailand (Newman et al., 1997).

The contingent valuation results for entrance fees were broadly similar to those found at other sites e.g. Goodwin et al., (1997) who estimated that divers are willing to pay around US$20–30 per trip and that people hold significant additional values for charismatic species (Loomis and Larson, 1994). Dixon et al., (1993) estimated a WTP for Bonaire Marine Park of US$27.40, which is US$2 higher than the estimated WTP for entry, but much lower than the total WTP for the reserve. The reserve entrance WTP was US$5 higher than that of tourists to other MPAs (Dharmaratne, 2002).

When assessing the validity of the entrance fee WTP, it should be noted that strategic behaviour is possible, if respondents giving lower bids that their true WTP for entrance fees, if they think that their responses are likely to influence costs (Carson & Groves, 2007). However, the higher bids given by respondents who want to return in the future is at odds with this. Visitor non-use values are higher than their use values and these are driven by perceived ecological and future benefits they believe the reserves will provide. As donations were specified as being additional to entrance fees, it is likely that these WTP bids are indeed additive. However, the donation question is likely to have provoked artificially high bids, as respondents plan to "free ride", whilst wanting to ensure that the good (long term funding) is provided. The donation WTP skewed and variable distribution could be indicative of this (Carson & Groves, 2007). Alternatively, this may partly be due to the tendency of respondents to choose rounded numbers and to be guided by typical donation solicitations they have received elsewhere.

Interestingly, lifetime non-use values of visitors and non-visitors are of a very similar magnitude, as are their motivations for contributing to the reserve and other key attitudinal and socio-demographic variables. It is likely that since so many people coming to Belize do so in some part due to the marine attributes, these are not two distinct groups of tourists. Instead it is likely that those who stay longer are more likely to visit the reserve (with the exception of those that come specifically for whale shark trips). However, the similarity of non-use values may point to the importance of information effects, as both visitors and non-visitors were provided with detailed information and supplementary materials about the reserve, before a bid was solicited. In general, it is not surprising that relatively large values can be seen even for non-visitors, as many of these have also come to Belize to marine related activities, many have been snorkelling and even seen other reserves and they have high incomes. Option values make up of the non visitor values however, which can be interpreted as use or non-use values (Mullarkey & Bishop, 1999). The low number of protest and zero bids is unexpected, but could be due to the fact that the survey instrument included a reminder that an environmentally motivated exit fee and entrance fees are already in place.

The OLS models have reasonable model fit, indicating that many of the important influences on respondent values have been included (R^2 values range from 19-27%). The payment vehicle appears to have been suitable in all cases, limiting instrumental bias. The difference in the WTP bids from each respondent shows that they are able to differentiate between the goods being valued and are sensitive to the information provided. This is also supported by the slightly different explanatory variables for each of the models. This means that the sequential format works well as a way to glean several values from one respondent. The current existence of entrance fees and exit fees and user familiarity is important as it reduced hypothetical bias. Although most of the respondents were aware of an entrance fee for the reserve, this did not affect their bids and few of them knew what was charged, which may have meant that the payment ranges presented in the payment card were important. Since several respondents fell into the highest category, it is probable that the ranges should have been larger.

There are several aspects of the CVM used which may be of relevance to this survey. The econometric analysis revealed order effects, with the last question producing lower bids for whale shark visits and donations. The reason why the order affects different questions in different ways is unclear. Other unexpected influences on bids included the type of survey and survey location. Face to face surveys produced higher values for some of the responses, but this may be due to different type of tourists interviewed, as there were significant differences found between face to face and self completed respondents. The fact that the samples were not equally split, with all the self completed surveys done in the low season, may have been important, or there could have been interview bias. These effects should be further examined in future research, however they do not undermine the credibility of the values estimated, which are shown to be theoretically valid (consistent with neoclassical economic expectations) in terms of the factors influencing WTP (Bateman et al., 2002). The only value which was not positively correlated with income was the whale shark experience, however, income is not always a good test of theoretical validity, especially where bids are a small in relation to income, as is the case here (Garrod & Willis, 2000). Protest bid removal and using certainty estimates to increase accuracy is always a slightly subjective process (Mullarkey & Bishop, 1999). However WTP values were not greatly affected in any case by the removal of protest or low certainty bids, so this is not a great matter of concern here. Interestingly, for the non-visitor survey, the variable of how people thought their WTP compares to others was highly significant, with those who expected others to pay similar levels having lower bids. Those people who had heard of whale sharks had higher values, suggesting that familiarity with the good in question may be important, as has been found elsewhere (Carson et al., 2001). Sequential CVM questions worked well to elicit different values which are shown here to pass tests of theoretical and convergent validity, but survey effects may be more important than is typically recognised.

The tourists that have been included in this analysis are highly educated, have high incomes and have a high level of concern for coral reefs; however there is no evidence to suggest that these are not representative of tourists to the area all year round, which means that aggregating the results to all tourists to Placencia general is not problematic. However, these results tell us little about general visitors to Belize and indeed international visitors, although these may hold high non-use values.

The demand analyses show that current fees are not maximizing MPA revenues. In order to maximize available funding for reserve management, the entrance fee and the whale shark fee should be increased by US$14 and US$15 respectively. This would be expected to result in approximately a 26% loss in visitor numbers for both kinds of trips. This could have negative repercussions for tour operators, so some kind of compensation might be necessary, but reducing visitor numbers could reduce environmental pressure, such as waste, which many tourists complained about. Whale shark visitation rates continue to increase and there is widespread concern that whale sharks are not returning due to stressful encounters with too many tourists. Increasing the fee will reduce numbers and increase revenues raised. However, tourists would need reassurance that the funds would actually be used for conservation. Since most tourists would like their money spent on education, enforcement and whale shark conservation, these should be highlighted as priorities for spending. Expected benefits such as ecological, conservation, community and future benefits should also be emphasised, since these are the key reasons people are WTP anything. Stressing the threatened nature of the reefs to tourists is likely to encourage support, as WTP is related to concern for reefs. Fundraising effort should be concentrated in the high season, ideally inside the reserve, but fishers and families who are sailing should not be heavily targeted. Advertising could be used to increasing awareness of the reserve and the whale sharks would be important for non-visitor revenue raising.

In particular, non-use values held by both visitors and non-visitors constitute a major part of tourist values and could be better captured. Increasing the an exit fee for all tourists (not just reserve visitors) to raise funds for marine reserves is a viable way to do this, as it is acceptable to tourists visiting this village and would raise the most money, out of all the mechanisms which were explored (an estimated US$860,000 million per annum).

If a secondary management aim is not to impose negative social impacts in terms of high fees, it is recommended that current low entrance fees are used in conjunction with donation solicitation (which is more acceptable to tour operators), exit fees or fund-raising using the values demonstrated here. Whilst actual donation behaviour would be likely to raise fewer revenues than suggested by the hypothetical donation question, meaning that this should not be the sole fund-raising strategy, there is still a case for soliciting donations, which FoN currently does not do. In general however, non-visitors are a more suitable target for revenue raising payments than visitors, as in aggregate they could contribute much more funds, although the coercive rather than voluntary nature of the fundraising is likely to be important for non-visitors.

5.6 Recommendations.

Several recommendations can be made:

- Use this valuation estimate as a baseline and repeat it in the future, to monitor reserve progress and effects of management or other changes.
- Carry out research into ecological and social carrying capacity and use the demand curve estimations to set fees accordingly.
- Investigate the non-use values of visitors to other areas in Belize and perhaps even in the US.
- Further investigate reasons for the divergence between values from different survey types.
- Consider the impact of various threats and policies on these values e.g. local cruise ship tourist expansion.
- Agree on standardized methodology for measuring tourist WTP for marine reserves, to aid comparison between reserves.
- Repeat study at another Belizean MPA, with a different special feature e.g. shark ray alley to compare recreational values with general reserve visitation and special features.

Local values for the Gladden Spit Marine Reserve.

6.1 Introduction and Rationale.

MPAs are widely advocated and increasingly established as they are expected to provide habitat, fisheries and socio-economic benefits (Halpern, 2003; Pomeroy et al., 2007; Sanchirico et al., 2002), including a foundation for economic growth and poverty reduction (Lani et al., 2003). Other socioeconomic goals of MPAs include fostering food security, livelihoods, proving non-monetary benefits, as well as equitably distributing benefits, maximizing compatibility between management and local culture, and enhancing environmental awareness and knowledge (Mascia, 2004). In chapter 4 it was shown that the ability of MPAs to provide social, economic and ecological benefits simultaneously is not universal. In theory, these benefits should be coupled, but in practice, trade-offs exist between different benefits. This is likely to be due to the distribution of costs and benefits that are generated both temporally and between stakeholders.

MPAs manage the behaviour of marine resource users (Bromley, 1991), as MPAs seek to modify human behaviour by establishing an incentive structure which produces habitat quality improvements, reduces threats and increases compliance, directly impacting performance (Pomeroy et al., 2007). Charles and Wilson (2009) suggest that the human dimensions which are critical to achieving successful MPAs include attitudes, participation, costs, benefits and the local context. Local attitudes and behaviour of key stakeholders will also determine the exploitation (Dasgupta, 1996) and the local conservation impact of PAs (Wattage & Mardle, 2008). These cannot be understood without taking into account both stakeholder values and the equitability of benefits (Scanlon & Kull, 2009).

MPAs produce benefits and costs that affect the main users of MPAs; resident individuals, households and communities (Carter, 2003; Sanchirico et al., 2002). Costs suffered by local users and communities can occur immediately and be substantial (even compared to management costs), reducing support and compliance (Balmford et al., 2002; Balmford & Whitten, 2003; Ferraro, 2002; Ostrom, 1990; Sanchirico et al., 2002), which can undermine management efforts (Pomeroy et al, 2006 Wilkinson, 2004). As a result, successful MPAs often need to produce tangible benefits quickly, to compensate local communities for these negative impacts (Kapoor, 2001; Newmark & Hough, 2000; West & Brechin, 1991). Furthermore, these costs may affect one user group disproportionately (e.g. see Ferraro, 2002), leading to increased conflict and reduced compliance (Sanchirico, 2000), which is a common problem for protected areas in developing countries (Bruner et al., 2001; Bruner et al., 2004).

Therefore there is a requirement for tangible economic benefits for local communities, in addition to the resource benefits which can take years to materialize (Mascia, 2004). Benefits can direct or be in-kind contributions such as community or development programs and revenue sharing initiatives (Emerton et al., 2006). Many MPAs produce benefits as a result of establishing preferential use rights, or catalysing the transition to a tourism based economy (Pomeroy, 1991), as has occurred at the Gladden Spit Marine reserve. However the impacts of changes to the fishing and tourism sectors can be complex. These changes would be expected to have significant consequences for local values and support for MPAs, although these aspects of MPA performance are poorly understood (Pomeroy et al., 2007). For example, economic rents associated with open access resources have often been dissipated, meaning that the PS is close to zero. However reserves where fishing regulations are enforced or where tourism development has resulted in reduced fishing effort can increase producer surplus from fisheries inside the reserve, increasing net economic value of the area. MPAs also often result in increased local tourism (chapter 3), which is likely to have direct positive economic impacts, such as income diversification, leading to less reliance on natural resources, as well as indirect impacts such as improved infrastructure and secondary tourist spending in the local economy (Dixon et al., 1993; Mascia, 2004). Nevertheless, excessive visitation undermines MPA management by threatening the protected habitats (Roberts & Hawkins, 2000). Increased tourism can also increase conflict as the re-allocation of rights to non-consumptive users can create feelings of inequity (Mascia, 2004) and resentment from perceived loss of traditional ways of life (Hoagland et al., 1995).

MPA planners are often surprised when local residents resist the establishment or expansion of MPAs, despite rarely carrying out assessments of the impacts of MPAs on local households (Caribbean Natural Resources Institute (CANARI)., 2005). Yet, it is locally that MPAs will have their most immediate effects and local analyses should address not only the community level, but also the individual or household level (Mallaret-King, 2004). There is a dearth of literature measuring the local use of coral reefs (Burke et al., 2008). There also exist few quantitative analyses of the local effects of protected area establishment (Adams et al., 2008; Ferraro, 2002) and even less research to quantify local values for MPAs. This is surprising given that support, compliance and ultimately outcomes depend to a great extent on the values which local people hold and the extent to which they can profit from natural resources in MPAs (Christie, 2004; Mascia, 2004; McClanahan et al., 2005a). Few studies valuing natural resources have applied CVM to developing countries (Adams et al., 2008; Dixon, 1993; Hadker et al., 1997), where local reliance on environmental resources is much greater than in developed countries (Naylor, 1998). Here, people often live at the subsistence level and have high discount rates, which means immediate impacts of MPAs are more important than longer term ones (Pomeroy, 1991).

Quantified local stakeholder producer and consumer surplus estimates can be used to draw attention to welfare benefits that are undervalued by policy makers or donors, which can be used to justify increased spending on marine conservation and to make clear the potential welfare impacts on local communities which would result from coral reef and local fishery declines. This information can also be used to identify marginalized stakeholders, who may need to be compensated or to be targeted for education initiatives to inform them of the existence and magnitude of the economic benefits of the MPA, to increase local support. Improved understanding of local impacts of the MPA could also be used to understand and counteract illegal behaviour, to design or improve management actions whilst taking into account trade-offs between different types of uses and users, and in indentifying novel sources of funding for management.

The ability of MPAs to produce both socio-economic and ecological improvements is contingent on their ability to provide tangible economic benefits which are perceived local communities and to distribute costs and benefits equitably, so that conflict does not undermine management and compliance. In this chapter I assess the extent to which Gladden Spit Marine Reserve has generated tourism, fisheries and in-kind benefits for local residents, the extent to which these benefits have resulted in economic values and positive perceptions towards the MPA and the resultant implications for management and fundraising.

See also section 2.5 for background to this section.

6.2 Aims and objectives.

The aim of this chapter is to characterize and quantify the producer surplus (PS) and consumer surplus (CS) which Belizeans realised in 2007, associated with a coral reef MPA, the Gladden Spit Marine Reserve. Specifically, I estimate PS of the two major industries which occur at the reserve, which involve Belizean fishers and tour operators. This is used in this chapter to explore effects of fisheries restrictions on profitability of fishing inside the reserve. It is also used to quantify PS associated with tours at the reserve. I also quantify resident welfare gains (CS) associated with fishing, tourist trips and recreation at the reserve, compare their relative magnitudes and explore the drivers of these different values. This enables me to gauge the relative importance of economic benefits from local business activities, socio-demographic variables, reserve experiences and attitudes in determining local community attitudes and values for the marine reserve. I test for sensitivity to scope to validate the application of CVM to measuring several bundles of values associated with both one and several reserves. In addition, I examine the effect of the order of the series of WTP values and the effect of incorporating levels of certainty on the values obtained.

6.3 Methodology

6.3.1 The Community Survey.

6.3.1.1 Survey design.

Design of the community survey was informed by interviews with key informants, including the data collector for this survey, the head of the community council and the head of the fisheries co-operative. Focus groups were also carried out to understand the main uses and values local people have for the reserves. In addition to the valuation scenarios, the survey contained 6 sections, which concerned socio-demographic variables, fishing, tourism, experiences at marine reserves, attitudes and follow-up questions. Questions were included to gather information on household and respondent demographic variables, as well as to determine respondent opinions about marine reserves. WTP can be seen as a behavioural intention (Bateman et al., 2002), and behavioural intentions are determined by demographic variables and attitudes (Ajzen et al., 2004). The link between sources of income and WTP was of particular interest, as WTP should be constrained by income and so questions were included to determine the percentage of household income from tourism and fishing. Previous experiences with both the GSMR, other nearby reserves and the management body, and environmental knowledge were also quantified, as they would also be expected to determine WTP (Turpie, 2003).

Households were defined as families which pool their resources and were chosen instead of individuals, since they typically operate as one economic unit in the village. Focus groups revealed that residents had three major direct uses for the MPAs; fishing, tour trips and recreation. CVM was chosen, as it could be adjusted to look at a range of values in sequence and is under-utilised as a valuation tool for PAs in LDCs. A survey was designed and pilots used to ensure language, length etc was correct. WTP is advised as more conservative than WTA, due to being more incentive-compatible (Arrow et al., 1993) and since property rights do not currently lie with the local community (Bateman et al., 2002). As a result, the scenario was designed to ask households what they would be WTP to secure access to the reserve, for the three uses separately and for all uses, if all local users were required to pay. Follow-up questions were included to enable identification of protest responses. Protest responses occur when the stated bid is not representative of actual WTP, as respondents object to some aspect of the scenario, such as the payment vehicle, or the need to pay for good, hence giving zero responses, despite having values for the good in question. Categories were used for income and age to reduce the number of non-responses.

Surveys were written in basic English to ensure respondent understanding and minimize non-responses. Surveys were done face to face, by the same interviewer and included a non-response option, as recommended by (Arrow et al., 1993). Focus groups and pilots were also used to make sure the valuation scenario and other questions were clear to respondents (Bateman et al., 2002). A Map of the reserves (figure 2.8), as well as photos were included, so that all respondents had a minimum level of familiarity with the reserve, as familiarity has been shown to increase the accuracy of the WTP bid elicited (Mitchell & Carson, 1989). Other reserves were also shown in the map, to remind respondents of substitute sites. Since respondents were being asked a series of WTP questions, whose order was changed, drawings were also used, which made clear the good being valued for each question. Comparison of the WTP distributions for one use versus many at GSMR and versus many uses at several MPAs enabled a test of sensitivity to scope.

The final CVM script elicited 5 values per household (appendix 6.1), which involved a coercive payment which could be paid weekly, monthly or yearly, to be allowed access to the reserve for one or several uses. It was made clear that substitute marine reserves in other parts of the country were not affected, to ensure they were only stating their bids for one value and to remind them of substitutes. Without this payment, respondents were told there would be no active conservation management and that they would be excluded from the reserve. All three payment amounts were included on the payment card for comparison. The same payment card was used for all questions, which ranged from Bze$0 to Bze$300 per week (US$150), to avoid biases from different ranges. The payment card methodology minimises starting point bias. The values elicited were:

- Yearly fee per household to be allowed to fish in GSMR
- Yearly fee per household to be allowed to take tourists into GSMR
- Yearly fee per household to be allowed recreational access to GSMR
- Yearly fee per household for all access for any use in GSMR
- Yearly fee per household for all access for any use of 3 nearby marine reserves, including GSMR.

6.3.1.2 Data collection.

The survey was confined to the village of Placencia, as this was the village were most of the stakeholders lived and where a reasonable proportion of responses from the population could be collected. The survey was conducted by a local data collector. This was necessary to reduce the number of refusals and for more honest responses, as some respondents were concerned negative comments would be reported to the management body who would then limit their access. The survey was conducted over 2 months, in November and December 2007 and was administered to 152 respondents. A map of the village was drawn and was stratified into four sections corresponding to different ethnic and wealth groups. A sample size target was set for each section and each household given a number, which were picked out randomly each day without replacement. The interviewer then interviewed the first adult encountered at each house drawn from the lottery. The order of the WTP scenarios was switched each survey, as ordering effects were expected both in terms of the stated bids and the degree to which values are sensitive to scope (Clark & Friesen, 2006).

In total 152 surveys were conducted, which is 54% of the households in the village. As a result, this survey covers 535 people, 281 adults and 254 children. 56% were conducted in respondents' houses, the rest were at respondents' place of work or elsewhere in the village. For the WTP questions, 30% of respondents received the smallest (single good) WTP question first and 39% received it last. 60% had their responses shuffled so questions were given in random order, rather than goods getting progressively larger or smaller.

6.3.1.3 Econometric analysis.

Once data had been organized in a spreadsheet, they were checked for errors and summary statistics were generated using Intercooled Stata 8 and "R". WTP bids were compared using t-tests and the effect of levels of certainty on stated bids was analysed using ANOVAs. Nine protest responses were removed from the econometric analyses, as is standardly done, since they do not reflect respondent values (Whitehead, 1992). The raw WTP distributions were highly skewed and did not pass normality tests, so it was necessary to transform them, using the natural log of (WTP + 1). The full set of possible explanatory variables was examined. Survey variables were also created and included, such as the order of the questions and certainty of response. For those variables that were correlated over 0.75, only one was used, such as having purchased a fishing license and fishing inside the reserve. OLS were used for each econometric analysis, in order to generate parameter estimates for linear functions of model variables. Interactions between explanatory variables were also included, as were non-linear terms for variables including income. These were used to gain insight into determinants of different types of WTP.

The underlying models implicit in these analyses are;

$$\text{Ln (WTP + 1) = f (Sd, Ru, At, Sv) + e.}$$

Where Sd = socio-demographic variables, Ru = reserve use and experiences, At = attitudes, Sv= survey variables, e = error.

Regressions were carried out with robust standard errors. Explanatory variables in the initial variable selection were based on theory and previous research. Age and income variables were estimated given median values for the categories presented to respondents. Income should be expected to constrain WTP, and therefore its inclusion was important as a test of validity based on theoretical expectations (Bateman et al., 2002). Thus it was included in the core model, for each analysis. Backwards stepwise selection was used, when non-significant variables were removed (alpha=10%). Models were compared using analysis of variance and when removal of a variable changed the model significantly, it was retained. This resulted in the identification of a minimum adequate model (Crawley, 2007). Model checking involved testing assumptions including heteroscedasicity, normality of errors and constant variance; if any of these tests were failed in the models, the appropriate steps were taken such as variable transformation.

In addition to OLS models, quantile regressions were used to explore determinant of bids along the WTP distribution and to reveal non-linearities such as threshold effects (see chapter 5.3.5). The co-efficients give marginal change in WTP given a change in the independent variable, for some percentage of conditional WTP distribution. Quantile regressions were carried out for the WTP for all reserve access and the three reserves, at the 10-90% quantiles.

6.3.2 Fisher producer surplus estimates.

Several methods were necessary to gather data related to gross and net values for fishers fishing inside the reserve. Initially, key informant interviews and observations were used to understand fishing and market practises for fishers in the village and those using the reserves. Then a detailed fisher survey was carried out, a catch survey inside the reserve and analysis of the reserve patrol records.

Reserve patrol records made by the rangers were used to establish numbers of fisher days by type of fisher inside the main reserve in 2007. Patrol records existed for almost every day of the year and rangers estimate that they detect and record 95% of boats during these patrols. This enabled a good estimate of fisher days inside the reserve, although it is possible that the actual number of fisher days is marginally higher than recorded. The number of fisher days was calculated by using the number of fishers on each boat, which was recorded in the patrol records. The origin of the boat was noted, as Sartenejan and local fishers needed to be analysed separately, given their very different fishing patterns (chapter 2.5.6).

The catch survey was done on randomly selected dates over the course of a year, with a minimum of 4 days each month. It was conducted by rangers, who patrol the reserve each day. It involved approaching every fishing boat observed and noting the time and location, the reported number of hours or days the boat had been fishing, weighing and counting all fish caught, plus noting the number of fishers and the gears used. Since fishing here is legal, there was no reason for fishers to report biased information. These catch surveys were used to calculate mean catch per hour for local and Sartenejan fishers; during the spawning aggregations and during the rest of the year; when all fisheries were open, when the conch fishery was closed and when the lobster fishery was closed. Fishers were also asked when they would stop fishing that day. Hourly catch rates were then used to convert this to catches for each day. This could bias results up or down, as catches are not expected to occur evenly during the day, with periods of little activity and periods of high yields. However, to minimise this bias from using a small number of hours to extrapolate to the whole day, fishers were approached as close to the end of the day as possible. These figures were then used, by incorporating the number of fishing days recorded in each season, by type of fisher, to estimate the total volume of product caught and its gross values. It was not possible to get detailed cost information out at sea, as fishers refused to give long interviews. Rangers were only able to do surveys several days each month and illegal catches, which occur at night or were hidden in the boats, would not be included in the catch estimates. As a result, catch estimates are likely to be biased downwards.

The fisher survey was not done randomly, as it targeted those fishers known to be using the reserve. Initially, a list was made of all fishers who had used the reserve at least twice over the previous 2 years (using patrol records), which resulted in a list of 85 fishers. Every fisher was approached and 52 surveys were completed in 5 different villages; Placencia, Hopkins, Independence, Monkey river and Sarteneja. Those refusing surveys were thought to be those who have had negative experiences interacting with rangers in the reserve and those who dislike the management body. Five individuals had retired from fishing or moved house. The fisher survey took just over an hour and contained questions relating to household income sources, their use of the GSMR and attitudes towards the reserve and conservation. There were also detailed questions relating to the type of fish that they catch at different times of year, good, bad and typical catches per day, plus good, bad and typical incomes per fishing trip, as well as where they sold their catch and expected prices. Probable catches gross revenues were estimated assuming that fishers had good days 20% of the time, bad days 20% of the time, and "typical" levels the remaining 60%, since fishers indicated this was what they experienced. Probable catches are marginally higher than average catches, but detailed key informant interviews with fishers said they better reflect actual catches than average catches. Finally detailed information was collected on major fishing related costs; variable (per trip) fishing costs such as fuel and food, large investments in boats and gears, maintenance costs for fishing boats and engines and details as to the cost and maintenance of fishing gear. For investments in boats and engines, it was assumed, based on information provided during the focus groups, that they would last 12 years, at which time they could be re-sold for 10% of the initial cost, which is relatively conservative relative to the ranges reported during the focus groups of 5-60%.

PS estimates were calculated for each fisher. Both mean and median were used, due to the high variability of the data. For local fishers, earnings from crew were excluded from PS estimates, as locals fish with family members, who did not charge them. However, for Sartenejan fishers who own boats, crew payments make up a large proportion of the revenues used to cover the investment costs associated with boat purchases. Boat purchases would not be possible without these revenues and PS for boat owners would appear highly negative and crew member catches would be artificially upwardly biased, which is incorrect. Crew earnings for Sartenejan fishers were easily calculated, as each member of crew pays the boat owner 1lb of lobster per day on board (which is worth US$11 per day). Each fisher will then sell what fish remains after this "crew payment". During the surveys, boat captains recorded the number of crew. For crew who do not own boats, these payments were subtracted from their gross revenues.

This information was used to calculate average daily producer surplus for each fisher, using equations 1. 2 and 3;

Equation 1

Total annual revenues per fisher = sum of number fishing days * (0.2*poor daily catch + 0.2* excellent daily catch + 0.6* average daily catch) [- total annual payments to boat owner if crew] or [+ total annual payments from crew if boat owner].

Equation 2

Total costs per fisher = annualised boat and equipment costs + annual boat and equipment maintenance + annual boat use costs + annual variable costs

Equation 3

PS per day for 2007 = (total annual revenues per fisher – total annual costs per fisher)/ number of days fishing.

Mean annual and per fisher day PS estimates were generated for all types of fishers related to their fishing in general. Finally, the information was combined to estimate costs and revenues generated from the days fished inside the reserve. Given that the total number of fisher days inside the reserve in 2007 was known from the patrol records, this generated an estimate of total PS for all fishing inside the reserve in one year. This is likely to be an underestimate, as it does not include illegal fishing. Fishers may also have reported higher equipment and investment costs than actually incurred, as several mentioned that they were concerned that taxes would be increased based on my earnings calculations. The inclusion both of fishers who do and those that do not use the reserve in the community survey enabled some triangulation of reported incomes and other results.

6.3.3 Tour operator producer surplus estimates.

To estimate gross and net values generated by tourism, patrol records were analysed to count both the number of tourists, the number of tours and the number of crew involved in the reserve each month and for the year of 2007. Tourists that dived versus those that snorkelled were noted, as well as those who travelled with local operators and those that came through their hotels, as these distinctions were known to affect both prices charged and costs incurred for operators (see chapter 2.5.7). To gather detailed cost information from tour operators, face to face open ended interviews were conducted, each of which took around 45 minutes. All operators who were open at the time of the surveys were interviewed (14 out of 21 operators). These interviews gathered information on operator-specific costs and prices. Cost information was gathered in two categories; costs associated with trips to the reserve, including boat hire, crew payments, food, fuel, etc. and business costs associated with the operator. These included both annual recurring costs such as advertising, insurance, permits, shop and / or land leases, gear purchase and servicing and the larger investments of boats, engines and premises. For large investments, it was assumed that they would last 12 years, at which time, they could be re-sold at 10% of the initial costs. Again this was based on respondent information and was a conservative assumption, which means that costs may be slightly upwardly biased. Costs to producers varied, depending on the levels of investment in shop, boat(s), diving equipment and the number of permanent staff. Prices for trips to the reserve also varied between operator, necessitating individual PS estimates.

Annual gross revenues at the reserve were calculated using equation 4, PS using equation 5. This enabled an estimate of aggregate annual PS for the operators using the reserve.

Equation 4

Gross revenues =Sum No. Tickets sold (by operator type; hotel or local and trip type; dive or snorkel) * mean price (by operator type and trip type).

Equation 5

Producer surplus = gross revenues – sum (trip costs per passenger * number of passengers) – sum (mean annual recurring costs, by type operator * no of operators) – sum (mean annualized investments, by type operator * no of operators).

6.4 Results

6.4.1 Community Survey

Roughly half of the respondents were male and respondents were from a range of age groups (see appendix 6.2 for main socio-demographic results). Households had a mean of 3.5 people, including 1.7 children. This is lower than the average for Belize of 4.5 (McPherson, 2005). 17% of respondent households were members of an environment-related group, such as the humane society or the fishing co-operative and 14% were a member of a tourism group. Just over half of all households did not own any type of boat, 36% owned a single boat and 10% more than one boat. Three wealth categories were developed with the data collector (appendix 6.3). The majority (70%) of respondents fell into the medium wealth group, 8% into the low and 22% into the high wealth category. Respondents had spent a mean of 27.7 years in Placencia (ranges from 2 to 78, SD = 16), which represented a mean of three quarters of their life, with 25% having been there all their life and 13% less than 20% of their life. Although a few respondents were retired, only one was unemployed, which is much below the average of 11% unemployment in Belize in 2000 (McPherson, 2005). 69% of respondents owned their property and 47% were self employed.

34% of households had a member who fished for food, of which 41% did so out at the cayes, and who caught an average of 5kgs of seafood per week, although this was very variable (range 0-114kgs, SD=16.4). Of the 37 people who fished regularly, 9.2% sold fish in the co-operative, 15.3% sold directly to local shops or restaurants and 71.1% of the remaining fish was given away or eaten. For lobster and conch, 60% was sold to the co-op, 11.1% in local markets and 28.9% was eaten or given away.

Ten respondents would not give their incomes. For those who did, there was a wide range of incomes (appendix 6.4) from a wide range of sources (appendix 6.5). Mean annual household income was US$26,208 per annum (Bze 52,416), with a median of US$15,340 and a range of US$1,040-182,000. The highest incomes were those of non-native but resident Americans. The mean annual income per adult was US$14,638 or Bze$29,276 (median US$14,100per annum), which is almost three times higher than the average for Belize of US$5,136 per annum (McPherson, 2005). Households characterised as low wealth had low incomes ($f=6.4$, $df=1$, $R^2=4.6\%$, $p=0.013$), and those with high wealth had high incomes ($f=45.3$, $df=1$, $R^2=25.4\%$, $p=0.000$). Households with higher incomes had more adults, were more likely to own their house and to be self employed and work in a tourism related job (appendix 6.6).

In terms of the source of household income, there were many types of jobs (appendix 6.5). Tourism (defined as jobs directly involved in the tourist trade: e.g. hotel manager, tour operator) represented the main source of income for 45% of households and provided a mean of 66.3% of all family income. Indeed 43% of the sample households relied entirely on tourism for their incomes, whilst only 16% relied in no way on tourism. In contrast only 5% of households relied on fishing for their main source of income. Fishing made up a mean of 3.2% of all household income, with 3.3% of households getting over 50% of their income from fishing and 93% getting none. This is low for the Caribbean region (Loper et al., 2008). Households whose main income was from tourism earned US$36,080 per annum, which is double that of other households (f=13.2, df=1, R^2=9%, p=0.000). Households whose main income was from fishing had a mean household income of US$22,256 per annum, although this was not significantly different from households whose main income was not from fishing. Percentage of income from fishing was related to the level of education (f=4.83, df=1, R^2=3.2%, p=0.029). Fishing constitutes a mean of 5.3% of the income of respondents with low education, compared to 0.4% of those with higher education levels. Income if self employed is US$38,300 per annum compared to US$16,016 if not (F=21.5, df=1, R^2=13.3, p=0.000).

6.4.1.1 Experiences at the reserve or with FoN.

68% of local people had been to GSMR, 48 times on average (ranging from 1 to 320 visits). Annually, all respondents made a total estimated 3000 tourist trips, over 1100 fishing trips and just over 1000 for recreation. Tourist and fishing trips were concentrated among a small number of households, unlike recreational trips (figure 6.1). Reasons given for those who had never visited the reserve were either that they were not sure why, they had no interest or it was too far away and too expensive. For the Laughing Bird Caye (LBC) MPA, respondents had carried out a mean of 27 visits and for Glovers Reef respondents had only carried out a mean of 4 trips per household (figure 6.1). These were not unexpected results, as LBC is the closest to the village and Glovers the farthest, and fishing is banned in LBC.

In terms of involvement with the NGO, only 5% of respondents said someone in the house had been part of a consultation and 7% had benefitted from a school trip there. Almost 16% of households had benefitted from fisher workshops or exchanges, 12% from alternative livelihood initiatives and 10% had done the whale shark training course. Almost 12% of households had volunteered in some way. None of these were highly correlated, apart from fishing workshops and alternative livelihood schemes (chi2=0.68, p=0.000). 53% of households had attended environmental talks, and 45% were given by FoN. In terms of reserve knowledge, respondents knew a mean of 2.4 reserves. When asked to name reserves, 97% of people mentioned LBC, 79% GSMR and 30% Glovers Reef.

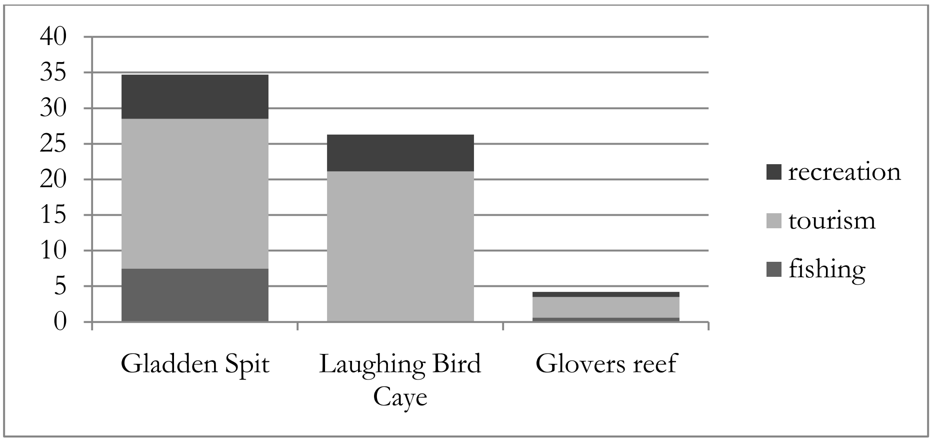


Figure 6.1. Mean number of visits for each reserve for the sample community.

When asked how the establishment of the GSMR had affected their household (appendix 6.7), 55% of responses mentioned things that had a positive impact, such as more work or income, more tourists and trips to the reserve. 14% had experienced a negative impact from fishing restrictions and interactions with rangers and 31% reported neutral impacts. Almost 7% of all households and 16% of people who fish for income reported changes in their fishing patterns caused by the reserve. Special licenses to fish within the park had been bought by 5.3% of households. Of those who fished for income, 6.5% of the total yearly catch was estimated to come from inside the whale shark zone and 4.2% from the rest of the reserve.

6.4.1.2 Attitudes.

69% of respondents said tourists came to Placencia for beaches, cayes and marine life. Other answers included the weather, the availability of tours, the food and local atmosphere. When questioned as to the disadvantages and advantages of tourism, respondents mentioned an average of 2.1 benefits and 1.3 disadvantages from tourism. The most common advantages (figure 6.2) seen were increased income and employment, although other collateral benefits such as increased development, better lifestyles and imported goods were also mentioned. Costs of tourism were cited as crime, pollution, increasing prices for goods, and village overcrowding (figure 6.3).

Only a quarter of respondents felt that the reefs were very badly threatened, 47% that they were somewhat threatened and 13% not at all threatened, with 15% being ambivalent. In terms of what threats residents thought were most serious in terms of reef damage, 72% cited pollution, 43% over-development for tourism, 20% severe weather, 9% over-fishing, 7% shrimp farms and 7% tourists.

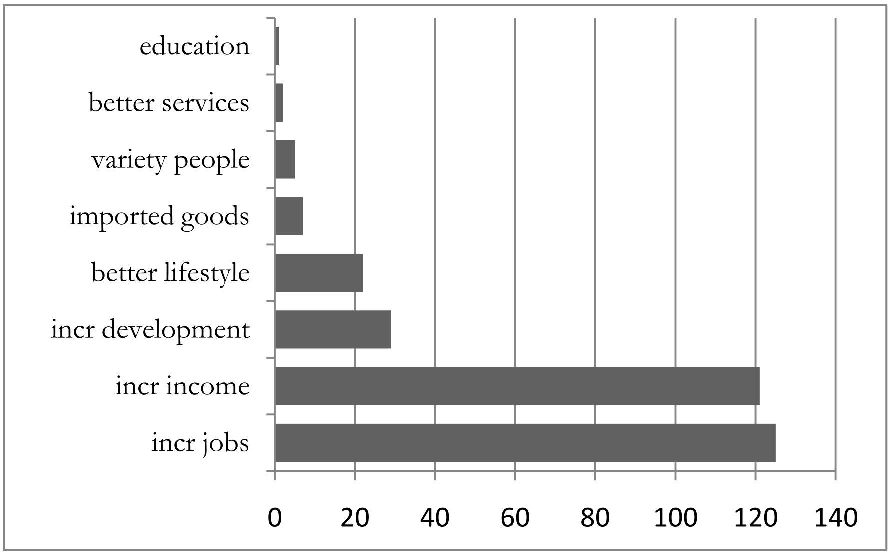


Figure 6.2. Benefits of tourism for the local community.

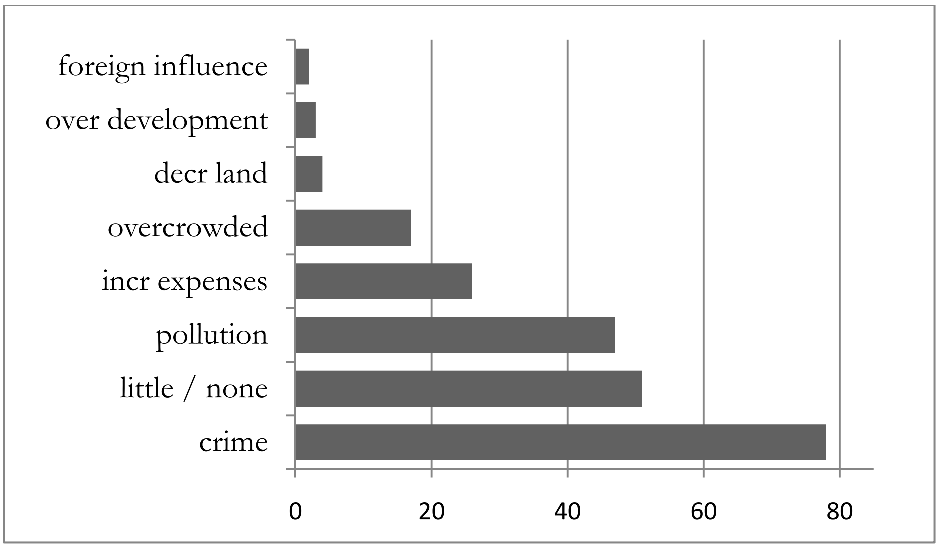


Figure 6.3. Costs of tourism for the local community.

When asked what benefits MRs provide, 56% said more tourists and 26% more income and 9% tourist control. Around 6% also mentioned funding for conservation, education, fishing improvements and revenues for the government. The key beneficiaries were seen as being the village of Placencia (77% of responses), NGOs (64%), the Belizean government (45%) and tourists (30%). 34% of respondents felt that marine reserves had no costs. Those who did see costs mentioned the expense involved, poor management, aggressive rangers, restrictions and corruption. When asked who were the people who lost out as a result of reserves, 55% of respondents said fishers and 33% no-one.

Respondents were asked about the extent to which they thought marine reserves in general and GSMR were helpful in various aspects. Responses were marginally less positive in terms of threat abatement and coral protection; however over 68% thought reserves were very helpful for these issues. Almost 80% felt that reserves did help fisheries, 85% that GSMR helped increase tourism.

When asked what would happen if local marine reserves were degazetted (figure 6.4), most respondents thought it would have negative consequences for Placencia, especially coral damage and reduction in the number of tourists, as well as loss of jobs and increased conflict and development. However, 27% thought there would be little effect and four respondents thought it would be a good thing.

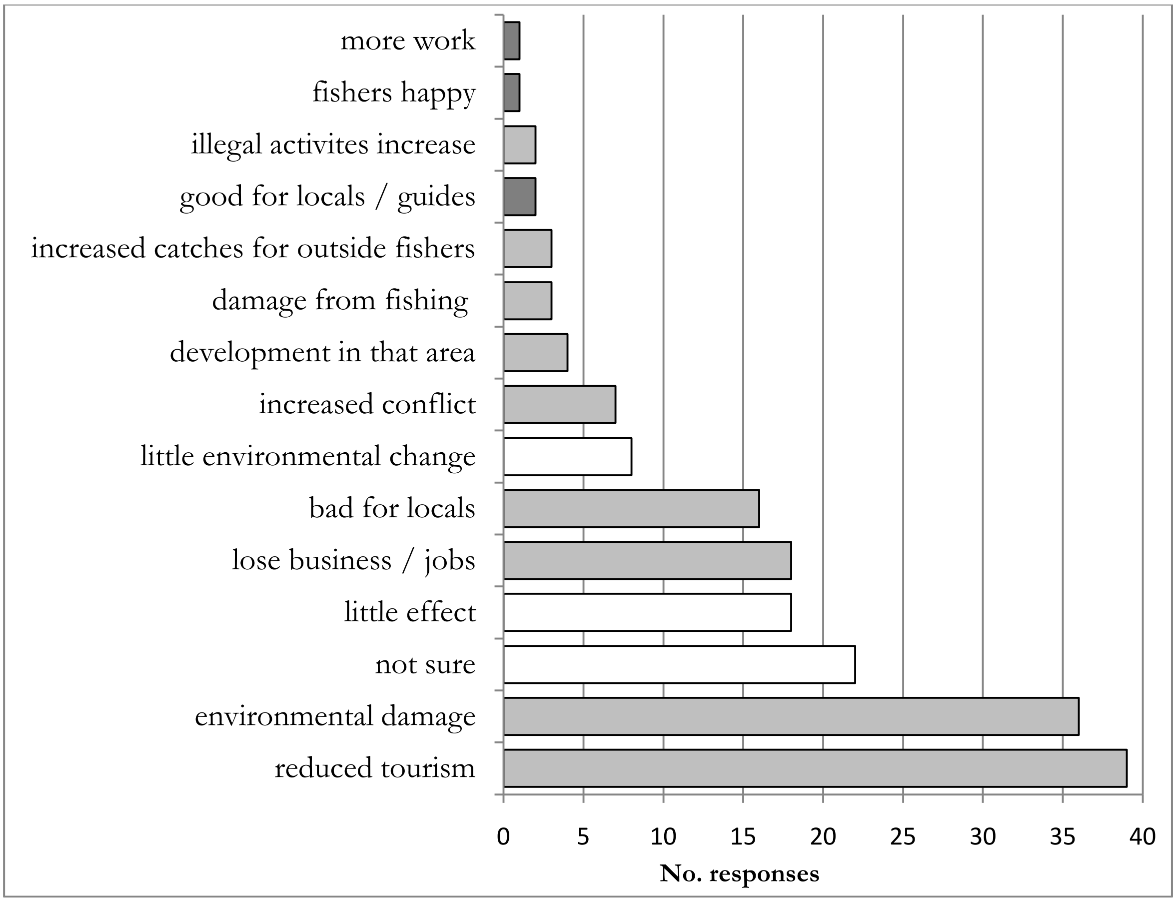


Figure 6.4. What would be the effect of degazetting the marine reserves? Note: positive effects are denoted by dark grey bars, neutral responses in white bars and negative responses in light grey bars.

In terms of how management could be improved, 38% said having friendlier rangers, 34% increased patrols or fishing regulation and 24% more research. In terms of the local community, 34% mentioned increased education, 16% increased consultation and 7% increased transparency in terms of use of funds and enforcement of regulations.

6.4.1.3 Willingness to pay for local Marine Reserves

Respondents were asked a total of 5 valuation question, in various orders. Protests were identified from follow up questions and included answers such as "they have no right to make people pay for this", "these things are priceless" and "this it is our right to have free access". Legitimate zero responses were also identified, including answers such as "I cannot afford to pay", "this does not benefit me", "this is not important", "I do not use these areas". The valuation scenario produced very few protest responses and legitimate zero responses, although these varied by type of value. Payment for recreational access produced the most protest responses (6%), but payment for recreation access produced the most zero responses (15%), followed by recreation (3%) and tourism access (2%). Follow up questions showed respondents think that recreational access should be free.

The numbers of zero and protests bids are presented with the mean WTP for each scenario in table 6.1. Figure 6.5 shows the relative size of each value elicited. Of the use values, tourist access was the highest, followed by fishing. The difference between the overall value of the reserve and the three use values corresponds to "other" values, such as non-use values, which are calculated at Bze$12.20 per household per year. In total, households would be WTP a mean of US$373 per year to access and support the GSMR. They would also be WTP almost double that, to support the group of three neighbouring reserves. T-tests showed that each WTP value stated was significantly different from the other (appendix 6.8) and the magnitudes are in the expected direction, confirming that respondents are sensitive to scope. However, WTPs at different levels of certainty are not significantly different (appendix 6.9).

Table 6.1. Responses for each WTP valuation Scenario and for Each Level of Respondent Certainty. For responses, the actual number of responses is given first, with the percentage in parentheses. For WTP result the bids are given, with the number of responses for each category in parentheses.

		Fishing	Tourism	Recreatio n	All access GS	All access all MRs
Responses	**No. protests**	4 (3%)	3 (2%)	9 (15%)	2 (1%)	3 (2%)
	No. zero bids	26 (17%)	8 (5%)	13 (9%)	6 (4%)	4 (3%)
	No. +ve bids	131	140	129	143	144
WTP (N)	**All responses**	16.8 (151)	28.9 (151)	13.0 (151)	61.8 (151)	121.5 (151)
	All (no protests)	17.2 (148)	29.5 (148)	13.8 (142)	62.2 (150)	123.1 (149)
	75-100 certain	17.5 (108)	32.6 (106)	12.7 (103)	66.2 (99)	129.2 (98)
	50-100% certain	17.4 (143)	31.0 (142)	13.2 (143)	63.5 (144)	122.3 (143)
	25-100% certain	16.9 (149)	29.1 (149)	13.0 (149)	62.0 (149)	121.7 (149)

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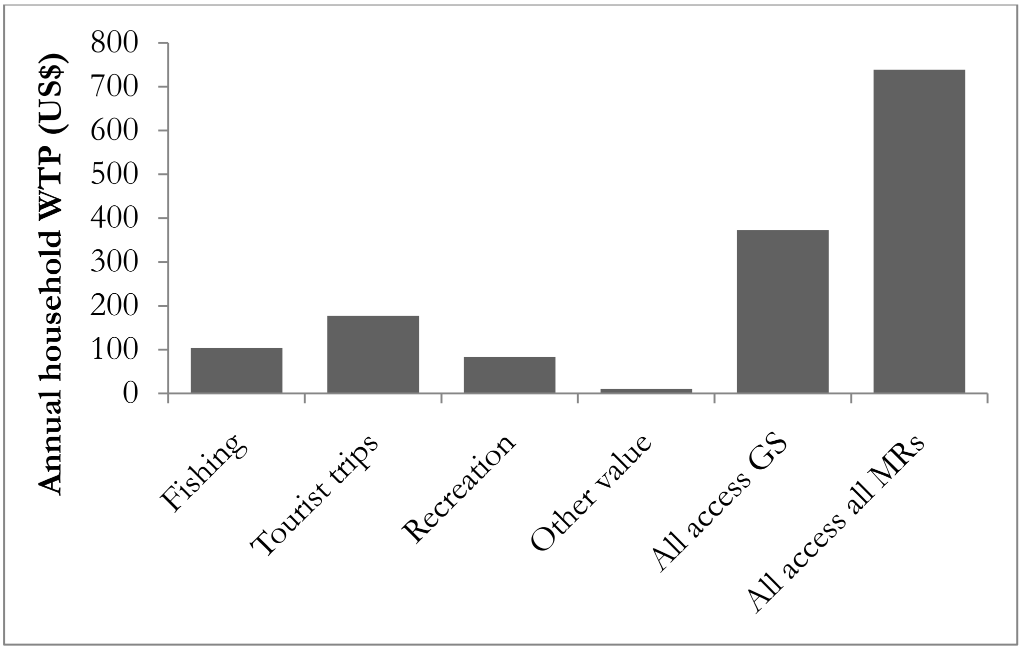

Figure 6.5. Annual household WTP (US$).

Mean household values without protests, were aggregated for the village population, excluding protest responses. The local data collector counted 280 households in Placencia. Gross values for fishing in the reserve are US$23,000-50,000 for each use alone (table 6.2). The percentage of household income that the total bid for GSMR represents (based on the median for the income category reported) represented a mean of 1.9% of household income, which whilst being large, is not unreasonable. Fishing and tourist access accounted for 0.5% and 0.8% of household income respectively and recreational access for 0.4%. All access to all reserves was the most variable, but also the highest proportion of income, which also demonstrates sensitivity to scope.

Table 6.2. Aggregated values and equivalent percentage of stated household income for marine reserves near Placencia.

	Fishing	**Tourist trips**	**Recreation**	**Non-use GS**	**All access GS**	**All access all MRs**
Annual household WTP (no protests) in US$	103.2	177	83	10.2	373.2	738.6
Max % of income	5.4%	5.4%	3.3%	1.2%	8.1%	19.2%
Mean % of income (SD)	0.5% (0.008)	0.8% (0.01)	0.4% (0.005)	0.2% (0.001)	1.9% (0.02)	3.9% (0.04)
Aggregate values (US$)	**28,896**	**49,560**	**23,184**	**2,856**	**104,496**	**206,808**

6.4.1.4 Econometric analyses.

The econometric models for the factors affecting local values for the reserve explain 36-51% of the variation in WTP bids (table 6.3). Income and wealth limit WTP, suggesting the models are theoretically valid. Concern as to the level that these reefs are threatened was also significant for in terms of tourism and fisheries values, but not for recreational values, which may reflect an underlying belief that coral quality is not as important for recreational uses. Use of substitute sites (the other reserves) was not significant, which was unexpected. Having done the whale shark training, or participated in an alternative livelihood scheme or reported a positive impact as a result of reserve designation were also not significant predictors of values. For two of the three values, increased certainty resulted in lower values, which suggests that mean WTP may over estimate actual values. Overall, fisheries values are largely affected by variables relating to fishing and tourist values are related to tourism variables. However, recreational values show evidence of being associated with perceived benefits beyond recreational benefits, which may indicate that WTP for recreation also incorporates values for general conservation and management of this area.

Table 6.3. Econometric analysis for the three Use Value at the Gladden Spit Marine Reserve Using Ordinary Least Squares Regression. Co-efficients for each variable are followed by p-values in parentheses. *** =p<0.001, **=p<0.05, *=p<0.01.

Variable type	Variable name	Log WTP fish access GS	Log WTP tourism access GS	Log WTP recreational access GS
	Constant	1.44 (0.000)***	0.1284 (0.088)*	1.062 (0.000)***
Household socio-demographic variables	Low wealth	-0.601 (0.001)***	NA	-0.498 (0.000)***
	Income per household	0.0008 (0.048)**	0.00014 (0.001)***	0.0001 (0.037)**
	Income per household²	NA	-0.00006 (0.005)***	NA
	% income from tourism	NA	0.002 (0.081)*	0.002 (0.039)**
	Adults per household	NA	0.085 (0.077)*	NA
	Self employed	NA	0.189 (0.021)**	NA
Gladden Spit MR	Fish in cayes	0.398 (0.011)**	NA	NA
	Fish in whale shark zone	NA	NA	-0.008 (0.052)*
	No. visits GS	-0.002 (0.006)***	NA	NA
	Volunteer at GS	0.371 (0.021)**	NA	NA
	Was part of consultation	0.429 (0.060)*	NA	NA
	% of trips to GS for fishing	NA	-0.002 (0.067)*	NA
	No. recreation trips to GS	NA	NA	0.010 (0.064)*
Attitudes	Reefs are threatened	0.277 (0.009)***	0.283 (0.002)***	NA
	Fishers lose from MRs	-0.197 (0.034)**	NA	NA
	% costs should be paid by tourists	-0.006 (0.036)**	NA	NA
	Marine reserves improve education	NA	NA	0.265 (0.013)**
	Marine reserves bring tourists	NA	NA	0.148 (0.035)**
	Marine reserves help improve coral	NA	NA	0.179 (0.030)**
	Tourism is excellent for Placencia	NA	0.195 (0.057)*	NA
	% costs should be paid by Placencia	NA	NA	0.005 (0.005)***
Survey variable	75-100% certain of stated WTP	-0.172 (0.019)	NA	-0.179 (0.000)***
	First WTP asked	NA	NA	0.228 (0.000)***
Model Parameters	N =	124	136	112
	F=	6.31	8.34	9.37
	R^2 =	36%	37%	51%
	P =	0.000	0.000	0.000

In terms of WTP for fisheries access to the GSMR, the small number of households classified as low wealth, who also had low incomes, had smaller WTP (table 6.3). Those who fished out at the Cayes (near the reserve), those who had volunteered for FoN or who have been involved in consultations and those who believe that reefs are currently threatened have a greater WTP for fisheries access. Those who had visited the reserve often had a lower WTP for fisheries access, as did those that thought that reserves should be funded by tourists and that fishers suffer as a result of the reserve. Finally, those who were more certain of their stated WTP had lower bids. These results are in the expected direction for all the variables, except that those who use the reserve more might be expected to have higher WTP.

For tourism access (table 6.3), income showed a quadratic relationship with WTP. Households with a greater number of adults had higher WTP for continued tourist trips to GS, as did those who relied on tourism for a great percentage of the household income and those who were self employed, as would be expected. Similarly, respondents who believed that reefs are currently threatened and that tourism is an excellent thing for Placencia had a higher WTP for tourism use. However, those who used the reserve most for fishing had lower WTP for tourism there, indicating a possible trade-off between fishing and tourism. All of the co-efficients are in the expected directions.

In terms of recreational access to the reserve (table 6.3), increased wealth and incomes resulted in higher WTP. Those households who received a greater proportion of their income from tourism had higher WTP, as did those who have used the reserve more for recreational trips. However, fishers who fished in the whale shark zone, where permits must be purchased, had lower WTP for recreational trips. Positive opinions about the effect of reserves on education, tourism and coral quality also increased stated WTP. When this WTP was asked first, it resulted in higher bids than otherwise. Those who were more certain of their stated WTP had lower bids.

The econometric analysis for all access and support of the reserve and for all uses for the 3 local reserves (table 6.4), shows that WTP is similarly constrained by income and wealth, as was expected. Values for the GSMR are significantly related to experiences at the reserve in terms of fishing, tourism, and indirect (tourism) benefits of the reserve, but not by use of the substitute sites. In contrast, those variables related to wider benefits of tourism and the use of the other two reserves are significant for the values for local reserves. Attendance at environmental talks is related to more positive values for both, although the direction of causation is not established. Again, the negative co-efficient for certainty suggests that respondents who are less sure have overstated WTP.

For the values associated with all use and support of GSMR (table 6.4) those from low wealth groups have lower WTP. WTP also has a quadratic relationship to income. Those who fish inside the reserve, who have benefitted from fisheries workshops and those use the reserve more for tourist work and who believe that tourism offers many benefits to the village of Placencia, all have higher WTP. Those who have already paid for special licenses at the reserve have lower WTP, which is as expected, since FoN collect fees from them already.

When analysing the determinants of WTP for all 3 marine reserves (table 6.4), wealth and income show the same relationships. Those who rely to a greater extent on tourism for incomes, who fish inside the reserve and those that have attended environmental talks by FoN, all have higher WTP. The number of recreational trips to the other 2 reserves has a positive relationship to WTP, although trips for other kinds of visits (tourist or fishing trips), do not. In addition, those who believe that tourists are attracted to this area because of the whale sharks, and that tourism brings benefits in terms of increased employment and imported goods, also have higher WTP. Again, those most certain of their responses have lower WTP, which suggests that mean WTP may over estimate actual values.

Table 6.4. Econometric analysis for all access to the GSMR and all access to all three marine reserves. Co-efficients for each variable are followed by p-values in parentheses. *** =p<0.001, **=p<0.05, *=p<0.01.

Variable type	Variable name	Log WTP to support all uses GS	Log WTP support all uses marine reserves
	Constant	1.600 (0.000)***	1.79 (0.000)***
Household socio-demographic variables	Low wealth*	-0.582 (0.000)***	-0.605 (0.001)***
	Income per household	0.003 (0.006)***	0.0003 (0.023)**
	Income per household^2	-3.721 (0.049)**	-0.00004 (0.086)*
	% income from tourism	NA	0.002 (0.074)*
Gladden Spit MR	% of visits to GS for tourist work	-0.003 (0.049)**	NA
	Fish inside GS*	0.011 (0.030)**	0.009 (0.078)*
	Attended fish workshops*	0.263 (0.082)*	NA
	Attended environmental talk(s) by FoN*	0.160 (0.062)*	0.178 (0.059)*
	Bought special license*	-0.595 (0.013)**	NA
	No. recreational trips to LBC last year	NA	0.018 (0.023)**
	No. recreational trips to GRMR last year	NA	0.075 (0.025)**
Attitudes	Tourism is excellent for Placencia	0.256 (0.015)**	NA
	Tourism increases employment*	NA	0.214 (0.077)*
	Tourism increases availability of imported goods	NA	0.399 (0.051)*
	Tourists come to Placencia to see whale sharks	NA	0.244 (0.055)*
Survey variable	75-100% certain of stated WTP	-0.155 (0.022)**	-0.178 (0.017)**
Model Parameters		N = 127 F = 7.24 R^2 = 41% P = 0.000	N = 125 F = 6.50 R^2 = 41% P = 0.000

Quantile regressions were used to understand the determinants along the full range of values for both the GS values (table 6.5) and for all three marine reserves. The first quantile regression suggests that income is more important as WTP gets higher, whereas low wealth has an effect throughout the range of WTP. Experiences at the GSMR and attendance at fish workshops exert more of an effect at low WTP. Attitudes are most important at median WTP. Certainty of stated bid is marginally significant only for the lowest 10% of the bids, suggesting that increased certainty reduces bids more for lower bids.

Table 6.5. Quantile regressions for total access to GSMR. Co-efficients for each variable are followed by p-values in parentheses. *** =p<0.001, **=p<0.05, *=p<0.01.

Log WTP support all uses GS		**10% Quantile**	**35% quantile**	**50% quantile**	**65% quantile**	**90% quantile**
	Constant	1.271 (0.003)***	1.219 (0.000)***	1.228 (0.000)***	1.555 (0.000)***	2.098 (0.002)***
Household socio-demographic variables	Low wealth*	-0.796 (0.040)**	-0.506 (0.003)***	-0.303 (0.025)**	-0.248 (0.182)	-0.549 (0.037)**
	Income per household	0.0001 (0.261)	0.0002 (0.022)**	0.0001 (0.072)*	0.0003 (0.013)**	0.001 (0.000)***
	Income per household^2	0.00001 (0.591)	-0.000001 (0.95)*	0.00003 (0.196)	-0.00004 (0.032)**	-0.00001 (0.000)***
Gladden Spit MR	% of visits to GS for tourist work	-0.008 (0.049)**	-0.003 (0.027)**	-0.002 (0.115)	-0.003 (0.084)*	0.002 (0.474)
	Fish inside GS*	0.016 (0.000)***	0.011 (0.000)***	0.011 (0.000)***	0.007 (0.074)*	0.008 (0.099)*
	Bought special license*	-0.739 (0.001)***	-0.587 (0.004)***	-0.744 (0.000)***	-0.489 (0.070)*	-0.029 (0.916)
	Attended fish workshops*	0.703 (0.004)***	0.231 (0.072)*	0.174 (0.135)	0.149 (0.419)	-0.159 (0.500)
	Attended talk by FoN*	0.135 (0.471)	0.141 (0.119)	0.236 (0.002)***	0.279 (0.013)**	0.059 (0.764)
Attitudes	Tourism is excellent for Placencia	0.347 (0.098)*	0.218 (0.032)**	0.269 (0.002)***	0.226 (0.085)*	0.24 (0.905)
Survey variable	75-100% certain of stated WTP	-0.211 (0.065)*	-0.067 (0.340)	-0.029 (0.605)	-0.106 (0.190)	-0.118 (0.509)
	R2	33%	21%	24%	26%	27%

A similar pattern emerges when looking at the effect of each variable on overall WTP for all the local reserves (table 6.6), as while low wealth is most important at low WTPs, income affects high WTP most. Again, experiences at marine reserves have most impact at low WTP, whereas attitudes related to tourism affect the range of WTP values differently. Certainty of bid has a minor and patchy impact on WTP.

Table 6.6. Quantile regressions for total access to three local marine reserves.

Co-efficients for each variable are followed by p-values in parentheses. *** =p<0.001, **=p<0.05, *=p<0.01.

Log WTP support all uses all marine reserves		10% quantile	35% quantile	50% quantile	65% quantile	90% quantile
	Constant	1.682***	1.334 ***	1.285 ***	1.995 ***	0.809 ***
Household socio-demographic variables	Low wealth*	-1.108 (0.000)***	-0.402 (0.066)*	-0.457 (0.012)**	-0.429 (0.060)*	-0.389 (0.244)
	Income per household	0.0003 (0.103)	0.0002 (0.119)	0.0003 (0.020)**	0.0003 (0.027)**	0.0004 (0.017)**
	Income per household^2	-0.00004 (0.165)	-0.00004 (0.168)	-0.000003 (0.088)*	-0.00003 (0.090)*	-0.00005 (0.068)*
	% income from tourism	0.001 (0.624)	0.002 (0.188)	0.002 (0.069)*	0.002 (0.152)	0.002 (0.426)
Reserve experience	Fish inside GS*	0.017 (0.086)*	0.013 (0.001)***	0.009 (0.011)**	0.006 (0.192)	0.006 (0.359)
	Attended environmental talk(s) by FoN*	0.096 (0.671)	0.265 (0.013)**	0.099 (0.298)	0.198 (0.098)*	0.101 (0.507)
	No. recreational trips to LBC last year	0.160 (0.000)***	0.021 (0.004)***	0.018 (0.005)***	0.009 (0.249)	0.00002 (0.998)
	No. recreational trips to GRMR last year	0.031 (0.001)***	0.032 (0.418)	0.058 (0.079)*	0.058 (0.130)	0.029 (0.391)
Attitudes	Tourism increases employment*	0.198 (0.449)	0.133 (0.338)	0.238 (0.049)**	0.357 (0.016)**	0.356 (0.014)**
	Tourism increases availability of imported goods	0.512 (0.016)**	0.420 (0.072)*	0.409 (0.045)**	0.433 (0.013)**	0.395 (0.054)*
	Whale sharks are key reason for tourism	0.421 (0.005)***	0.244 (0.079)*	0.178 (0.156)	0.355 (0.022)**	0.095 (0.456)
Survey variables	75-100% certain of stated WTP	-0.274 (0.051)*	-0.073 (0.402)	-0.016 (0.833)	-0.209 (0.020)**	-0.071 (0.718)
	R2	39%	21%	23%	23%	24%

6.4.2 Economic Analysis of Fisheries at GSMR

I now turn to results from methods used to calculate the producer surpluses generated for fishers using the reserve.

6.4.2.1 Patrol records

GSSCMR's excellent patrol records enabled a good understanding of the number and type of fishers visiting the reserve (figure 6.6). In total, in 2007 there were 556 boats, with 3453 fishers. Local fishers who fish in small numbers from small boats, made up 33% of the boats, but only 12.4% of the fisher days. In contrast, the Sartenejan fishers accounted for 374 boat days, but these involved 3000 fishing days. The local fishers use the reserve most in March to June and in December, when spawning aggregations occur inside the reserve. Sartenejan fishers come all year, but even more frequently from June to December, when there are fewer tourists.

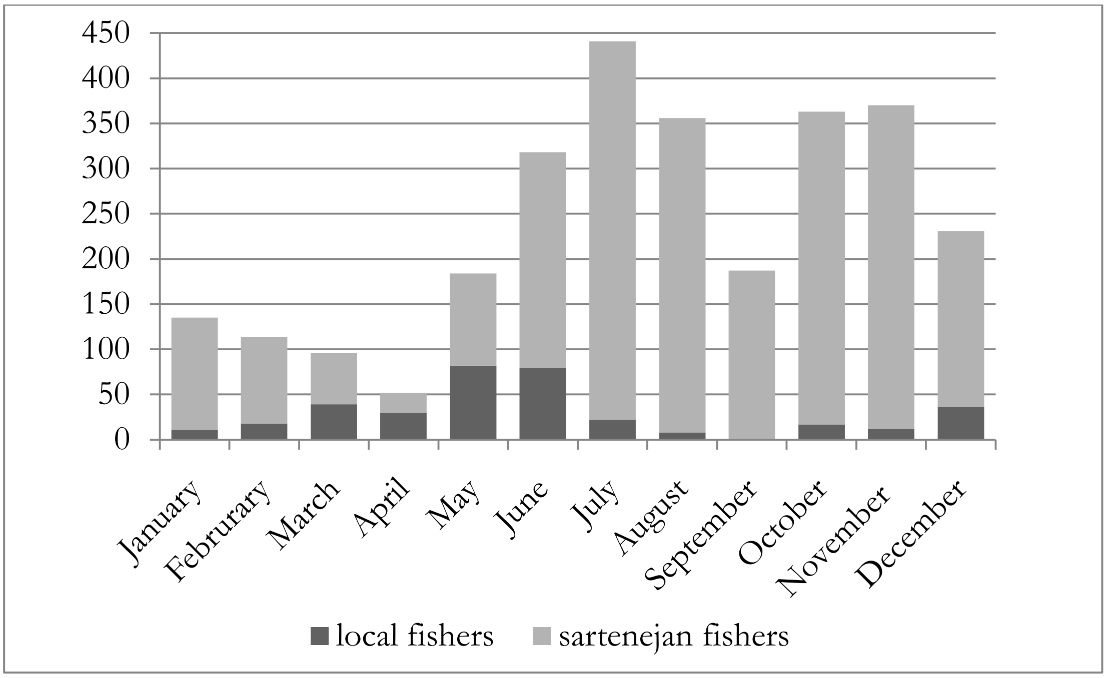

Figure 6.6. The number of fisher days, by type of fisher in the GSSCMR each month in 2007.

6.4.2.2 Fisher Survey.

Fishers who were interviewed had spent an average of 35 years in their villages and had fished a mean of 27 years. There were a mean of 4.5 people in their houses; 2.5 children and 2 adults per house, which was similar to the household survey. 98% of respondents fish for income, 87% for food and 52% for pleasure. In general, 62.4% of personal income came from fishing (ranging from 5 to 100%), this represented 45% of the total household income (ranging from 3.8 to 100%). Residents of Placencia had lived fewer years in Placencia (28), suggesting that immigrants are less likely to be involved in the fishing industry. They also have fewer people (3.7) and fewer children (1.7) per household, have only 3.2% reliance on fishing for income and are less likely to fish for food (17.4%). Whilst fishing constituted 89% of personal and 76% of household income for Sartenejan fishers, it was less important for local fishers, making up 56% of personal and 37% of household incomes. Indeed 72% of Sartenejans rely on fishing for 100% for their income, compared to 30% of local fishers.

Fisher attitudes (appendix 6.10) showed that a 39% of fishers had perceived fisheries declines as a result of the reserve being established, compared to 50% that had not. However, 61% thought that catches were better near the no-take area than in other areas of the park, suggesting spill-over might be occurring, as the no-take site was chosen due to its suitability as a tourist picnic location, rather than because it was a very productive area. The large majority (77%) felt the reserve was helping to improve fisheries, that management was necessary (96%) and that coral reef declines would affect them personally negatively (85%). Nevertheless, 67% felt that illegal fishing was a serious threat to the reserve. In the community survey there was evidence of trade-offs between fishing and tourism. Among fishers, 44% thought that tourism negatively affected their catches. Nevertheless, 82% agreed that tourism was a good thing and wanted it to continue to grow.

There are four major types of fish products targeted during different seasons which fetch different prices (appendix 6.11). Fishers carried out a mean of 177 day fishing per year (range 8-300). Fish are caught for the most months, with catches from 19-98kg per day for local fishers (mean 48kg) and 3-24kg per day for Sartenejan fishers (mean 11kg), who opportunistically catch fish using spear guns, which are less efficient. As a type of triangulation, fishers were asked both about average earnings per day and average volumes of catches. These were found to correspond very well (appendix 6.13). Locals target lobster 6 months a year, with a mean daily catch of 9kg, compared to 6kg for Sartenejan fishers, who target lobster for the 9 months the season is open. Conch are targeted over fewer months, generating a mean daily catch of 19 and 12kg respectively. Revenues from fish depend on where they are sold and if they have been filleted (appendix 6.15). Respondents reported selling a mean of 45% of fish and 86.6% of conch and lobster to co-operatives, eating 15% of fish and 4% of conch and lobster they catch. The remaining 40% of fish and 10% of conch and lobster is sold locally, meaning that fisheries estimates from co-operative data are a considerable underestimate. Respondents fillet on average 55.8% of fish and 74.8% of conch and lobster, which influences fisher revenues.

The two types of fishers differed in many aspects, which affect both costs and revenues they experience (table 6.7). Local fishers did many short trips with a few people sharing a boat, as well as a mean of 17 days of tourist related work inside the reserve. They had gross annual earnings from fishing of approximately Bze$48,000 (US$24,000) and gross annual costs of over Bze$12,000 (US$6,000). Fishing revenues were made up almost exclusively from fish sales. Trip costs were a mean of Bze$57 per person per day and equipment costs were a mean of US$225 per year. Their mean annual PS was US$18,048, which corresponds to Bze$119 per day fished. This PS is of similar magnitude to the income reported in the community survey by respondents whose main income stems from fishing (US$22,3000), suggesting that the PS calculations are relatively robust. The percentage of income from fishing that came from inside the reserve ranged from 2.5% to 95% (mean 26%), but the percentage of time reported fishing inside the reserve was lower, from 3-90%, with a mean of 21%. The income associated with fishing inside the reserve is significantly higher than the time spent inside the reserve ($z= -3.496$, $n=62$, $df=2$, $p= 0.000$), which indicates that fishing inside the reserve is more profitable than fishing elsewhere.

Sartenejan fishers relied almost exclusively on fishing for household income and fished for many more days, but on ten day trips with many other crew members. Their earnings were much less, as they caught little fish, but instead free-dived for lobster and conch. However, for those that had invested in a boat, each crew must pay the equivalent of Bze$26 per day (0.5kg of lobster), which generates large revenues for boat owners and can reduce revenues significantly for crew. The number of people sharing a boat also reduces costs, to only Bze$16 per person per day, including food. As a result, they generate a mean PS of over Bze$55,000 per year (US$27,500), which is equivalent to Bze$114 per day. Their income from inside the reserve is much smaller than local fishers, due to their exclusion for the period of the spawning aggregations (chapter 2.5.6).

Table 6.7. Gross annual costs and revenues in Belizean dollars (Bze$) from sample population. * probable revenues are calculated assuming that fishers have good catches 20% of the time, bad catches 20% of the time and "typical" catches 60% of the time. NB Bze$2=US$1.

	Statistic	All fishers	Local	Sartenejan
Effort	Percentage household income from fishing	62	56	89
	No dependents supported by fishing	2.9	2.5	4.4
	No trips / year	71	82	28
	No days fishing per year	177	160	241
Revenues	Average gross annual earnings	38,121	42,781	19,904
	Probable gross annual product revenue*	43,634	48,144	26,005
	Annual earnings from crew	10,222	433	45,027
	Total annual revenues	51,395	48,466	62,845
	Probable gross earning per fisher day	314	329	259
Fisher costs	Percentage to own a boat	76%	74%	81%
	License, permit costs	200	200	175
	Annual boat maintenance	1,039	988	1,241
	Annualised boat cost	774	650	1256
	Annual boat use costs	896	925	786
	Variable costs (trip costs per trip pp)	147	150	136
	Variable costs (trip costs per trip pp per day)	49	57	16
	Annual variable (trip) costs	8,089	9,179	3,829
	Annual equipment costs	402	450	217
	Total annual costs	11,379	12,370	7,503
	Mean costs per fisher day	79	91	32
Producer Surplus	Mean Annual Producer surplus (median)	40,016 (30,634)	36,096 (25,792)	55,342 (49,072)
	Producer surplus per fisher day (mean)	235.5	237.5	227.3
Gladden Spit MR fishing	% time inside GS	20	21	19
	% income from GS	26	26	26
	Gross annual earnings from fishing in GS	11,846	12,957	7,500
	Other working days inside GS	14	17	0

All aspects of fishing were highly variable. Some fishers fished occasionally and had few investments and therefore relatively low revenues, others had invested heavily and could catch large volumes of seafood. However, annual costs only explain 18% of the variation in annual revenues (F=11.7, df=1, p=0.0001, appendix 6.13). Furthermore, PS per day only explains 22% of the variation in PS per day (F=14.5, df=1, p=0.000).

An analysis of factors influencing PS was only able to explain 8% of the variation in daily PS (table 6.8). Older fishers had higher profits, as did those for whom fishing made up more of their income, which could be related to fishing experience. Those who had longer fishing trips (Sartenejans) had lower PS. Fishers concentrating on conch and lobster (also Sartenejans) also had lower PS, which is likely to be due to the fact that these are time consuming activities. There was a strong effect of fishing inside the reserve on PS. Local fishers who spent more time all year inside the reserve had a lower PS, perhaps due to high fuel requirements to reach the reserve all year. Those who spent a higher number of days inside the reserve, over fewer months, had higher PS, which is likely to be related to the spawning aggregations. This is supported by the fact that whilst fishers reported that 20% of their time was spent fishing inside the reserve, 26% of their income came from this area.

Table 6.8. Negative binomial regression to understand determinants of daily fisher PS (LR chi^2 = 57.2, n=52, p > chi2 = 0.000, Pseudo R^2 = 0.084).

Variable description	Daily producer surplus
Constant	4.564 (0.000)***
Fisher age(years)	0.0148 (0.004)***
Local fisher (dummy)	1.106 (0.002)***
Percentage income from commercial fishing	0.0069 (0.023)**
No of days per fishing trip	-0.0682 (0.003)***
No months fishing for conch	-0.0965 (0.000)***
Using lobster traps, shade or drums (dummy)	-0.405 (0.010)**
Percentage time fishing inside GS	0.0421 (0.005)***
No. Months fishing inside GS	-0.076 (0.000)***
Local fisher * percentage time inside GS	-0.028 (0.062)*

6.4.2.3 Catch survey data.

Catch surveys were carried out on 126 fishing boats and 632 fishers, over the course of a year, which is 22% of the boats and 18% of the fishers using the reserve. Catch estimates enabled mean catches per day inside the reserve to be calculated for both types of fisher (table 6.9, for full details, for each type of fisher: see appendix 6.14 and 6.15). Local fishers had on average 2.2 fishers per boat and spent an average of 2.5 days fishing inside the reserve. As table A15 shows, mean daily fish catches were 35kg during the spawning aggregations, compared to 29kg in the reserve at other times of year, which supports the idea that spawning aggregations are the most profitable fisheries. Mean daily catches calculated from catch data were lower, but much less variable than those reported in the fisher survey of 48kg per day. This suggests either that fishers have over-reported catches in the fisher survey, or that catches are better at the end of the day (after catch surveys were done). This is often the case for spawning aggregations, which occur at sunset. Sartenejan fishers have an average of 8.1 fishers per boat and had spent a mean of 2 days fishing inside the reserve. The catch survey suggests that they catch a mean of 4kg of lobster per day and 12kg of conch per day. This is very similar to the 5.5kg of conch and the 12kg of lobster per day they reported in the fisher survey.

Table 6.9. Total value of all catches inside the reserve during each major season for the local and Sartenejan fishers.

Type of fisher	**Local**			**Sartenejan**	
Season	Handline (spawning aggregations)	Handline (rest of year)	Free diving (all open)	Free diving (conch closed)	Free diving (lobster closed)
Expected mean value catch per day (Bze $)	243.6	524	268.1	132.2	183.6
Mean value catch per day whole (Bze $)	228	190	270.8	126.9	167.1
Mean value catch per day processed (Bze $)	684	520	406.3	182.5	233.7

In the fisher survey, fishers estimated that they fillet 56% of fish and 75% of conch and lobster. This enabled total annual catches to be estimated, based on mean and median catches per day, per type of fisher (table 6.10). The total annual product taken from inside the reserve was approximately 48,000kg in 2007. Given the size of the reserve, I estimate a mean yield of 4,500kg per km^2 per year. These data were used to generate gross estimates of the value of catches inside the reserve of US$800,900. Median values, which are more conservative estimates, are provided in appendix 6.16 for comparison and would suggest gross values of US$740,000.

Table 6.10. Fish catches and gross values for fisheries within GSMR using mean catch data for 2007. NB whole fish had a mean value of Bze$3,5/lb and fillet fish of Bze$7.5/lb.

Fisher type	Product quantity (lbs)	No. Fisher days (% of total)	Value if whole (Bze$)	Value if filleted (Bze$)
Local	28,172 fish	428 (12.4%)	98,601	211,290
Sartenejan	59,800 conch 17,237 lobster	3025 (87.6%)	639,160	973,690
All	**105,210 product**	**3453 (100%)**	**737,760**	**1,184,980**

Since the number of fisher days that local and Sartenejan fishers made is known (from the patrol data) and the mean PS per fisher day (from the fisher survey), the PS associated with fishing inside the reserve can be calculated (table 6.11). In total fishers using the reserve enjoyed profits of almost US$395,000 in on year. This suggests a rate of return of 0.49 from gross revenues (see chapter 7).

Table 6.11. Fisheries producer surplus estimates in US$ using mean daily PS inside GSMR in 2007.

Type of fisher	Local	Sartenejan
Producer surplus per day (US$)	118.75	113.65
No fishing days in reserve	428	3025
Annual PS	50,825	343,791
Total (US$)	**394,616**	

6.4.3 Economic Analysis of Tour Operators at GSMR.

6.4.3.1 Patrol records.

The number of tourists coming to the reserve was 6,253 in 2007, an average of 521 per month (figure 6.7). A third of all tourists took whale shark trips during the full moons from March to June. Overall, 52% came to snorkel, 30% came to dive, 13% were sailing and 2% were sports fishing, which provided almost US$50,000 in gross revenues from ticket sales for FoN. Tours provided 1206 days of jobs, an average of 100 days per month, or 2.8 staff per boat. There were 3 major types of tourist trips, those on self catering yachts (16%), day trips with local operators or hotels (51%) and whale shark trips (33%). Of those 3,620 tourists doing day trips, a third went through high end hotels (158 trips) and the remaining 68% went through local tour operators (329 trips).

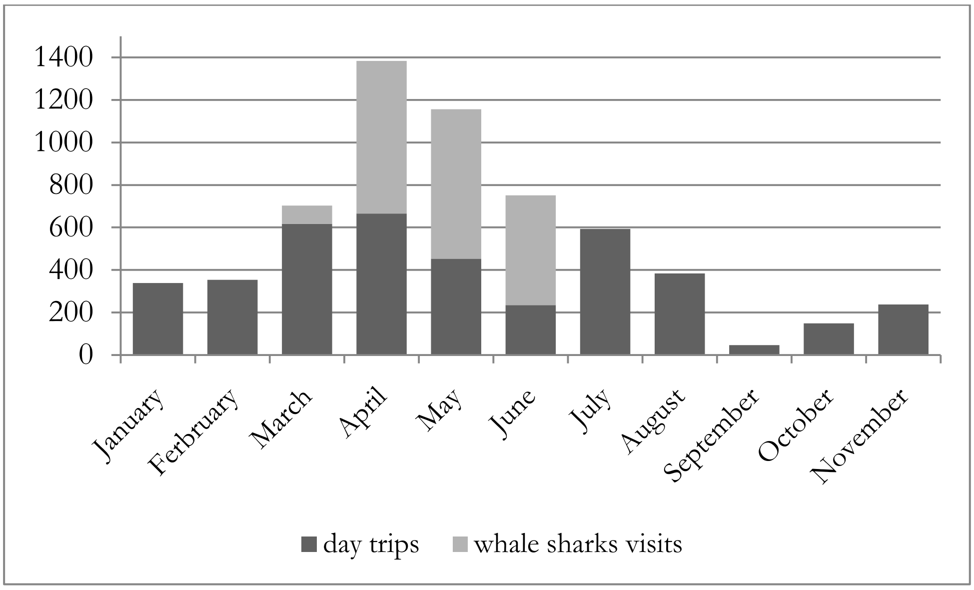

Figure 6.7. Visitor numbers at the reserve in 2007.

6.4.3.2 Tour Operator Survey.

In total, 14 operators who used GSMR were interviewed, which represent 80% of the actual population of tour operators. Of these, 100% did diving and sports fishing trips, 86% diving trips, 42% kayaking, 29% dive instruction, 21% sailing. They reported that a mean of 73% of their business came from marine activities. All those offered diving as an activity took trips to GSMR, 93% took snorkelling trips there and 57% sports fishing trips. Operators estimated the tourist high season to last a mean of 6 months (from December to May), and most were closed for one month, usually in August or September.

Operators estimated that they take a mean of 3 trips per week to the reserve during the low season and 7 during the high season. In total operators made 268 trips during the whale shark season, of which 33% were with top end hotels and of the remaining 67%, 22% were through hotels and 47% through local operators. Revenues collected varied with type of trip and operator (appendix 6.17). Tourists coming to the reserve on small yachts generated no revenues for operators and so were excluded from this analysis.

Table 6.12 shows tour sales (gross revenues) for the reserve for 2007, by type of operator and trip. Top end hotels account for 30% of both day trips and whale shark trips. Local operators sell 70% of the tours for whale sharks, but only 46% of day trips, due to the number of chartered yachts. Although day trips account for 68% of tours, they only account for 56% of the gross revenues. Ticket sales are not included in gross revenues, as they do not go to the operators but to FoN. Total revenues for 2007 are therefore US$1,069,767.

Table 6.12. Revenues from tourist trips to GSMR. % of visitors is given in parentheses. Numbers of visitors in square brackets are further broken down.

	General visit No. Visitors (%)	Price per person	Whale shark visit No. Visitors (%)	Price per person
Total no. visitors	4221	n/a	2032	n/a
Visited in yachts	971 (23%)	0	0%	0
Visitors with local operators	[1942] (46%)		[1422] (70%)	
Diving	718 (17%)	208	528 (26%)	303
Snorkelling	1224 (29%)	134	894 (63%)	155
Visitors with top end hotels	[1308] (31%)		[610] (30%)	
Diving	485 (11.5%)	332	224 (11%)	380
Snorkelling	823 (19.5%)	155	386 (19%)	218
Total revenues collected (US$)	**601,945**		**467,822**	

Trip costs varied by operator, but include transport to the reserve, equipment, guides and lunches. There must be at least one guide per 8 tourists. Boats took a minimum of 5 and a maximum of 15 tourists per trip. Boats used a mean of 37 gallons of petrol for regular trips and 53 during whale shark trips. This resulted a total cost for all operators of almost US$175,000 for 2007 (appendix 6.18). Annual recurrent costs were also incurred for equipment purchases, boat purchases and maintenance and shop leases (appendix 6.19). These resulted in a total of almost US$217,000 per year for all operators using the reserve. As table 12 shows, operators generated a total of US$678,000 for trips conducted in the marine reserve. This is equivalent to almost US$38,000 in net revenues per operator, if they get equal proportion of the profits, which is unlikely. In fact, hotel owners enjoy 30% of the producer surpluses estimated here, which is similar to their proportion of tour trips. However, average profits for hotels are almost US$52,000 compared to US$33,700 for local operators. The returns generated from gross revenues was 0.37, which is equivalent to on average US$128 per tourist.

Table 6.13. Summary of total revenues, costs and producer surplus for all operators using the GSMR.

Revenue / Cost	US$
Revenues from day trips	601,945
Revenues from whale shark tours	467,822
Gross revenues from tours	1,069,767
Total annual trip related costs	174,964
Business related investments	216,810
Total annual costs	391,774
Tour operator producer surplus 2007	677,993

6.4.4 Summary of Local Values.

Here gross revenues of tour operators quantified generated over US$1million and producer surpluses of almost US$680,000. Fishing inside the reserve, over almost 3,500 fisher days, generated PS of around US$115 per fisher day and almost US$395,000 for 2007. In addition, the residents of Placencia enjoy a suite of values from this reserve, and other nearby reserves. Use values make up most of this value, especially tourism and fisheries access. Each household had a mean WTP of US$373 per annum to support and access the GSMR. Of this, tourism access accounts for 47% of the value and fisheries 28%. In aggregate, this value totals almost US$210,000 for this small village alone (180 households). In total, these three local values have a net value of US$1.29 million for 2007, of which community CS make up 16%, fisher PS 31% and tour operators PS 53%.

6.5 Discussion.

The 'local' values quantified in this chapter are three distinct values associated with use and conservation of the GSMR. Significant welfare gains were demonstrated for residents of the nearest village, Placencia. Net benefits from fishing inside the reserve are enjoyed by fishers in many villages, both near and far from the reserve. Net benefits from reserve tourism are enjoyed by tour operator owned by Belizeans and non-Belizeans and constitute the greatest share of the values quantified. The inclusion of CS values held by residents of other villages, especially those also near the reserve, would be expected to result in a substantially higher estimate of local values for this area. However, these villages have different levels of fishing and tourism development, which means that values for Placencia cannot be extrapolated. Valuation, such as carried out here, enables a better understanding of the values held by reserve beneficiaries and marginalised stakeholders, which has implications for management and conflict reduction, a common problem in developing country MPAs (Christie, 2004).

The tour operator analysis showed that a relatively small number of businesses are profiting from and able to capture a significant amount of the rent associated with the 6,200 tourist visits to GSMR over 2007. Much of the PS is being captured by small scale local operators, who charge less for visits, but have lower costs than the large hotels. Three quarters of their business is associated with marine activities, of which GSMR makes up a significant proportion. Profits generated during whale shark season are crucial, as they allow local businesses (both those directly linked with the reserves and secondary tourism businesses) to survive during low seasons. This was not an exceptional year in terms of visitation, so these results are expected to be representative of the last few years. There has been some concern that whale sharks are being harassed during dives and are therefore returning less often and there is also a trend of increasing numbers of visitors. Since visitor values that visitors are WTP more than current fees, it is suggested that rather than increasing the number of whale shark tours, operators seek to capture more rents from current levels of visitation, by charging higher prices.

The values measured here are small in relation to tourism values at other MPAs e.g. (Israel, 2004; Ruitenbeek & Cartier, 1999). However, the PS associated with tourism depends on many factors such as the level of general tourism development, accessibility and the age of the MPA. These results also do not take into account secondary impacts of tourist and tour operator spending, which will increase the value of the reserve tourism both locally and at a national level. The level of return from gross revenues of 0.37 was similar to that of 0.35

used by (Burke & Maidens, 2004) for the Caribbean. If the same multiplier of 1.25 they use is applied here, a total value of US$1.53 is associated with tour operator business at this reserve alone. Gross tourist spending at this reserve was estimated at US$1.07million (or US$2.4million if the same multiplier is used), which is also small in proportion to the estimated US$30-37million in tourist spending on diving in Belize in the same year reported by Cooper et al., (2008). This may be due to the more conservative approach used here.

Poor data exist on fisheries volumes generally due to the cost and logistical difficulty in obtaining accurate data, which is exacerbated by the high levels of natural variability. This research was greatly facilitated by detailed patrol records. Even less information exists on the profitability of fisheries inside reserves, as detailed cost data are costly to obtain. Catch data was used to estimate the volume and gross value of fisheries inside the reserve and fisher surveys were used to obtain generate estimates of fisher profits both annually and per day, for those fishers using the reserve most. The mean yield of 4,500kg km^{-2} yr^{-1} is lower than the global average of 6,600kg km^{-2} yr^{-1}, but higher than the 1,320kg km^{-2} yr^{-1} for the Caribbean region (McClanahan, 2004) and much higher than the Belize average of 340kg km^{-2} yr^{-1} in Belize (Koslow et al., 1994). This would be expected given the long standing importance of this area for fishers. Jennings and Polunin (1995) suggest that the estimated yield calculated inside the reserve yield is sustainable, but given the widespread decline of fisheries in Belize, this may not be true in this area. Nevertheless, catch data from this area in 1992, long before it was managed, recorded yields of 2,930kg km^{-2} yr^{-1} (Koslow et al., 1994). This may be indicative of the fact that management has improved fisheries here, as many fishers also attested. This supposition was also supported by the result that the proportion of income from inside the reserve is greater than the proportion of time inside and that PS is increased with time spent fishing inside the reserve. The method applied here would be expected to underestimate total off-take, as illegal catches, which fishers reported as significant in this area, were not included here. Hence current effort may not be sustainable over the long term.

The PS quantified here are in line with the incomes fishers gave in the community survey, as many local fishers also work in the tourist industry. There are likely to be various reasons what these producer surpluses are relatively high. First, the reserve is remote, which reduces effort, since fuel costs to reach it are high. Secondly, special licenses are required to fish during the spawning aggregations which are only given to certain fishers, which means this is not an open access fishery. This is reflected in the fact that local fisheries are willing to pay for licenses for the whale shark zone and the local community hold significant values for fisheries access to this area. Thirdly, fishing regulations related to gears, catch sizes and the no-take area and enforcement by rangers is likely to have reduced fishing effort and habitat impacts. Time series data would necessary to establish if these measures have increased fisheries productivity, but they are not available. Finally, for fishers from Sarteneja, costs are extremely low, given that large numbers share boats and they have minimal fuel requirements.

It is important to note that the direct costs associated with fishing absorb approximately 50% of gross values in this study (in contrast to an open access fishery when costs can be equal to or greater than revenues), which suggests that studies which calculate fisheries values based on gross revenues over-estimate the true value of the catch significantly. It should be noted that the inclusion of opportunity and indirect cost would reduce net benefits. Thus this method has produced relatively conservative results compared to other studies, such as estimates of reef-dependent fisheries in Belize of US$13million (Cooper et al., 2008). Regional comparisons between different MPA fisheries are of limited use, given the large variation in reef fishery productivity globally. Secondary impacts of fisher spending have not been included, nor nursery nor spillover benefits, which would further increase fisheries value. Declines in these fisheries would have serious consequences for local fishers using the reserve, but even more so for fishers from Sarteneja, who rely almost exclusively on fishing for income as they have no real access to tourism employment.

Local community values are rarely measured for coral reef MPAs, despite the fact that they are likely to determine MPA outcomes (Mascia, 2004). It is clear that this reserve generated direct benefits, from profits associated with tourism and fishing industries. However, the community survey also demonstrated significant local values associated with direct use and conservation of this area. Donor funding has also enabled indirect benefits from community outreach programs, alternative livelihood schemes and education initiatives which have benefited many of these households. Local WTP for fishing and tourism access, even for those households that do not regularly use the reserve, demonstrates that community members perceive tourism, fishing and other indirect benefits to the local community. This is also reflected in the attitudes of local people, who feel that Placencia is one of the principal beneficiaries of this reserve. Recreational values measured are however also significant, although the econometric results suggest that these may also reflect secondary benefits generated by the reserve. This may be the reason that the remaining value for the reserve, which was not reflected in the 3 use values, was so small. Alternatively, non-use values could in fact be small for this community.

The community survey applied CVM to measure distinct resident CS values for this reserve. CVM showed that local values are theoretically valid, as they are highly constrained by wealth and income, as has been found in other WTP studies e.g. (Naylor, 1998). Those who have incurred costs already, such as for special licenses, also had lower WTP. Interestingly, WTP values were not affected by substitute sites, but much more by current use of each area. They are also affected as was expected by environmental awareness and to a great extent by experience of the reserve and its management. WTP did not differ between different levels of certainty, yet those who were most certain about their stated bids gave lower bids. Respondents demonstrated sensitivity to scope and therefore understood the valuation questions, which succeeded in measuring distinct values. Unlike the tourist analysis, ordering effects were not present. There was an unusually low incidence of protest and zero bids e.g. compared to Adams et al., (2008), which indicates that the scenario used was both plausible and acceptable (Meyerhoff & Liebe, 2006). It was particularly effective here, as respondents are in general highly familiar with the reserves. Since local values are likely to be a key component of MPA performance (see chapter 4) they should be more routinely incorporated into natural and protected area valuations. CVM is a useful tool to do this and involves less effort than the revealed preference methods used to calculate fisher PS.

The overall WTP of the community for these reserves was relatively high, compared to that measured for other marine resources, which range from US$1.58-23 per year (Adams et al., 2008; Hadker et al., 1997; Maharana et al., 2000; Naylor, 1998; Wattage & Mardle, 2008). However, these studies were done in areas with higher poverty levels, less tourism development and higher local dependence on natural resources for subsistence. The WTPs reported here constitute a minor percentage of household income, which is largely tied to marine based tourism. However, the values quantified for the reserve are of similar magnitude to the WTA values of residents to forgo access to wetlands in Nepal (Shretsha, 2007). Here respondents are paying for continued access to this resource, so values could be comparable, although WTA less conservative than WTP and usually results in higher bids (Arrow et al., 1993).

While a large part of the local values for this reserve are related to fishing and recreation, tourism emerges as the main motivation for local support, as indicated by Deidrich (2006). This is in contrast to the analysis of Loper et al., (2008), who suggest that residents in Placencia see tourism as threatening their well-being, although residents did also report being concerned as to the threats posed by pollution and development. Here. The link between reserve values and tourism was elucidated in several ways. Respondents believed that marine reserves are crucial for increasing tourism. Indeed, they said that the majority of tourists come to Belize at least in part due to the marine resources. This is reflected by the fact that the main benefits which were identified for reserves were tourism and employment benefits, as well as tourist control. Furthermore, the most frequently given response with respect to the effect of degazetting the reserve was reduced tourism or tourist income. Finally, perceptions of perceived tourism benefits emerged in the econometric analysis as a significant determinant of WTP for all the values elicited in the CVM, apart from WTP for fishing access. This is not surprising, given that 43% of households have all their income from tourism and 73% have over half their income from tourism, and that resident incomes are much higher than those of other Belizeans. Respondents identify income, employment, increased local infrastructure development and a better quality of life as the main benefits of tourism and most would like to see it continue, despite the associated crime and pollution. Whilst most respondents reported that the reserve increases tourism, there is relatively, a less widespread belief that coral reefs are highly threatened or that reserves are helping to improve coral cover, to abate threats or that management is currently optimal.

The perception of Placencia as the main beneficiaries is validated by the net fisheries and tour operator profits demonstrated here. This perception that that reserves enable or tourism, which produces many indirect benefits which currently override the negative aspects, combined with the fact that management costs are indeed largely paid for by international donors and tourists, suggests local people are enjoying significant benefits from this area, which is similar to the result of in terrestrial PAs (Wittemyer et al., 2008). This explains perhaps why increasing numbers of outsiders are coming to the village (McPherson, 2005). This contrasts to concerns that PAs generate large costs for local communities (Balmford et al., 2002; Balmford & Whitten, 2003; Ferraro, 2002; Ostrom, 1990; Sanchirico et al., 2002). Despite positive perceptions, current levels of tourism development may not actually be sustainable in Belize (Deidrich, 2006) and efforts should be made to ensure continued environmental quality. Asking local community members to pay for access rights would be unpopular and could undermine management efforts. However, local benefits could be used to demonstrate the value of this reserve to local people, to donors and the government of Belize in order to justify continued or increased investment. They could also be used to build local support for management, through targeted education and outreach initiatives. Attitudinal responses suggest that efforts should however be made to increase transparency of management spending and enforcement of regulations, as well as improving the relationship between rangers and tour guides. This would be expected to further increase resident values.

The local values demonstrated here are of key importance to understand, since they will partly determine performance against management goals based on incentives generated and the subsequent behaviours of local stakeholders. However, this assumes that stakeholders are able to perceive these benefits and costs and are sensitive to equity in terms of winners and losers. This is the subject of the next chapter.

Real and Perceived Costs and Benefits Generated for Stakeholders of the Gladden Spit Marine Reserve.

7.1 Introduction and Rationale.

Coral reef MPAs protect ecosystem services that directly and indirectly contribute to the welfare of people, both nearby and far away (see table 2.4). This means they can be a prudent investment in the context of widespread marine pollution, ocean acidification and water temperature increases, which threaten these fragile ecosystems. Economic valuation can be used to inform donor and policy makers of the ranges of values which coral reef ecosystems and their protection generate. A range of values should always be measured, as market values indicate the dependence of the local community on the marine resources, non-market values show the important life-support functions of coastal and marine ecosystems and net benefits reflect the magnitude of potential losses due to improper management of marine resources (Samonte-Tan et al., 2007). Yet Balasubramanian et al., (2003) report that in the Caribbean, 83% of marine resource valuation studies focus solely on direct use values. As a result of the gaps in values, standard research only captures a quarter of the "total economic value" of these coral reef ecosystems. Benefit estimations are increasingly used in policy and investment decisions and compared to the costs of management. This means that the benefits reported are likely to be underestimates of the true values of these reefs and result in under-investment in coral reef conservation and under appreciation of the welfare benefits to a range of beneficiaries.

Furthermore, the protected area literature usually suggests benefits are limited at local level, increased at national level and are substantial at regional and global level, with costs following reverse pattern (Wells, 1992). This is of importance, as concentrated costs and diffuse benefits create disincentives for conservation (Shrestha, 2007). I will examine the extent to which this occurs at the Gladden Spit Marine Reserve (GSMR).

See also section 1.3.2, 1.3.3 and 2.4.5 for background to this section.

7.2 Aims and objectives.

Results from valuations of visitors, non-visitors, fishers, tour operators and local communities (chapters 5 and 6) are critically examined and are amalgamated to compare consumer and producer surplus estimates for a wide range of stakeholders. An economic value is calculated for the reserve's use and total values for 2007. These are compared to management costs to perform a cost benefit analysis at the manager level. The proportion of values attributed to various aspects of the reserve, as well as the ratio of use to non-use values is compared to previous research. Net present values are generated with a sensitivity analysis employing different discount rates. The distribution of both costs and benefits is quantified by stakeholder group and at different scales, to test the hypothesis that costs are greatest at the local level and benefits greatest at the international level. Perceived costs and benefits are compared between stakeholder groups and to actual costs and benefits quantified. Implications of equity of economic values are used to develop management and funding recommendations.

7.3 Methodology

Producer and consumer surplus estimates, plus aggregated values for 2007 were collated, from the surveys described in chapters 5 and 6. These were used to generate an overall net value for the GSMR in 2007, based on used values and all values. I do not use the term "total economic value", as there are some values which could not be quantified due to time and budget constraints, or lack of sufficiently developed methodologies.

Different discount rates reflect different predictions as to the relative value of money in the future. This is a contentious area and so here, a range of constant discount rates are used to estimate net present values over the next 25 years, as it was felt that beyond this, habitat and economic conditions are likely to change substantially.

In addition to survey data from tourists, tour operators, fishers and residents of Placencia, financial information was requested from the management organisation, as to the sources and spending of management budgets. This was used to compare the relative distribution of costs and benefits, between stakeholder groups and for local, national and international scales. Transfers of wealth between stakeholders, which would not be incorporated into valuation estimates are used for this analysis. Local tour operators, the residents of Placencia and local fishers were used to quantify gross and net benefits at the local scale. The national level incorporated fishers from elsewhere in Belize and national NGOs who fund the MPA. Finally, international stakeholders were international hotel owners, reserve visitors, non visitor tourists to Placencia and international NGOs who fund management costs. Quantified costs and benefits were also compared to attitudinal data from the five stakeholder groups: visitors, non-visitors, local community, fishers and tour operators. Qualitative answers from respondents as to the benefits of MPAs were re-coded as extractive use, non-extractive use, ecological benefits, option and non-use benefits. Future benefits were included in option values. Perceived and real distributional aspects of the costs and benefits were then compared.

7.4 Results.

7.4.1 Values Quantified for the Gladden Spit Marine Reserve

This research quantified the principal economic values generated in 2007. This included a large range of values enjoyed by five major types of stakeholders; visitors to the reserve, tourists to Placencia, local communities, fishers and tour operators who use the reserve. Table 7.1 summarises the findings of each valuation, with mean consumer and producer surplus estimates for each value measured. The time period over which the value accrued, the economic unit surveyed (individual, household, fisher day) and the location of the stakeholders vary between value types.

Table 7.1. Summary Table of Net Economic Values at the Gladden Spit Marine Reserve.

Value category	Value	Number surveys	Time, unit	Mean value US$ (median value)	Beneficiary
Visiting tourist values	One day visit		Per visit, per visitor	25.2 (20)	International visitors to GSMR
	One day visit + whale shark interaction	302	Per visit, per visitor	40.2 (30)	
	Lifetime option and non-use value		Per lifetime, per visitor	68.4 (50)	
Non visiting tourists	Per trip option & non-use value		Per trip to Belize, per tourist	21.1 (15)	International tourists to Placencia
	Lifetime option value	282	Per lifetime, per tourist	71.6 (35)	
Community values	Annual fishing access		Per year, per household	103.2 (60)	Residents of Placencia
	Annual tourism access	152	Per year, per household	177 (68)	
	Annual recreational value		Per year, per household	82.8 (60)	
	Total Value GSMR		Per year, per household	373.2 (180)	
Fishing values	Annual fisher profits (PS) for fishing inside GSMR	56	Per fisher day inside reserve	118 (110)	Local Belizean Fishers Sartenejan fishers
Tourism values	Annual profits (PS) for tour operator trips to GSMR	18	Per trip, per tour operator	108.4 (n/a)	Local Belizean Tour operators International hotel owners

Non-use values were similar for visitors and non-visitors (figure. 7.1). However, community annual values were larger than lifetime tourist non-use values. Tourism access for local communities of US$177 was valued at over double the tourist non-use values of US$70. Recreational use values for tourists per day (US$25) were also much less than those of local residents (US$80 per household per year). Overall values for visitors (US$109) were less than a third of those for the reserve for community households per annum (US$373). These comparisons underscore the importance of this area for these communities, especially in the context of lower community incomes, which are a key determinant of WTP. PS per day fishing was US$118, compared to CS of US$103 per annum for local residents. This was related to the fact that fishing has declined in importance for fishers in Placencia, compared to residents of other communities. In addition, only 5 of the households interviewed in the community used the reserve for fishing. In contrast, tourism access was valued at US$177 per household per year and tour operator PS was estimated at US$108 per trip. The PS per fisher day is slightly higher than that per tourist trip

In both the tourist and community econometric analyses, survey related variables emerged as important. For the tourist analysis, these were the type of survey and ordering effects. For the community values, these were certainty of stated bid and ordering effects also for one value.

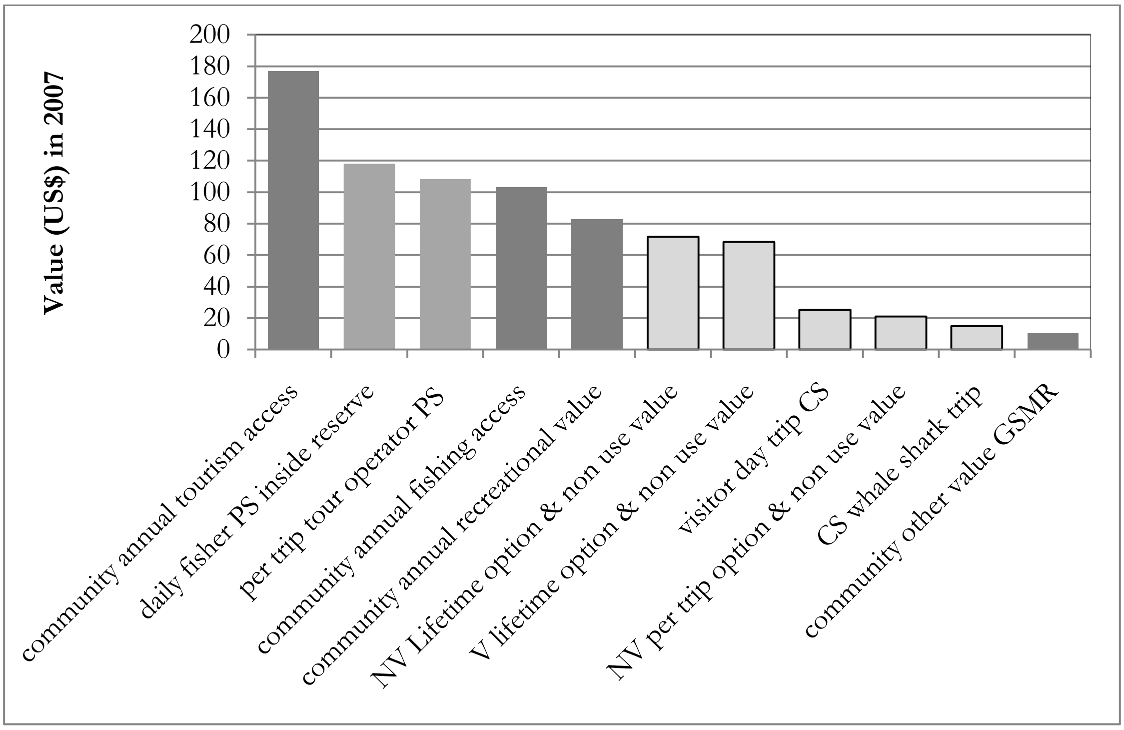

Figure 7.1. Producer and consumer surplus estimates for the values quantified for the GSMR for 2007. Note: V denotes a visitor value, NV a non-visitor, CS consumer surplus, PS producer surplus. Community values are denoted by dark grey bars, local business values by grey and tourist values by light grey bars.

Aggregated values applied to different populations and so show different magnitudes to individually held values. Aggregate values have greater salience for managers and businesses, as values held by large numbers of beneficiaries are a key source of potential funds which can be used to justify conservation investment more easily than consumer or producer surpluses enjoyed by a small number of stakeholders. Table 7.2 shows all the aggregated values measured. In total the reserve generated a minimum of US$4.05 million in net economic value in 2007, of which direct use values make up a third.

When looking at net present values (table 7.2), the choice of discount rate affected estimates substantially. Direct use values of the reserve alone had a net present value of US$13-29 million over the next 25 years. Inclusion of non-use values increased the net present value of the resources within the reserve to US$41-93 million. Overall, 31% of the reserve's net aggregate value was directly attributable to spawning aggregations and the whale sharks that feed on them. This means that much of the value of this reserve is concentrated in a small area.

Table 7.2. Aggregated Net Annual and 25 Year Values for the Gladden Spit Marine Reserve. *corresponds to the number of visitors in 2007.

Value	Population applies to	Aggregate net annual value	Value (U$'000)	Value (U$'000)	Value (U$'000)	Value (U$'000)
Discount rate	n/a	n/a	10%	7%	4%	1%
Visitor day trip CS	4,221*	59,516	600	753	989	1,370
Visitor Whale shark interaction CS	2,032*	19,304	1.8	3.6	7.2	15
Visitor lifetime option and non-use value	6,253*	437,085	4,405	5,530	7,265	10,063
Non-visitor lifetime option & non-use value	39,570*	2,354,415	23,726	29,792	39,135	54,206
Annual fishing access	180 households	28,896	291	366	480	665
Annual tourism access	180 households	49,560	499	627	824	1,141
Annual recreational value	180 households	23,184	234	293	385	534
Other value	180 households	2,856	29	36	48	66
Annual fisher PS for fishing inside GSMR	3453 days fishing	394,616	3,977	4,993	6,559	9,085
Annual PS for tour operator trips to GSMR	20 operators hotels	677,993	6,832	8,579	11,270	15,610
ALL USE VALUES	**n/a**	**1,253,069**	**12,627**	**15,856**	**20,829**	**28,850**
ALL VALUES (use + option + non-use)	**n/a**	**4,047,425**	**40,786**	**51,214**	**67,277**	**93,185**

In 2007, FoN had expenditures of over US$325,000 associated with this reserve. Revenues on-site generated US$146,000, of which US$34,000 went to the fisheries department and the remaining portion was retained. If values generated are compared to the costs incurred in management, the management budget was only 8% of the net economic value generated at the GSMR and 36% of the use values generated in 2007. This means that this relatively small investment has generated large values. Overall, 82% of revenues were spent on enforcement and ticket collection by rangers.

7.4.2 Distributional aspects of values.

Due to the large number of visitors to Placencia, the non-visitor values were the largest component of overall value at 58% (US$2.35 million; figure7.2). The second largest value (17%) was the tour operator PS, of US$678,000, followed by visitor non-use values (11%) of US$437,000 and annual fisher producer surpluses of US$395,000 (10% of the value). In comparison, aggregate use values for the local community and visitors were small (3% and 2% of aggregate values).

Overall, tourism constituted US$3.6 million of aggregate value (89%), fishing US$424,000 (10.4%) and local recreational use US$26,040 (0.6%). This also corresponded to use values making up 69% of aggregate values, compared to 31% for direct use values (fishing and tourism).

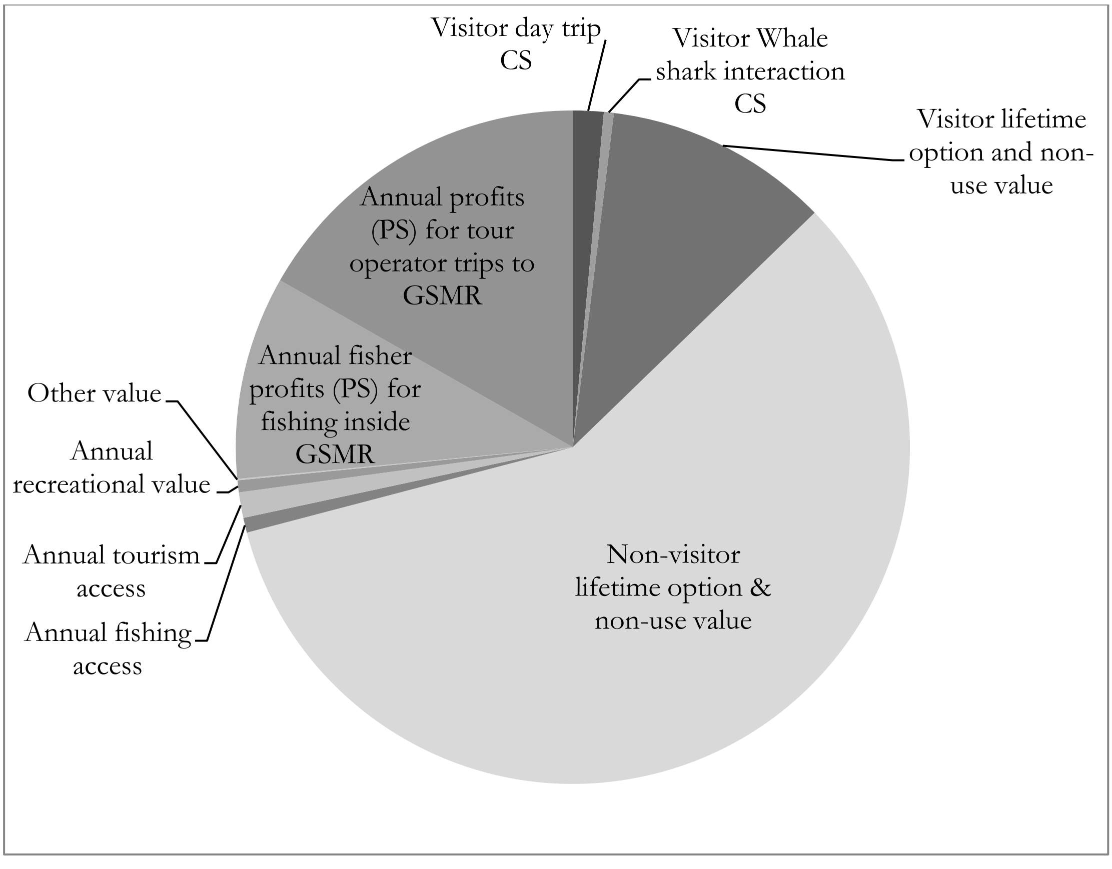

Figure 7.2. The proportion of overall value made up of each net aggregate value measured in 2007.

Visitors, whose values are most frequently measured in the literature, only make up 21% of the values measured here (figure 7.3). Overall, Belizeans enjoyed 24% of all the values (15.5% to the residents of Placencia and 8.5% to fishers from the North of the country), which is a high proportion, given that the population that accrue these benefits is estimated to be only 1200 people. If other villages nearby were considered, where residents may also enjoy use or non-use values, the proportion received by Belizeans would be considerably larger. There was also relatively little leakage of profits associated with reserve tours to international hotel owners. Of the tourist values, non-visitors account for 61% of measured consumer surplus, visitors the remaining 39%.

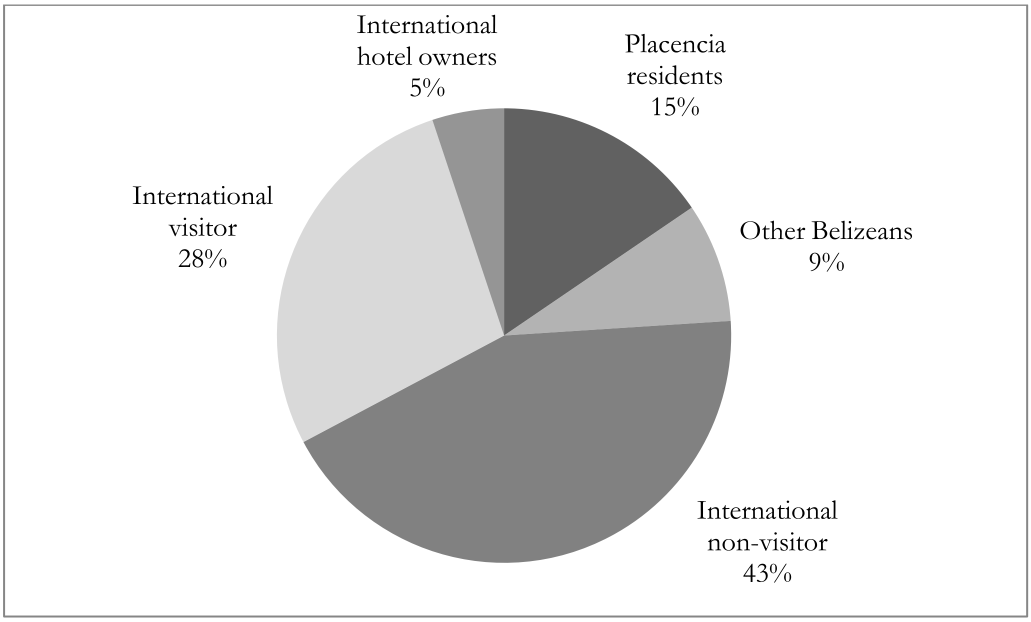

Figure 7.3. The distribution of net aggregate values generated by the GSMR in 2007.

The net benefit calculation for the reserve only considered net benefits and not transfers between stakeholders that occur as a result of the MPA. For example, management budgets were provided by international donors and a portion of visitor fees that are collected were returned to the government's fisheries department. Tour operators and fishers paid the majority of the direct costs of the reserve, followed by international NGOs, who funded management (figure 7.4). Visitor entrance fees made up only a small proportion of this cost.

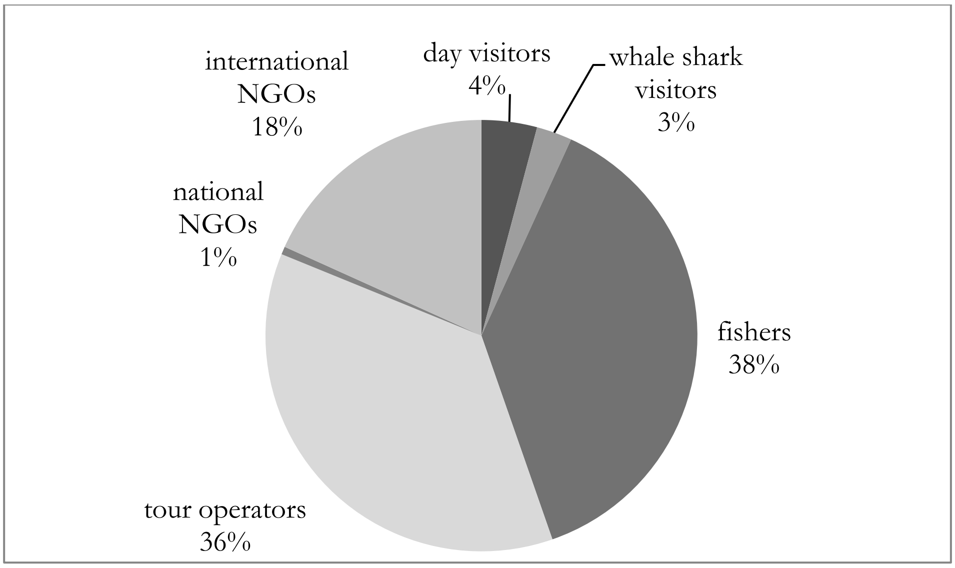

Figure 7.4. The distribution of costs among stakeholders.

The ratio of costs and benefits varied by stakeholder (figure 7.5). Visitors paid little relative to the large benefits they enjoy. Non-visitors enjoyed large non-use values in aggregate (although they are comparable to user non-use values per individual). Similarly, the small number of households in Placencia and the fisheries department enjoyed welfare benefits despite no direct costs. In contrast, international NGOs, whose donations could be thought to express international non-use values, incurred direct costs, but no direct (measurable) benefits. Finally, both fishers and tour operators lost a significant proportion of gross revenues to production costs. While fishers have a rate of return of 0.5 on spending, tour operators enjoy a better rate of 0.64.

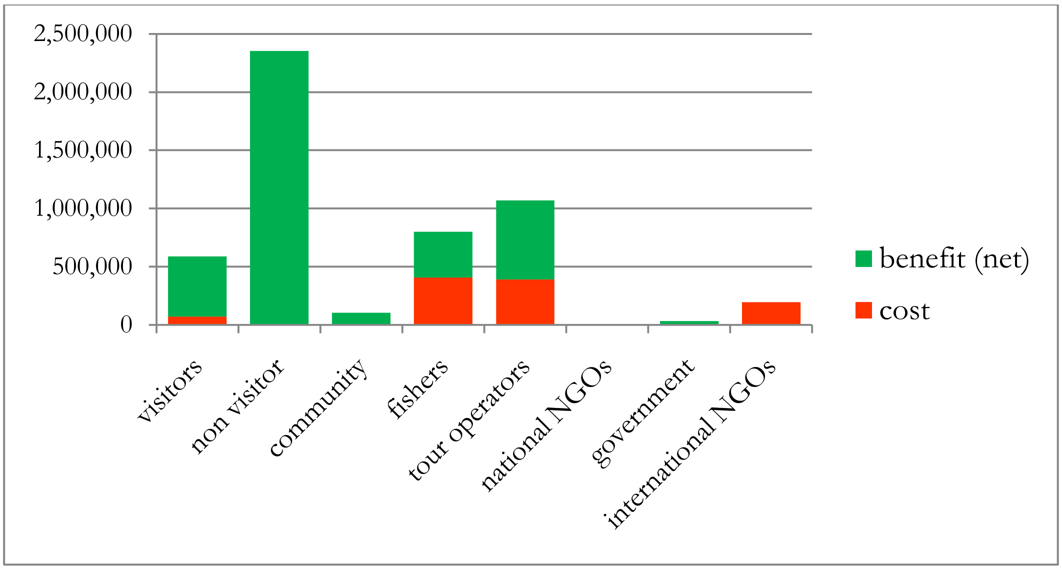

Figure 7.5. The ratio of costs to benefits for each stakeholder. Note: the total height of the bars is equal to the gross benefits.

Costs and benefits were exerted at different scales (figure 7.6). Costs were very similar at local, national and international scales. However Belizean costs (which include fishers from the North of the country) were the highest and only marginally greater than Belizean benefits. In contrast, benefits were smallest at the national level. International benefits dwarfed other benefits, but this was largely due to non visitor values, which were large in aggregate. If these values are omitted, then international benefits were very similar to local benefits.

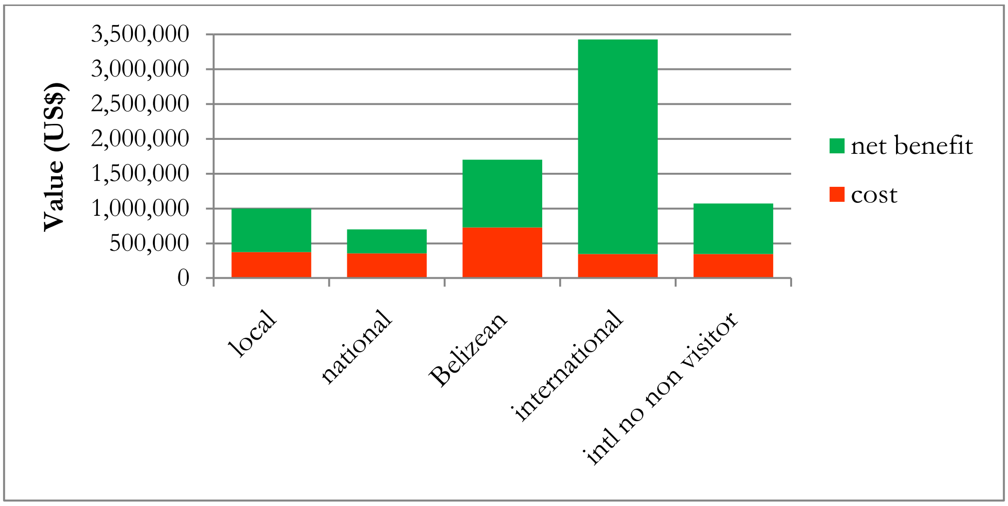

Figure 7.6. The distribution of costs and benefits at local, national and international scales. Note: the total height of the bars is equal to the gross benefits. In the second column, Sartenejan fishers are considered national stakeholders. In the Belizean column, they are pooled with local people.

7.4.3 Stakeholder Attitudes about perceived costs and benefits.

Respondents had a range of opinions about the benefits that the GSMR generates (figure 7.7). Most stakeholders reported benefits related to the way they most use the reserve. Non-visitors and visitors both identified recreational values (non extractive use values), although visitors were more aware of extractive use values. Fishers were more aware of extractive uses, as well as non use values. Interestingly, tour operators were equally focused on extractive, non extractive uses and non-use values. The community focused on the two major income sources in the village, fishing and tourism. The values expressed by the communities were much more skewed towards non use values and were most similar to those reported by tour operators.

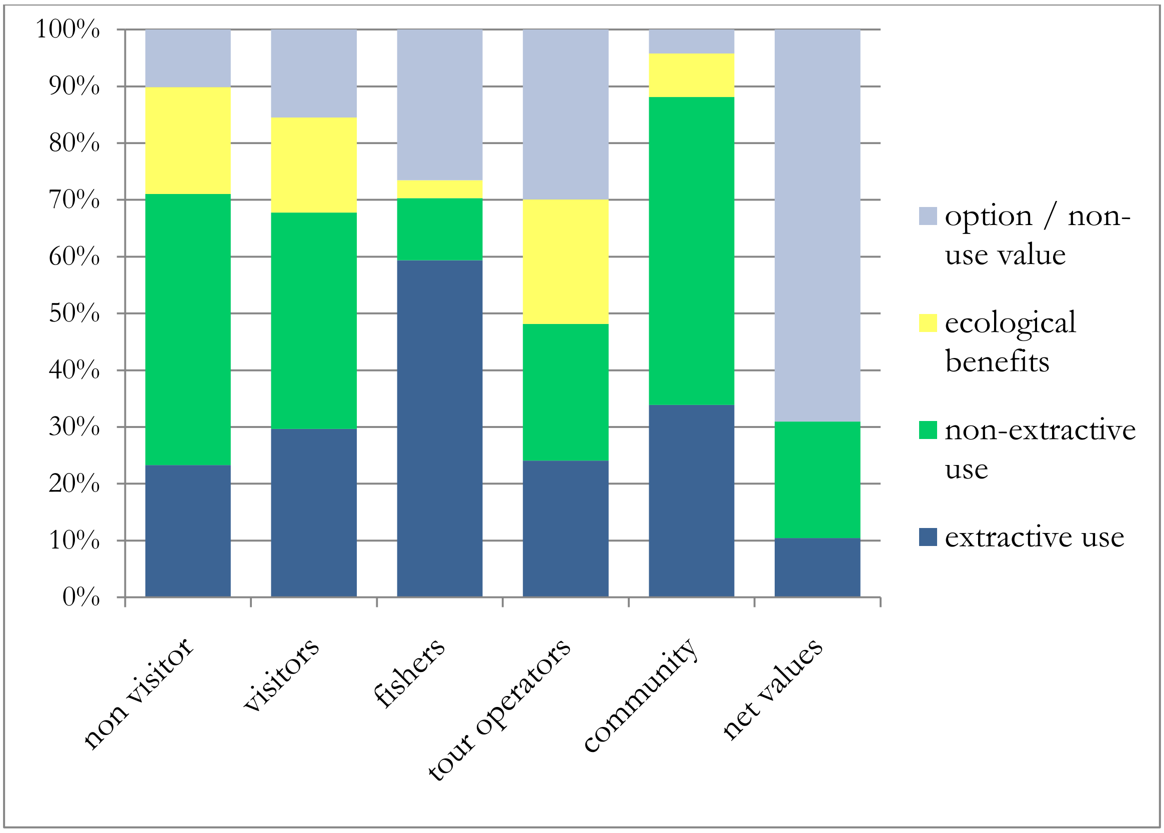

Figure 7.7. What are the main benefits of the GSMR? The first 5 columns show perceived values. The "net values" column shows actual net values measured in this research and reported in figure 7.3.

Respondents were aware of a wide range of beneficiaries of the reserve (figure 7.8). Each respondent group saw themselves as the main beneficiary. The local community was often identified by community members and tourists. Tour operators were also frequently mentioned by all groups, but especially by fishers. Local community members thought that NGOs were major beneficiaries, as did fishers to a lesser extent. The environment was mentioned by tourists, but not Belizeans. The community also focused on government benefits more than the other respondents. Non visitors identified more beneficiaries than visitors, which could be as they were thinking of MPAs in general. If perceived and real beneficiaries are compared, this shows that all stakeholder groups have a good awareness of the reserve beneficiaries, although they named more than I was able to quantify. This indicates a high level of awareness of reserve impacts and funding. Few respondents had considered non-users. The community also underestimated tour operator and over-estimated NGO benefits. The lack of future values cited by locals may also indicate high discount rates, although this was also true of tourists.

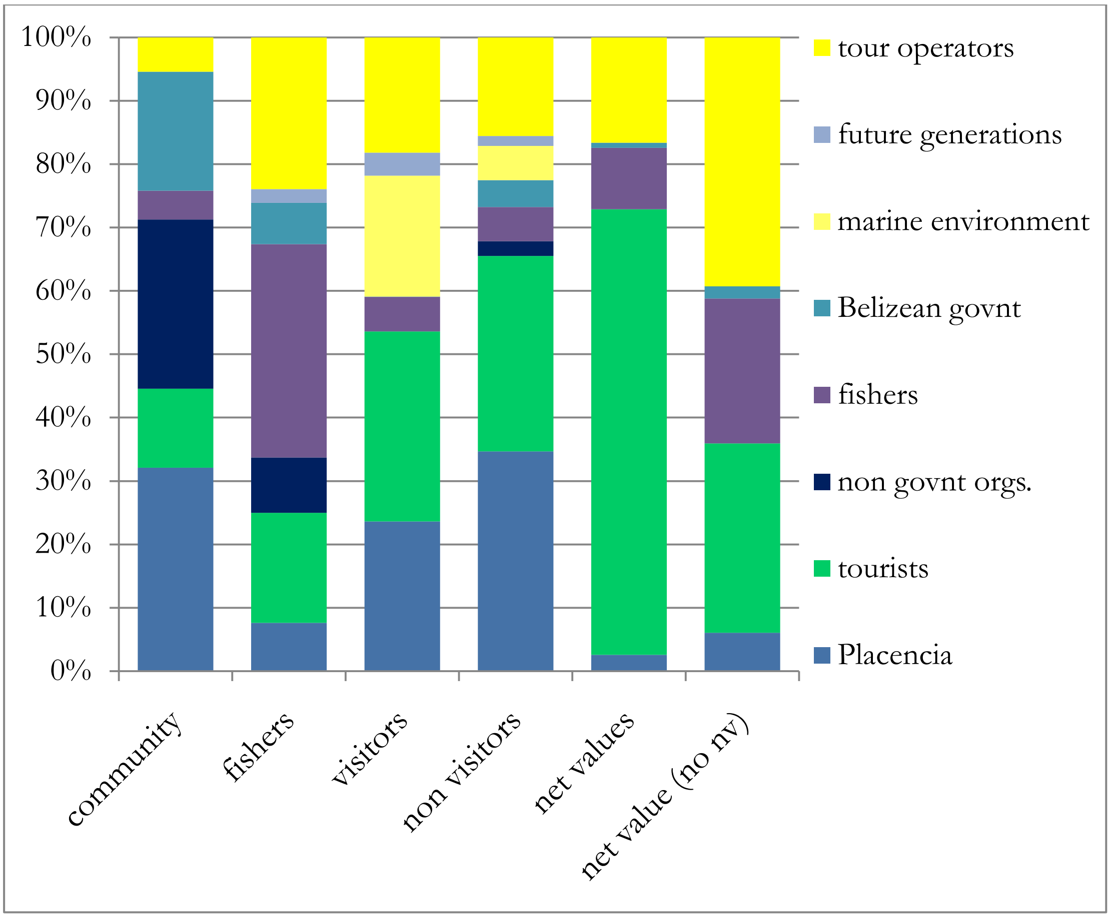

Figure 7.8. Who benefits from Gladden Spit Marine Reserve? Comparing responses from stakeholder perceptions and gross values quantified. The first 4 columns show perceived beneficiaries. The "net values" column shows actual beneficiaries from the values measured. The final column shows the distribution of actual benefits, but without the non-visitor values.

The government was most often cited as the body that should pay for the reserve, followed by tourists and NGOs (figure 7.9). The community had a strong preference for NGOs as funders. Visitors suggested that they themselves should pay, whereas non visitors cited the government. Overall, the percentage of funding that was expected to come from Belizean sources, such as the government, or local businesses, was only marginally lower that that expected to come from international sources such as NGOs and tourists. However, visitors expected Belizeans to fund more than international groups and the local community expected more funding to come from international sources, despite seeing themselves as the principal beneficiaries (figure 7.8).

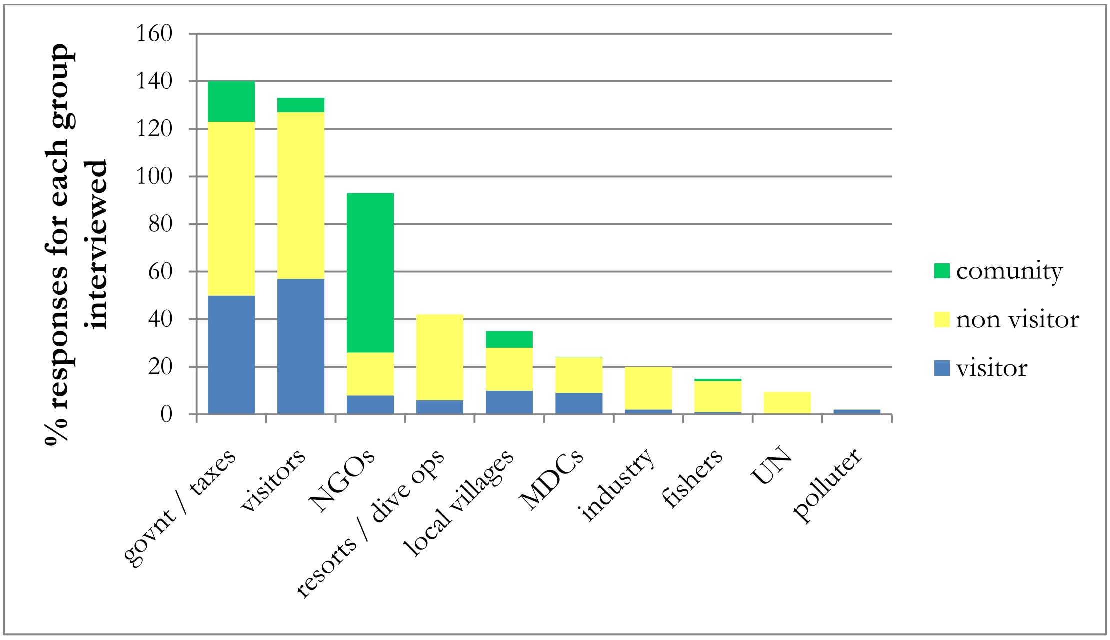

Figure 7.9. Who should pay for the management costs of GSMR by stakeholder group?

The majority of respondents thought there were no disadvantages to the reserve (figure 7.10). The community focused most on the expense, poor management outcomes, negative experiences with patrol rangers and too many restrictions. Tour operators focused most on losses for fishers, poor management and poor facilities, as well as overcrowding and ranger interactions. Fishers focused on their losses, as well as restrictions, poor management, the continuation of illegal fishing inside the reserve and overcrowding. Visitors focused most on coral damage from use, increased restrictions and losses for fishers. Non visitors were similar, although they also mentioned poor management, expense and corruption. The fact that visitors did not mention management issues suggests that they did not perceive poor management. While a third of the Placencian respondents thought there were no costs associated with tourism, 5% said that tourism had had a strongly negative impact on them personally, although none thought the same about its impact on the village. This indicates that they distinguish between personal and community impacts.

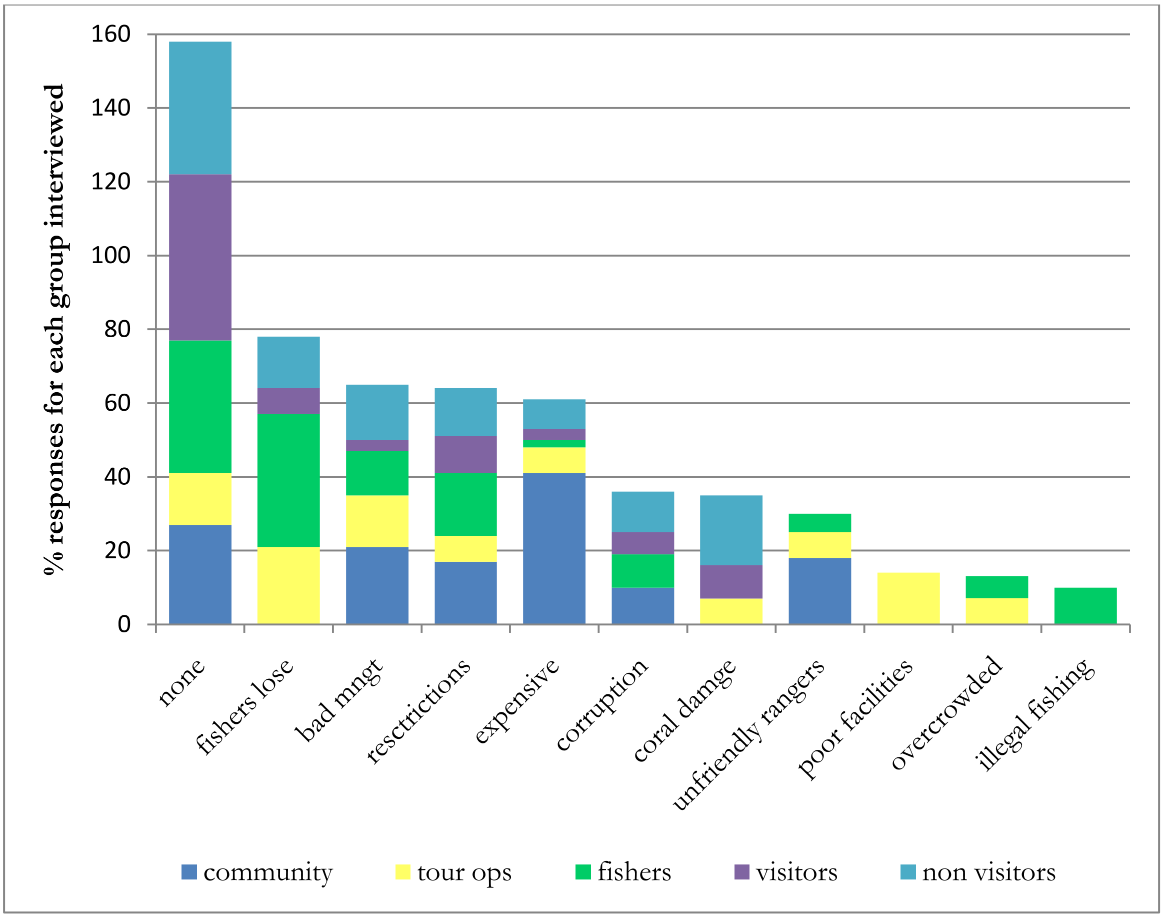

Figure 7.10. Disadvantages of marine reserves cited by each respondent group.

Community perceptions as to who should pay for and who should manage marine reserve were very similar, although they thought fishers should manage, but not pay for reserves (figure 7.11). When comparing who should pay and who benefits, responses suggested that NGOs are expected to pay whilst receiving relatively few benefits, which is in contrast to Placencia, which is perceived to receive benefits, while paying less of the costs. Tourists were expected to pay less than they benefit, which may be because community members are nervous of negative impacts on the numbers of tourists as a result of increased tourist expenses. Fishers were identified as the overwhelming losers from reserves, whereas fishers and tour operators were seen as incurring similar costs. Fisher costs were shared between many fishers (approximately 70) compared to tour operators (18), so per individual, tour operators incur in actuality the most direct costs. The community estimated relatively well the proportion of costs covered by tourists, but did not account for those of NGOs.

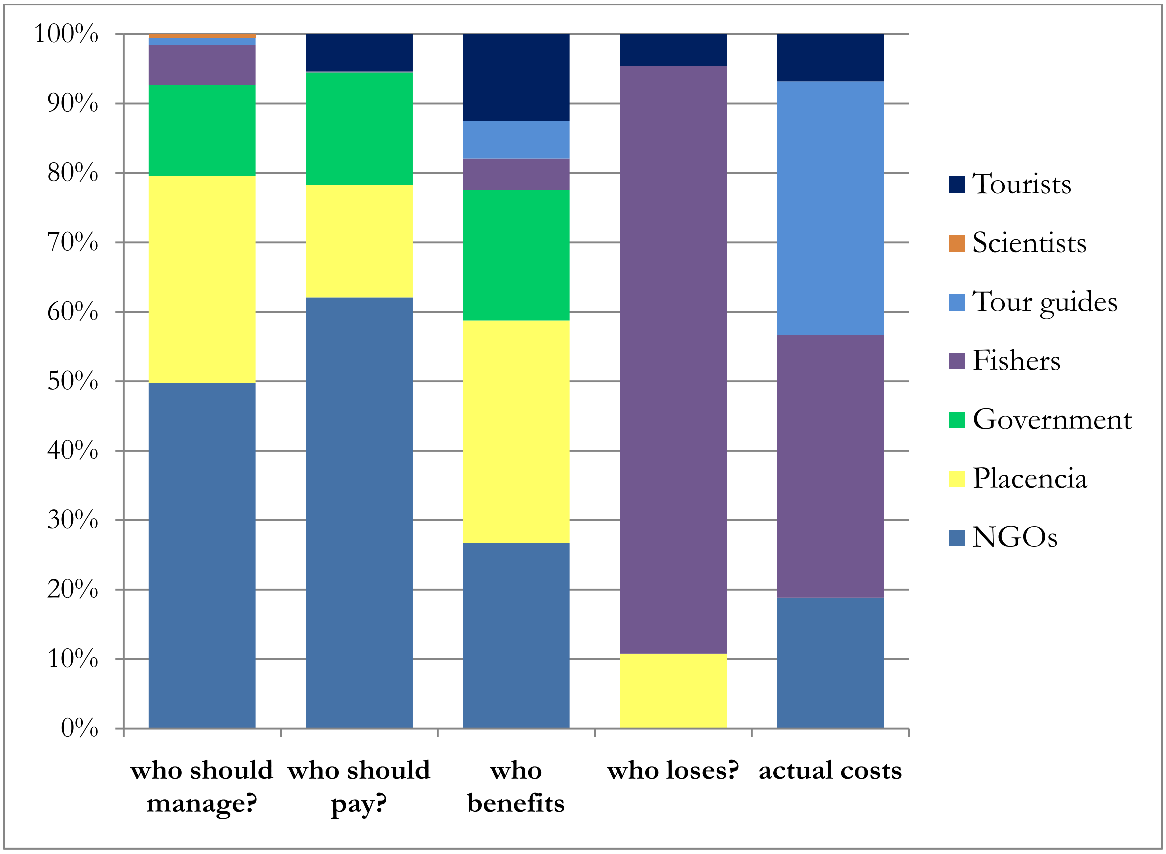

Figure 7.11. Community attitudes as to different equity related aspects of marine reserves. The first four columns show perceived distributions and the last column "actual costs" shows real costs measured here and reported in figure 4.

7.5 Discussion.

Contingent valuation (CVM) which was employed to measure consumer surplus (CS) values, proved to be flexible and intuitively simple to understand, especially as existing markets were often used. Non-use values and CVM scenarios which are more hypothetical are likely to be less accurate, but it is difficult to disentangle non-use and CVM issues (Carson et al., 1999). This is reflected in the effect of uncertainty calibration for community use values and higher standard errors for non-use values than for use values. Survey related variables which emerged as significant in both the tourist and the local community consumer surplus estimates should ideally not be present and they reduce the strength of confidence in the results. However, tests of theoretical validity such as income effects and sensitivity to scope suggest results are nevertheless accurate.

Use values reported here for tourists had smaller standard errors than the tourist non-use values and the use values of community members. This is likely to be due to the more hypothetical nature of the donation, taxation and access fees scenarios, in comparison to user fees which are already in place. The accuracy of fishery producer surplus estimates is hampered by the large natural variability in fisheries catches. The estimates given in table 7.1 provide accurate estimates of a wider range of net values than has been reported at any coral reef MPA previously, and which therefore can be used to examine total benefits in the context of management costs and the distribution of benefits.

I used both revealed and stated preference techniques to determine the 2007 economic values of the GSMR for a wide range of stakeholders. The values quantified were all measured net of costs, as gross values (often reported in other studies) overstate the true economic value of the resources. Tourists to Belize enjoy large non-use values, but of all the values quantified, these are likely to be the least accurate, as the donation scenario is not incentive-compatible (Carson & Groves, 2007). However, the similarity of non-use values between visitors and non-visitors suggests that stated values are relatively robust, despite one being coercive (with WTP being influenced by the belief that everyone else will pay for many respondents) and the other voluntary. The relatively small local non-use values could reflect relatively lower incomes or higher discount rates.

Community CS values associated with reserve tourism were larger than those for fishing access, despite the lower PS values tour operators glean, compared to fisher PS. However, this is likely to reflect the large number of secondary benefits tourism brings the community, the larger aggregate tourism PS and the fact that there are few full time fishers in Placencia. For fishing, indirect benefits could be related to traditional ways of life and fish as the primary protein source, but they are relative minor compared to income and employment benefits which filter through the community.

The PS per fisher day is slightly higher than that per tourist trip, which was unexpected given the lower incomes of fishers compared to those working in tourism (see chapter 6). This may indicate that fisher PS estimated here is too high, or that tour operators have overstated the costs involved in their businesses. Community non-use values may be partly reflected in stated WTP for recreational use (see chapter 6), but they are nevertheless much smaller than those of international tourists. This cannot be explained by income disparities alone and may also indicate that local communities value the reserve principally for the direct use values and less for conservation, or option, existence and bequest values. It may also reflect the fact that non-use values are more dependent on incomes than use values.

The high significance of non-use values in this case study (69% of overall value) is similar to that reported by Spurgeon et al., (2004), but higher than the 45-55% estimated by Wattage and Mardle (2008). However, the ratio of non-use to use values is similar to that of marine ecosystems reported by Hee Dong (2002). The relative importance of tourism, at 89% of the total value, is higher than the mean of 51% from the studies in table 2.8, but similar to the 79% reported elsewhere in the Caribbean (Burke et al., 2008). This relatively high value is likely to be due to the relatively small costs incurred by tourists and operators and because dive tourism in Belize and in Placencia is highly developed (McPherson, 2005). Fishing was estimated to comprise 10.4% of overall aggregated value, which is lower than the mean of 19% (from table 2.8), and may be due to the reduction in dependence on fishing as a source of income as tourism features more prominently in local livelihoods, the costs incurred in fishing in the reserve and its relative remoteness. While the aggregate values suggest local values are relatively small (0.6% of all values), this is because of the small population they apply to. However comparison of individual and household WTP shows that local communities enjoy large welfare gains from the reserve. Hence when comparing stakeholder values, both individual and aggregate values need to be considered.

The overall value of US$4 million for 2007 is small compared to the estimated value of Caribbean reefs of US$3-4.6 billion in 2000 (Burke & Maidens, 2004) and compared to the gross value of all of Belize's reefs of US$220-310 million per annum (Cooper et al., 2008), but this would be expected for a small reef (the exact area is unknown, but less than half the area has coral reefs). This research has also strived to be as conservative as possible, generating minimum estimates. It is difficult to compare the results directly with values calculated for other reefs, as they refer to sites with different levels of fisheries productivity, tourism development, local use, condition and crucially, different sizes and may or may not contain other ecosystems such as mangroves and seagrass beds. The estimated value of US$13-41 million over the next 25 years (with a 10% discount rate), is small compared to the NPV (with the same discount rate) of US$53 million for the Portland Bight MPA in Jamaica (Cesar et al., 2000), but this area is over double the size of the GSMR, meaning that they are broadly similar.

7.5.1 Missing benefits and costs

When considering the overall value reported here, it is important to consider whether the value reported is an overestimate or underestimate of the net economic benefits inside the reserve. Conservative assumptions have been made wherever possible, to avoid over-reporting values. Certainly the value of US$4.05million is an underestimate, as several goods and ecosystem services were not quantified, which nevertheless generate values at this reserve. Of particular note are a large number of indirect ecosystem services, such as biological support of fisheries elsewhere, biodiversity values such as those reported in Van Beukering et al., (2007) and in Carleton & Lawrence (2005), nitrogen fixation, carbon sequestration and waste assimilation (Moberg & Folke, 1999). This is largely because the biophysical aspects of these ecological services are poorly understood and difficult to model. Also, environmental economists have largely developed methodologies to monetise human preferences towards natural ecosystems rather than ecosystem services which may not be subject to preferences (Wattage & Mardle, 2008). Coastal protection values, which are often measured for reefs, were not valued here. This reef lies 26km offshore and there are other reefs and sandbars between the GSMR and the coastal villages. As a result the marginal protection it offers is small and subject to large uncertainty. In addition, use and non-use values of Belizeans in other nearby villages, or values associated with food or income security and cultural values associated with traditional ways of life were not measured, although they could be significant. This was due to time and budget constraints. Non-tourist residents of other countries may also hold non-use values, as was demonstrated by Spurgeon et al., (2004). Although the magnitude of values is likely to decrease with increasing distance from the site (Pate & Loomis, 1997), this may not universally hold (Ahmed & Gotoh, 2005) and in aggregate, these values could dwarf other values measured here.

There are also costs being incurred at this reserve, which have not been quantified. The most important of these relate to the local community, who have indirect costs associated with reserve tourism. The community identified these as increased crime, pollution and over-development (chapter 6). In addition, there is the opportunity cost which international donor funds produce, as these could have been spent on other development or conservation projects, although these funds may have gone to other countries. Fishers are also likely to have incurred indirect and opportunity costs associated with the no-take area and seasonal fisheries restrictions, but the fisher survey suggests that these are not large and that better than average catches in this area may compensate those fishers using the reserve (see chapter 6). Other fishers who may have been affected may simply have moved into tourism, which means they enjoy greater incomes. Several tourists also mentioned the congestion at this site as a disadvantage of the reserve. However, negative attitudes such as this are likely to have been reflected in their stated WTP. As a result, those costs which remain unquantified for stakeholders are small, although they would principally be expected to occur at the local community level.

The distributional analysis by stakeholder clearly shows that not all stakeholders have equal incentives to support the reserve. The majority of costs are felt by fishers and tour operators who are incurring costs of production. International NGOs receive no direct benefit, but they do support the values of the wider public indirectly, which would include to some extent international tourists to Belize. Visitors and non-visitors in contrast, enjoy large benefits and very small costs, as do the local community who are not directly employed at the reserve, although to a lesser extent. Figure 7.6 suggests that local, national and international stakeholders have equal costs, which is contrary to most protected areas (Balmford et al., 2003). If all Belizeans are considered locals (the country is unusually small), the more standard picture emerges of large local costs and only marginally greater net benefits. This means that further international funding could be justified and that the largest costs are indeed at the local level and the greatest benefits at the international level (Balmford et al., 2003; Wells, 1992).

Stakeholders had different attitudes about costs, benefits, winners and losers of MPAs. All stakeholders showed a high level of awareness about these aspects of the reserve. Although no group predicted the measured relative magnitude of costs and benefits by stakeholder group precisely, this was largely because they did not consider non-users, which skewed the distribution of benefits heavily. In general, each user focused on the area they most benefitted from and considered themselves the main beneficiary. This should contribute to a highly successful MPA and suggests that the NGO is doing a good job with education and outreach. The community identified NGOs as the principal managers and funders of the reserve, which is likely to be a result of management by FoN. Tourists consider the funding of MPAs as principally a joint responsibility between the government of Belize and tourists, as well as local business and communities to a lesser extent. Thus respondents often thought another stakeholder group should fund the reserves, despite feeling they benefit most. Tourists might be surprised to learn that the government does not contribute at all to the reserve costs.

Whilst tourists bear a relatively small part of the burden of overall costs, they do however, fund 65% of the management budget.

There is a strong perception of local communities and businesses that fishers are the principal losers from the reserve. However, fishers actually enjoy large profits from fishing at the reserve, which are likely to be due to enforced fisheries regulations and limited access to spawning aggregations. The opportunity costs suffered by fishers have been much reduced by the impact of tourism, which generates increasing income locally, especially as whale shark tourism has grown at the reserve. Thus increased tourism at this reserve has enabled both local increases in quality of life compared to other parts of Belize, but has also limited fishing access, which may increase benefits to the remaining fishers, although there is no time series data available to test this. This finding is likely to hold even if the missing costs are taken into account.

7.5.2 Implications for management and fundraising

GSMR's spawning aggregations and the whale shark aggregations that come to feed on the spawn make this area unique and add significantly to the reserve's value. This special feature of this case study MPA needs to be protected, with access to fishing and whale shark interactions limited to ensure that future benefits are not lost. Many tour operators are able to trade and employ staff in part due to the whale sharks and day trips to the reserve. The limited access to fishing during spawning aggregations and tour trips during the whale shark season are also likely to be a key factor in determining the magnitude of PSs measured for local fishers and tour operators, although this has not been directly tested.

Omitting non-use and local community values, as other coral reef valuation research frequently does, would have led to a serious underestimate of the true value of this reserve. It is important that studies do include these values to ensure that investment in reserves is proportionate and to identify marginalised stakeholders who should be the focus of management actions. Similarly, gross values will overstate benefits and stakeholder analysis is necessary to understand the distinct incentives each stakeholder group face, which are not represented in efficiency related analyses.

The values measured are unlikely to persist unless effective management remains, since reefs in the Mesoamerica region have suffered serious declines and remain threatened by overdevelopment, pollution and other stressors (Wilkinson, 2008). This is supported by the community survey, which revealed that community members consider the key threats to coral reefs to be pollution and over-development (chapter 6). The tour operators and fishers also expressed concerns as to the ability of marine reserves to protect fisheries, to control tourist visitation in the whale shark zones and to counter threats. In addition, in June 2009, the GSMR was added to the list of "World Heritage sites in danger". This was as a result of excessive tourism development and mangrove clearance and is intended to encourage policy makers to act quickly to increase protection.

Valuation studies such as this make clear the potential economic losses that could occur if reefs were further degraded, which would reduce the welfare of local stakeholders through impacts on tourism and fishing (although there would be expected to be a lag time. This is because recreational values are sensitive to coral reef quality and because healthier reefs have higher fisheries yields (Chou, 1998). The maintenance of the current values depends to what extent these reefs are protected from overfishing and overuse, including by tourists, and are able to maintain their resilience to more pervasive challenges such as warming and acidification. Effective management depends to a large extent on adequate financial support. In addition, further funding would be likely to result in better enforcement, research and community outreach, which could increase the value of this reserve even further.

Historically, financial support for reserve management has been made possible through government funds (which have been raised partly through a tourist departure tax) and through the support of international NGOs and foundations. Indeed, the management body has received US$235,000 in grants for GSMR and its neighbour in the last 10 years, principally from international sources. The Gladden Spit Marine Reserve constitutes an efficient use of national and international funds, both in terms of conservation of habitats and biodiversity and in terms of the secondary welfare impacts they produce, since for a relatively small investment they protect resources with large net economic benefits. Currently management costs are only 12% of the values measured for 2007, suggesting that this reserve is an efficient investment of conservation funds and tourist dollars. The extent to which other reserves represent a better or poorer use of donor funds should be a focus of future research.

Of great interest to managers of any coastal marine system is to capture at least a portion of this rent to pay for the necessary management, and potential enhancement, of the resource (Ruitenbeek & Cartier, 1999). The values estimated for the GSMR could be important when considering policy actions. Whilst demand curves have proven unreliable in practice at some sites (Lindberg, 2001), I demonstrated that current fees do not capture a large proportion of visitor consumer surplus and could be raised if increasing revenues was a primary goal of the MPA (e.g. to improve the self-financing capacity of the reserve). Also, this MPA could raise significant extra funds through an increased departure taxes for non-visitors, who in aggregate have the largest values for this reserve. In 2007, a portion of the user fees collected were being returned to the Belizean government. These results demonstrated that the GSMR generated almost US$1million in welfare benefits for Belizeans in 2007 and that the per individual consumer surplus values for local residents are greater than those of tourists. Furthermore, local residents receive many secondary benefits from the tourism and fisheries benefits that are generated by the marine resources in this reserve. The role of the reserve in maintaining community welfare could be used as an argument for maintaining government financial support for the management of this MPA.

Discussion and Recommendations.

8.1 Key findings.

This research used two approaches to examine the links between economic aspects of MPAs and their effectiveness. The global study evaluated the performance of MPAs against ecological and socio-economic goals, as well as analysing the factors driving each distinct facet of MPA performance. The detailed case study quantified a range of costs and benefits generated by the reserve and examined the real and perceived distribution of these costs and benefits for local, national and international stakeholders.

The global study highlighted the fact that MPAs are not a homogenous group. They vary widely in the contexts in which they occur, the features and resources they have and the management actions which they carry out. In addition, they differ in terms of the ecological and socio-economic outcomes they produce. Whilst it has been generally acknowledged that many MPAs have no active management, this analysis demonstrates that even those with active management will not necessarily produce habitat or fisheries benefits, whilst nevertheless being perceived as successful. MPA performance has often been measured by assessing status of chiefly biological variables, or by assessing which actions are carried out, which conflates the action and the expected result. However, this research uses comparisons over time and compared to unprotected areas, wherever possible, to evaluate outcomes. Those MPAs which are improving over time and out-performing conditions outside are not always the same as those which currently have high coral cover or support many jobs.

The global study also suggested that many MPAs had generated significant benefits for local communities, in terms of income and employment benefits, whilst at the same time, producing only minimal opportunity costs from banned extractive activities. This is important from an equity perspective, as local benefits are necessary for local support and compliance (Mascia, 2004). However, the divergence between regulations and activities occurring, the low levels of punishment, coupled with often small no-take areas, limited fishing regulations and no set carrying capacities in many MPAs means that ecological benefits may be being traded off against socio-economic benefits for local communities and tourists. This may be one of the causes of conflict, which had been reduced in relatively few MPAs. The MPAs included in the sample, whilst broadly representative in terms of the regional existence of MPAs and IUCN categories, are likely to be the best performing MPAs. This means that the results presented here reflect the 'best case scenario'. Since few MPAs are reported to have have produced fisheries or ecological benefits, and that few have out-performed outside areas, despite a huge investment in funds, this is cause for concern.

The threat analysis revealed that MPAs face a mean of 3.3 large scale threats and that often these are beyond the control of the manager. Those MPAs which were situated in countries with coastal zone management or who had fisheries regulations outside their boundaries had showed improved outcomes. These facts suggest that policy makers should not rely solely on MPAs for coral reef conservation. For those MPAs who have inadequate financial resources, valuation could be a useful tool, to identify beneficiaries and to provide a basis for charging polluters.

The local study demonstrated that visitors hold a suite of values associated with the GSMR. Non-visitor non-use values were of very similar magnitude, despite having been elicited with a (more conservative) taxation payment vehicle. Welfare benefits to Belizeans were demonstrated by the high local community consumer surplus values, associated with use and recreation at the MPA. Significant producer surpluses were also quantified. The limited access for tourism and fishing to the site contributed to the magnitude of these. Non-use values made up a large part of the values measured, which underscores the importance of including them in valuations, although community non-use values were minimal. Non-use values can be captured, for example through donations, so they can constitute an important additional source of revenues. Aggregate values were found to have different relatively magnitudes from per individual values and are more salient in terms of revenue raising.

The cost of management was small in relation to net benefits measured, which means that this reserve represents an efficient use of funds. The stakeholder analysis showed that the costs at this reserve are equally distributed along local, national and international scales. This is contrary to what has been hypothesized at protected areas elsewhere (see section 2.3). However, the GSMR is unlikely to be typical of other MPAs in developing countries, due to its relative inaccessibility, the relative affluence of local people compared to elsewhere in the country (McPherson, 2005) and the development of whale shark tourism. However, stakeholder groups did not incur equivalent costs. Tour operators, fishers and international NGOs incurred the greatest share of the costs, whereas the large majority of benefits accrued to international tourists. Importantly many stakeholders perceived fairly accurately the type and distribution of costs and benefits at the reserve. This further supports the conclusion that the provision of local benefits is crucial for MPA performance.

Overall, MPAs continue to be established, as they are expected to provide habitat and conservation benefits, as well as a range of other benefits (Sanchirico et al., 2000). Yet there is a discrepancy between their goals, the resources they have and their outcomes. This research supports previous assertions that MPAs are necessary, but not sufficient to protect coral reef ecosystems (Jameson et al., 2002), that the majority of MPAs are failing to meet the large expectations which have been placed on them to produce conservation and development goals or to fulfil their management objectives (Allison et al., 1998) and that MPAs have yet to realise their potential (Mascia, 2003). It is hoped that research such as this, can critically examine which conditions are most likely to enable MPAs to produce both ecological and socio-economic benefits, and so help to improve their performance and the impact of conservation funds.

8.2 Contribution to knowledge.

The case study in Belize quantified a larger range of economic costs and benefits than has been measured at a single MPA before using primary data. This contributes to our understanding of the relative magnitudes of distinct values which are enjoyed by a wide range of stakeholders, including both users and non-users. It enabled an exploration of the motivations and factors behind willingness to pay towards the reserve, which is especially lacking for non-visitors, which can be useful when designing revenue raising strategies. A demand analysis was also employed to help determine user fees which could be used at the reserve to support a range of policies, or to inform damage assessments. Distributional analysis by stakeholder group and by scale was also employed, which has not been done at a coral reef MPA, to the best of my knowledge. This provides an understanding of the incentives different groups face for conservation. This information could be used to try and re-distribute costs more equitably, for example by charging proportionally to benefits, or using targeted education, rebalancing policies, informed institutions or fiscal initiatives.

The estimation of economic values for the case study MPA was also used as an opportunity to explore various methodological issues related to contingent valuation for local users and visitors to a coral reef MPA. The tourist-related research investigated the impact of the order of the valuation questions, the decision making process when respondents are considering their willingness to pay, including the extent to which they considered others in their choice and compared the results from face-face versus self completed questionnaires. In addition, the non-visitor survey examined the effect of anchoring bias linked to knowledge of current departure and environmental taxes and the community survey examined the correct application of certainty bid estimates, respondent sensitivity to scope in terms of uses allowed and in terms of one versus several MPAs.

The global study developed measures which relate to distinct facets of MPA performance, in terms of outcomes, threats and goal achievement. A key strength of these measures, was the emphasis on demonstrating additionality, compared to areas outside the MPA, which produced different conclusions as to which MPAs had been "successful" than simply measuring current conditions, such as compliance or coral cover. These measures can be assessed more widely using the approach employed here of expert knowledge, at minimal cost. Another strength of the expert approach utilised here was the inclusion of MPAs from all over the world, which generated a quantitative dataset, which was adequate to test drivers of performance using a single methodology, which has not been done before on a global scale for coral reef MPAs. Hypotheses developed from previous research were also explicitly tested, to understand the combinations of endogeonous and exogenous variables which determine outcomes. These findings can be used to provide recommendations for MPA management. For example, it is recommended that certain management actions are more effective than others in producing results, that management actions need to be chosen based on MPA aims and taking into account major threats.

8.3 Policy Recommendations.

The research described here points to various policy recommendations, both for the management of individual MPA and for MPAs on a broader scale which can be made to policy makers and managers;

- Use valuations to help raise revenues and sustainable financing. CVM is a useful tool for this purpose. For example through raising stakeholder, policy maker and donor awareness of values and impacts generated, to justify additional investment to protect and/or to enhance benefits or to identify more kinds or more equitable sources of funding. Methods need to be developed to reduce the costs of such studies however, as valuations are time consuming and methodologically challenging.
- Use net economic values, rather than gross financial values to understand the incentive structures generated by management for local stakeholders. Include both non-use and local community values for conservation in natural resource valuations to support informed decision-making for policies and investment in protected areas. Contextualise local values with local incomes and welfare changes, as aggregate values emphasise benefits which beyond to those with more income.
- Enhance and adapt MPA management decisions. For example through the establishment of baseline indicators to judge policy impacts or management goals, to choose investment priorities, to understand incentives faced by illegal resource users, to understand trade-offs implicit in management decisions, to provide information for cost-benefit analysis, to enable full cost accounting and therefore to ensure the maximisation of benefits through targeted management based on whole range of values, beyond only financial analyses.
- Use valuation to realise improved policy or management through influencing legislation, designing interventions (taxes, regulations, incentives) such as appropriate price setting or controlling visitor numbers, to identify marginalised stakeholders, to inform damage assessments to aid compensation claims for shipping accidents and other environmental impacts or to predict how different policies or initiatives will differentially impact individual incentives and behaviour. Valuation can be limited to the most policy relevant and aspects such a consumptive and non-consumptive use values, where there are concerns over the validity of non-use and indirect value elicitation in a particular location or situation.
- Use performance evaluations as a tool for adaptive management, by repeating them over time, to chart increases or decreases in performance. This should involve

standardised performance measures which demonstrate additionality, by using controls and trend data to measure performance over time and using spatial comparisons. Regular monitoring of ecological and socio-economic variables will provide data for analyses to determine the impact of policies or management changes over time. Evidence of positive changes compared to other areas can also be a good way to increase donor funding.

- Consider costs incurred by stakeholders and consider compensation or the provision of benefits through community projects, to minimise negative impacts on local stakeholders and therefore reduce conflict.
- Focus on increasing resilience inside MPAs, to counter large scale threats which originate outside the MPA. Establish carrying capacity, use mooring buoys, and educate tourists, to minimise coral damage.
- Ensure MPAs new MPAs have minimum requirements likely to be necessary (see section 2.2.3). Focus on improving management in current MPAs, rather than lots of new designations (as chapter 4 shows spending has a large influence on performance).

8.4 Recommendations for future research.

There is considerable scope to use the values quantified here and for coral reefs and MPAs in other valuation studies. At the case study site, costs and benefits which were not incorporated into the analysis, such as opportunity and indirect costs, could be quantified, to further add to the understanding of the incentives that are likely to be driving illegal behaviour within the park. Values here can be modelled in the context of national and regional trends in fisheries, tourism, coastal development and climate effects, to see how there are likely to be affected. This research should specifically take into account inter-relationships between different values, some of which may reinforce one-another and others which are mutually exclusive.

Modelling future scenarios is helpful as a management planning tool and as a way to implicitly calculate the value of management in the future (Cesar et al., 2000). This can also serve to highlight incompatible goals and potential future problems. Valuation studies currently rarely utilise this information, despite the fact that current values are likely to alter significantly as reefs are degraded and other threats emerge or management measures are put in place (Burke and Maidens, 2004), limiting the usefulness of complex and expensive valuation studies for policy development and adaptive management.

There are currently few models which seek to understand conservation-related behaviour related to economic aspects of conservation policies or projects. There is a dearth of information on the links between stakeholder incentives (which are largely determined by cost and benefit distribution) and their behaviour. Since poaching is commonplace in many MPAs (Mora el al., 2006), this should be considered a priority for research. For example, more research is needed on the impact of distinct kinds of positive and negative incentives (such as fines, alternative livelihood training, rewards systems etc), on local and non-local poacher behaviour. By understanding real incentives currently being generated by MPAs and potential impacts of social or economic interventions, poaching, which undermines many of the benefits of MPAs, can be better tackled.

Other research which is needed, related to MPA costs, benefits and effectiveness, including;

- Development of methods to quantify indirect values, such as nursery functions, insurance and option values, as is increasingly done in the terrestrial ecosystem research.
- Development of methods to quantify marginal changes in values which occur from increased management and ecosystem decline, which are constitute the value of management, rather than the ecosystem in question (Pendleton, 1995).

- Undertaking distributional analyses on a wider scale, as these may partly determine variations in MPA performance.
- Model trade-offs between values generated by different investments, regulations or policies which could occur in the MPA, e.g. increased investment and enforcement, increasing no-take areas.
- Testing demand curve elicitation for entrance fees and other revenue raising mechanisms, which have previously compared poorly against valuation generated predictions (Lindberg, 2001).
- Further explore survey effects of CVM, such as the impact of non-familiarity, the type of survey, ordering effects and the application of certainty bids.
- Investigate temporal components of benefit provision, to inform assessments of conservation success.

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Appendix.

Appendix 3.1 Management effectiveness methods, metrics and Applications for evaluating Marine Protected Areas.

Name of method (reference)	Definition Effectiveness	Methods / Notes	Applications / results
Coral reef management effectiveness (McClanahan et al, 2006)	The percentage difference (95% CI) in the total biomass of commonly targeted reef fishes between managed/ conserved reefs and matched control reefs without management/ conservation.	Measured number of ecological variables using under water visual surveys, replicated at 12 sites (divided into 3 management categories). Coral cover was not deemed an appropriate indicator, as this showed a weak relationship to management. Socio-economic variables were measured using household surveys, key informant interviews and participant observation	Traditionally managed areas were doing the best. They found that higher levels of biomass were positively linked to compliance, reserve visibility, reserve age and negatively linked to market integration, wealth and village population size. They also looked at density of target fish species, species richness, percentage of live coral cover and coral diversity. These other indicators were did not produce any significant differences between inside and outside sites. They conclude that this is because only parameters that document changes in the most heavily targeted resources are effective indicators of management success.
MPA success (Christie, 2004)	An evaluative matrix. Biological variables are; increased fish abundance, fish diversity and live coral cover. Social variables are; broad stakeholder participation, equitable sharing of economic benefits and conflict resolution mechanisms.	Used published work and biological and social field research, plus visual surveys and in-depth semi-structured interviews from key informants. Criteria coded as yes, likely, possibly, in the past and no.	Used to review 4 MPAs in South East Asia, all of which met biological criteria more consistently than social criteria.
Marine Protected Area Evaluation Model (MPAEM) (Alder et al, 2002)	Multidisciplinary approach to explore the sustainability of fisheries in; renewable resources, non-renewable resources, market values, social equity, ecosystem functions and efficient management	Based on rapid appraisal of fisheries (RAPFISH). Results recorded from 0-100, using multivariate ordination. Used managers and researchers linked to an MPA.	20 MPAs all over the world.
(Hockey and Branch, 1997)	Broad criteria to measure performance on MPAs in scientific, practical, social and economic performance against management objectives.	No measure of uncertainty included in criteria. Some are combined.	
How is your MPA doing? Pomeroy et al, 2004	The degree to which management actions are achieving the goals and objectives of a protected area.	Is intended for a manager. Identify your MPA goals and objectives A mixture of potential indicators, of which 10 are biophysical, 16 are socio-economic and 16 are governance related indicators. Chosen with reference to	Piloted at 17 sites. Found lack of capacity and difficult to involve local community, plus lack of clear definition and understanding of the MPA goals and objectives. Need guidelines how to use

		MPA goals from management plan. Needs clear objectives, a management plan, baseline data and to have been running for at least 2 years. Quantitative. Time consuming. Usually requires primary data.	results. Need to incorporate temporal aspects
COMPARE (Criteria and Objectives for Marine Protected Area Evaluation).	The system comprises a matrix of 14 objectives against 17 criteria, with each scored on a scale of 0-2. The scores are then totaled to give a sum for each reserve.	3 categories are biotic protection, fisheries management and provision of human uses.	Used in Alaska Woody et al, 2002.
"Measures of Success" framework (Parrish et al, 2003).	The three goals of biodiversity health, threat status and abatement and conservation capacity.	Focuses conservation impact (outcomes) in 2 areas: the assessment of threats to biodiversity, and the ecological health of those species, communities, and ecological systems that are the focus of conservation action within protected areas. Focus on impact and outcomes. Identifying focal conservation targets, and their key ecological attributes, acceptable range of variation to rate target status.	
Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) methodology (Ervin, 2003)	Scoring the various elements of management effectiveness (e.g., biological importance, planning, inputs, and processes). It also qualified the extent, impact and permanence of past pressures and future threats within protected areas.	Questionnaire during participatory workshops (with managers, staff, administrators, and other stakeholders). Uses perception-based, qualitative scoring to identify trends. Was developed at a system level tool for terrestrial Pas with >100 indicators. Adapted for MPAs	*Implementation of the RAPPAM methodology in Bhutan, China, Russia, and South Africa. Five threats emerged warranting concerted policy effort: poaching, alien plants, tourism, logging, and encroachment. Similarly, five management issues emerged that influence protected area management effectiveness: funding, staffing, research and monitoring, resource inventories, and community relations. Applied in 13 sites in Mesoamerican MPAs (Arrivvillaga, ????)*
World Heritage Management Effectiveness Workbook (http://www.enhancing heritage.net (Hockings et al, 2004)	Fulfilling semi-qualitative ratings for all 6 stages of the management component.	Site level assessment. Tables on each of the mngt elements are filled in and reviewed by stakeholders. Low cost, direct involvement. Broad scale analysis incorporating wide range of views from internal and external participants. May not be useful for all Pas. Can require funding.	Used at Aldabra and Great St Lucia wetlands park. Pilots have taken 6-12 months.
MPA Report Guide and Rating System (http://www.coast.ph/text/MPA%20Report%20Guide%20Local.doc)	??	Contains a survey developed for use as part of a national rating system for Philippine MPAs. Survey addresses mostly context, processes, and outputs. Qualitative and semi-quantitative	Quick and simple. Allows comparisons across sites if used consistently. May need to be adapted for use by MPAs elsewhere
Coral reef management in the Western Indian Ocean (Wells and Manghuiabai, 2005)		Implementation team complete worksheets. 2-3 weeks and these are reviewed. Simpler version of Hockings et al (2004)	8 sites in Africa. Fear of admitting weaknesses. No standards for mngt in mngt plans. Encouraged stakeholder dialogue. Should have included funding section. Goals not well enough defined. Few good baseline surveys. Poor monitoring. Limited socio-econ

			monitoring. Some evidence reefs inside recovered faster. Key threats are bleaching and destructive fishing
Healthy reefs for healthy people (McField and Kramer, 2007)	Healthy reefs are those with specified ranges in a variety of ecosystem structure (12), ecosystem function (15), drivers of change (15) and social well-being and governance indicators (15).	Synthesises existing data for key indicators for reef health and reference standards for these indicators. Ideal, benchmark and problem levels are defined for each indicator. No attempt is made to add them.	Only just printed.
World Bank GEF MPA project scorecard (Staub and Hatziolos, 2003)	Current status and appropriate and effective context and planning (the management process).	Focus on process of mngt cycle. Scorecard filled out by MPA staff. Takes 1/2 day. Focus on appropriateness and effectiveness. Assumes equal weighting of variables. Includes for context: legal status, regulations, enforcement, boundary demarcation, coastal management plan, resources, stakeholder awareness. For planning: objectives, management plan. For inputs: research, staff, budget. For process: education, communication, participation, indigenous people, staff training and equipment, monitoring and evaluation. For output: context indicators, products and services, mechanisms for participation, educational activities, management activities, visitor facilities, fees and staff training. For outcomes: objectives addressed, threats reduced, resource improved, welfare improved, env awareness, compliance, satisfaction. Does not asses impacts.	Marine version of WB?WWF tracking tool
WWF/CATIE evaluation methodology	The achievement of conditions for indicators of inputs and processes and to a lesser extent outputs at a site	Uses quantitative scoring system of hierarchy of indicators of different aspects of management performance. Each indicator has conditions and the optimum value is earned if these are all met. Results are presented as 5 of total score. Uses evaluation team.	Developed in central America, especially for forest ecosystems. Used in the Galapagos national park and the results were incorporated into new management plan (Cayot and Cruz, 1998);. Adapted for MPAs by McField 2007).
PROARCA/CAPAS Monitoring strategy (Corrau, 1999)		Developed at workshop, monitors 43 indicators in 17 management factors (inputs and processes). Score maximum of 5 for each indicator, Done at stakeholder workshop.	Used in some Central Amercian MPAs to improve conservation financing and to improve ecotourism capabilities. (http://www.irgltd.com/Resources/Publications/LAC/2001-10%20Results%20in%20PROARCA-CAPAS-Guatemala.pdf)
Protected areas or threatened spaces (Ferreira et al, 1999)	Focus on status of management and vulnerability of PA	Uses mainly quanitative multiple choice questions, scored on 6-point scale.	Used to evaluate 86 PAs in Brazil and then to promote these areas by WWF.
State of the Parks	key themes of: - natural values management, including fire management; - cultural heritage management; - recreation, tourism and visitor	Qualiatiatve and quantitative	Used in Victoria, Australia for terrestrial and marine PAs. Relseased in report.

	appreciation; and - community involvement.		
World Bank / WWF tracking tool	Protected areas are fulfilling high standards in the key management design, appropriateness and delivery criteria of import	Rapid assessment to track changes in effectiveness of management. Given up to three points in 30 indicators from all parts of management cycle. Total score is summed. Quick and inexpensive.	http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/07/14/000160016_20050714165152/Rendered/PDF/32939a10ENGLIS1InProtectedAreasTool.pdf
MPA network learning tool	Current progress in MPA implementation, including strengths, weaknesses, knowledge, enabling conditions and local context.	Questionnaire filled out by managers ad other partners. Explores site stresses, objectives, stakeholders, management implantation and context, enforcement, compliance, problems, conflicts, policies, strategies, plus observed outcomes related to biophysical, social and MPA benefits, plus national and international context. Graded qualitatively or yes/no.	
Success for community based MPAs (Pollnac and Crawford, 2000)	Measures of success (several composite measures): difference in coral health, difference in mortality index, perceptions of resource abundance, MPA features, degree adherence to rules, community member mngt empowerment	perceptions of resource abundance– 3 point scale MPA features – one for presence each feature. Range 0-7. Degree adherence to rules, used consensus from expert panel, ranked from 0 -5 based on many factors Community member mngt empowerment – consensus expert panel ranked from 0-5 based on many factors	
successful community coastal resource management Pomeroy et al (1997)	Develop indicators associated with for 5 categories; access, compliance, conflict, control and harvest.	Explored independent variables related to jobs, resource related variables and co-operation related variables. Used PCA and correlations.	Community and fisher co-operation were significant predictive variables for four of these 5 indicators. Perceived resource crisis was important for 2 indicators, as was post implementation influence.
Sustainability of resource use and management in MPAs Senaratna (2001).	Used indicators for 5 categories; general MPA attributes, resource uses and issues, institutional framework and MPA implantation, socio-political and socio-economic contexts.	Used primarily secondary data. Used to assess combination of factors enhancing and constraining sustainability.	For 4 MPAs: Following factors were significant; empowerment, user and government commitment, institutional framework and strong national policies and legislation, management plan, adaptive management approach, independent governing body, economic and political stability and geographic location.
"Five-S" Framework for Site Conservation Planning (TNC, 2000)	Success linked to measures of biodiversity health and threat abatement at a site. Implicit conservation goal at a site is to maintain viable occurrences of the conservation targets.	Tool for site planning and conservation success evaluation. Focus on systems, stresses, sources, strategies and success. Biodiversity health, species or community viability, threat status are ranked. The conservation capacity is categorised using 7 indicators e.g. staff and project funding.	
Evaluation of management effectiveness of MPAs of Mesoamerica (MBRS, 2004)		Quantiative levels given for each indicator and summed for biophysical, socio-economic and governance fields. Suggest using weighting, but do not develop. 19 essential metrics; 11 of which are biophysical e.g. salinity and percent coral cover and mangrove density and 8 socio-	Also identify 24 additional measurements e.g. dissolved nitrogen, coral recruitment, spillover, public opinion surveys and contingent valuation.

		economic variables e.g. value of fishery landings and tourism activity, cost per unit no-take area and ratio legal: illegal behaviour.	
(Alder et al, 2002)	Multiple objectives: - maintaining natural capital of living resources, - appropriately valuing MPA resources, - maximizing economic benefits of non-renewable resources, - meeting societal expectations, - maintaining ecosystem functions, - ensuring management efficiency.	- 10 attributes of the dynamics of fisheries (stocks of target & non-target species, CPUE, recruitment rate, change in trophic level) - 6 attributes of resource extraction (threats, impacts, exploitation rates, compensation, capital) - 10 measures of economic performance (GDP, wages, profitability, access-entry, diversity, ownership, fees, consumer rate) - 10 criteria of social equity and value (no-net loss, growth, conflicts, stakeholder influence & association, wastes, entry, illegal activity) - 10 attributes of management process (planning, implementation, MCS, research, monitoring, awareness, assessment, review, training, emergency measures) - 10 indicators of ecosystem function (size, capacity, corridors, linkages, habitat, species & habitat diversity, disturbance, pollution, mitigation)	
Progress and Outcomes of Integrated Coastal and Ocean Management *(*Belfiore et al., *2004)*	Improvement in indicators chosen to assess progress and desirable outcomes in Integrated Coastal and Ocean Management.	Based on Driver-Pressure-State-Impact-Response (DPSIR) framework. Performance indicators are linked to specific objectives. Include 15 governance indicators e.g. existence of adequate enabling legislation and use of economic instruments, 9 ecological indicators e.g. biological diversity, mortality and water health and 13 socio-economic indicators including total economic value, direct investment, employment and marine dependency.	Case studies in 5 countries suggest need baseline information and classification schemes to interpret results. Difficult to define boundaries. dependent on a data and information management and reporting system
Marine integrated decision analysis system Conservation international (in prep)	Decision support software tool for management effectiveness	Designed to understand factors affecting outcomes, to predict future conditions and feedback based on changes. Panel 1 contains 12 socio-economic, governance and ecological vars. Panel 2 contains outcomes – can see each of the 6 at once; state of governance outcome, quality of life outcome and ecological resilience index. Panel 3 shows a cell input and GIS map of threats based on the info in panels 1 and 2 and percent of biodiversity layers.	Still being developed
Sustainable use of natural ecosystems Hockings et al, 2000	Global conservation through management intervention analysis.	- estimate population size of key species - estimate extent & condition of critical habitat - calculate the magnitude of key ecosystem performance indices (ie: P/R) - measure the extent of income derived from "sustainable" production	

Kelleher et al, 1995	- area under protection - existence of enabling legislation - existence of a management plan - evidence of active management actions	Global Multiple objectives depending on the MPA (1306 examined). Postal questionnaire.	29% are failing to meet their objectives. 71% have unknown management (unassessed) and the median size is only 16km². Much of the area is zoned for resource extraction, enforcement is poor and the outcome of zoning is poorly known. Of the remaining ones, 31% had achieved their management objectives, 40% had a moderate achievement level and 29% generally failed to achieve management objectives. Only 9% had a "high management level that generally achieved their management objectives". Over 66% of Caribbean and 90% of East Asian MPAs have not reached their management goals. 20% of 150 marine bio-geographic zones have no type of protected area designation.
Multiple objectives For tropical MPAs Alder, 1996	- resons for establishment - existence of enabling legislation - existence of a management planning - constraints to implementation - involvement of stakeholders - evidence of educational outreach - perceptions of success	Surveyed perceived success in MPA management in 65 tropical countries (N = 90), where respondents were government and nongovernmental managers and academics.	Only 43% considered their MPA successful, 35% considered their MPA a failure, and 20% were undecided or neutral.
Belize barrier reef (McField, 2000)	Multiple objectives measured using indicators.	Unweighted rating (%) of degree of success in meeting 6 crtiteria. N = 8.	Find MPAs lack adequate personnel, facilities and funding for effective mngt. Little evidence that user community knows about goals and supports mngt, or that there is much punishment for violating regulations. Do not think marine resources are being well preserved, despite reserves.
Australia: Great Barrier Reef Marine Park Sweatman 2002	3 issues critical to successful management: - Maintaining conservation, biodiversity and World Heritage values; - Ensuring that all industries are ecologically sustainable; - Reducing land based impacts on water quality.	- annual measurement of live hard coral cover and crown of thorns starfish density on 168 reefs along 8 cross-shelf transects - annual censuses of reef fish abundance on 25 reefs spread along reef in protected and fished areas - disaggregated fishery landing statistics for all commercial and major recreational fisheries compiled annually - monthly water quality and nutrient concentration analyses from 14 sites along the coast - logical framework analysis of objectively verifiable indicators of management activity	
Reefs at risk (Burke and Maidens, 2004)	Qualitative ranking based on existence of management activity, a management plan, human and financial resources and level of		

	enforcement.		
Chumbe Island, Tanzania Francis et al (2002)	4 indicators of success; Measurable increases in bioD. Establishment for necessary features for management e.g. marker buoys, offices and patrols. Compliance to park rules. Level of support and participation.	Review size and location, type of MPA, zonation, and financing for Eastern African MPAs.	Main sources of financing are government funds, bi and multi-lateral donors and foundations which usually provide project by project funding for short time periods for infstructure, education or monitoring and user fees, which can be substantial. Malindi makes 300% of operational costs on user fees, in Kristie, only 15% of the money collected is returned to the MPA, Cousin Island is self-sustaining and Chumbe is only funded through eco-tourism.
Reefs at Risk. Bryant et al, 1998.	Detailed, map-based assessment of potential threats to coral reef ecosystems.	Draws on 14 data sets (including maps of land cover, ports, settlements, and shipping lanes), information on 800 sites known to be degraded by people, and scientific expertise to model areas where reef degradation is predicted to occur, given existing human pressures on these areas.	Fifty-eight percent of the world's reefs are potentially threatened by human activity. Coral reefs of Southeast Asia, the most species rich on earth, are the most threatened of any region. Overexploitation and coastal development pose the greatest potential threat.

Appendix 3.2 MPA manager survey

Introduction.

Thank you for participating in this survey about marine managed areas (MMAs). We are targeting MMA managers. We are also interested in receiving replies from researchers with a good current working knowledge of an MMA, based on at least a year's involvement with it. The MMA should contain at least 50% marine habitat and an area of coral reefs. If you fit this profile, we would be very grateful if you could answer the questions below. We would like to look at trends from many MMAs around the world, so your answers are very important to us. This questionnaire is part of an on-going research project by Venetia Hargreaves-Allen, from Imperial College London, with support from the World Fish Centre and Reefbase. We are hoping to increase understanding of MMA management by benefiting from your experience. We are researching costs and benefits generated by MMAs and how these are linked to conservation success. This will enable us to make recommendations, including identifying strategies for enabling more sustainable support for MMA management costs. Please be aware that all your responses as strictly confidential and will not be linked to your specific MMA. Summary results only will be published. If you would like a copy of the report produced from this study, please add your email at the end of the questionnaire.

Personal Details.

Your name____

Name and country of protected area____

Your position (please give as much detail as possible):____

Contact e-mail address ________________________________Telephone number_______________________

Has there been any scientific or social research done at your MMA? If yes, please give details of any reports or publications and if possible, please list them): ____

Enter the address of any website(s) that contain information on this MMA: _________________________________

Background Information.

1) Total marine managed area (MMA) size ______________________ km^2
2) Year of formal designation _________________ Not applicable □
3) Please list all designations including IUCN category, national and international designations e.g. World Heritage site:____
4) Which best describes the management structure at your MMA (please choose one)?

   Local or central government department or government agency □
   Community-based management □
   Government and local community co-management □
   Government and NGO co-management □
   Other (please specify) ________________________________ □

5) How many zones (if any) are there in your MMA? If no zoning exists, please mark 0.

   0 □ 1 □ 2 □ 3 □ 4 □ >5 □

6) Is there an area or zone where no human uses are allowed (except research)?

   Yes □ No □ Not sure □ If yes, please state size __________ km^2

7) What percentage of live coral cover is currently found, on average in the following areas? ** Please give details, including dates of any publications at the beginning of the questionnaire.*

(a) within your MMA, when it was established? ________________ % Don't know □

How have you estimated this? Expert judgement □ On-going scientific monitoring* □ One off study * □

Other ____

(b) within your MMA currently? ________________% Don't know □

How have you estimated this? Expert judgement □ On-going scientific monitoring* □ One off study * □

Other ____

8) What is the primary aim of the MMA? Please choose ONE.

Habitat conservation □ Cultural heritage □Local economic development □ Species conservation □

Fisheries enhancement □ Education &/or research □ Recreation and tourism □ Other _________________

9) Is there an MMA management plan? Yes □ No □ In preparation □

10) Have there been any of the following schemes aimed at local fishers and other users, either run by your MMA, government departments or NGO or other international organisations, since the MMA was set up?

	In the past	Current
Small business grants or credit programs	□	□
Alternative livelihood schemes	□	□
Fisher micro-credit schemes or loans	□	□
Cash compensation payments	□	□
Boat or equipment buy-back schemes	□	□
Benefit sharing projects	□	□
Conflict resolution mechanisms	□	□
MMA-associated development initiatives	□	□

11) Does current MMA management include or involve any of the following (please tick all those that apply)?

	Past	Current	Planned	No	Not sure
MMA formal staff training (e.g. enforcement, monitoring, conflict resolution)	□	□	□	□	□
Fisher compensation schemes for lost fishing grounds	□	□	□	□	□
Fisheries management extending outside the MMA	□	□	□	□	□
Network of MMAs (when sites designated)	□	□	□	□	□
Network of MMAs (collaborative monitoring/management)	□	□	□	□	□
National integrated coastal management plan	□	□	□	□	□
International monitoring or research initiatives	□	□	□	□	□
International conservation grants or initiatives	□	□	□	□	□
Education outreach initiatives	□	□	□	□	□
Socio-economic monitoring	□	□	□	□	□
Ecological monitoring	□	□	□	□	□
Management effectiveness monitoring	□	□	□	□	□
Wider endangered species protection initiative	□	□	□	□	□
Local MMA related community institutions	□	□	□	□	□
National or International NGOs	□	□	□	□	□
GEF project funding or technical assistance	□	□	□	□	□

Budgetary Information.

12) What was the total value of all initial investments and grants made when the MMA was first set up?

Year __________ Currency______ Amount ____________ Don't know □ None □

13) What was the total budget (from all sources) spent on MMA (including staff, management and tourism infrastructure, educational outreach etc) in 2005 Currency______ Amount __________ Don't know □ None □

14) What proportion of management costs were covered by each of these source in 2005 (please make sure these add up to 100%)?

Government funds	__ %
MMA generated revenues	__ %
Donations and gifts	__ %
National foundations or NGOs	__ %
International foundations or NGOs	__ %

15) Considering all the tools described above, what percentage of revenue generated goes to each of these uses:

Kept by MMA staff for MMA management costs	__ %
Collected and kept by local community members / businesses	__ %
Returned to central government office(s) or department(s)	__ %
Other (please name) ______________________________	__ %

MMA Uses and Benefits.

16) Have you seen evidence in local fisheries of any of these things, since your MMA was set up? Please tick ALL those that apply. If you are not sure, or it is not applicable, please leave the boxes blank. *Fishing effort is staff and equipment investments and/or time spent by fishers. Harvest variance is the number or types of fish. Crowding refers to fishers being crowded close together*.

	Inside MMA	Near 5km the MMA	Away from (>5km) the MMA
Less fishers	□	□	□
More fishers	□	□	□
Increased fishing effort	□	□	□
Decreased fishing effort	□	□	□
Increased catches	□	□	□
Decreased catches	□	□	□
Increased crowding	□	□	□
Decreased crowding	□	□	□
Increased harvest variance	□	□	□
Decreased harvest variance	□	□	□

17) Have you seen evidence of any of these things related to tourism within the MMA? Please tick all that apply. If you are not sure, or it is not applicable, please leave the boxes blank.

Increased tourism	□
Decreased tourism	□
Increased stakeholder conflict	□
Decreased stakeholder conflict	□
Damage to coral from these visitors / users	□
Erosion of local culture from MMA associated tourism	□
Greater income / wealth for local communities	□
MMA tourism-related pollution	□
Greater local community employment opportunities	□
Higher local prices for goods	□
Great availability of goods	□
Other (please describe) __________________________	□

18) Do fishers congregate on the edges of areas where fishing is not allowed?

Rarely/never □ Some fishers □ Most fishers □ Not applicable □

19) How many people work in each of the following types of employment in the area within 5km of MMA? Of these, how many are originally from the area (are local, meaning, have lived in the nearby area for more than 10 years)?

	Number employed	Of which are local
MMA paid staff, monitoring and research	___	___
MMA tourism related employment	___	___
Fishing inside or within 5km of the MMA	___	___

20) How many of the following businesses are linked to the MMA? Please count total number of businesses and then fill in how many people are employed permanently in these areas.

	No. of businesses	No. of people employed
Hotels / guest houses / resorts	___	___
Dive shops / boat operators	___	___
Fishing or diving guides	___	___
Restaurants	___	___
Tourist gift shops	___	___
Tourist services	___	___
Other ____________________	___	___

21) Which activities are allowed and prohibited within your MMA? Limited activities include those only allowed in certain zones, or requiring permits and other restriction.

	Allowed	Limited	Not allowed	No rules
Extractive uses:				
Local commercial fishing	□	□	□	□
Local subsistence fishing	□	□	□	□
Foreign commercial fishing	□	□	□	□
Blast fishing	□	□	□	□
Cyanide fishing	□	□	□	□
Coral mining	□	□	□	□
Shell /ornamental species collection	□	□	□	□
Sports fishing	□	□	□	□
Mangrove wood collection	□	□	□	□
Aquaculture	□	□	□	□
Traditional hunting of protected species	□	□	□	□
Extraction for building materials / medicines	□	□	□	□
Other ____________________________	□	□	□	□
Non extractive uses:				
Boat anchoring / mooring	□	□	□	□
Diving / snorkelling	□	□	□	□
Photography	□	□	□	□
Research/ monitoring	□	□	□	□
Recreation	□	□	□	□
Tourist tours, trips or visits	□	□	□	□
Education	□	□	□	□
Other ____________________________	□	□	□	□

22) Now, focusing on what takes place within the MMA, please look at this list of potential activities that occur. Please include both legal and illegal activities. This is the same list.

	Frequently	Occasionally	Never	Don't know
Extractive uses:				

Local commercial fishing	□	□	□	□
Local subsistence fishing	□	□	□	□
Foreign commercial fishing	□	□	□	□
Blast fishing	□	□	□	□
Cyanide fishing	□	□	□	□
Coral mining	□	□	□	□
Shell /ornamental species collection	□	□	□	□
Sports fishing	□	□	□	□
Mangrove wood collection	□	□	□	□
Aquaculture	□	□	□	□
Traditional hunting of protected species	□	□	□	□
Extraction for building materials / medicines	□	□	□	□
Other ____________________________	□	□	□	□
Non extractive uses:				
Boat anchoring / mooring	□	□	□	□
Diving / snorkelling	□	□	□	□
Photography	□	□	□	□
Research/ monitoring	□	□	□	□
Recreation	□	□	□	□
Tourist tours, trips or visits	□	□	□	□
Education	□	□	□	□
Other ___________________________	□	□	□	□

23) How many of each of these visited your MMA, in 2005? Please avoid double counting: fishers who also visit the MMA should only be counted in the fisher category.

Local fishers (extract goods) ___
Local visitors (no extraction) ___
National visitors ___
International visitors ___
Other (please specify)_________________________ ___

Have these figures been estimated?
Based on entry fees/ permits □ Based on manger estimates □ Other ______________________ □

24) What are the main uses of the MMA by nearby communities? Please rank these in order, from 1 (most frequent use) to 5/6 (least frequent)? Frequency refers to number of visits occurring. If the use does not take place in the MMA, please leave mark the box 0.

Subsistence fishing ___
Commercial fishing ___
Collection of natural resources for food, building materials, medicines ___
Recreation ___
Cultural ceremonies or other cultural practises ___
Other ___________________________________ ___

MMA Threats.

25) Have you had any of the following in the last five years (please tick all that apply)?

	Within the MMA	Within 5km of MMA
Coral damage due to cyclones, hurricanes	□	□
Significant sedimentation from on-land practises	□	□
Chemical or agricultural pollution	□	□
Large scale coastal development	□	□
Significant coral bleaching	□	□
Oil spill (s)	□	□

Significant immigration	◻	◻
War or civil unrest	◻	◻
Natural disaster(s)	◻	◻
Other (please specify) ______________________	◻	◻

26) Since the MMA was set up, have these activities INSIDE the MMA:

	Increased	Decreased	Stayed the same	Don't know	None when estab.
Unsustainable/destructive fishing	◻	◻	◻	◻	◻
Large scale aquaculture	◻	◻	◻	◻	◻
Mangrove clearance	◻	◻	◻	◻	◻
Seabed drilling or mining	◻	◻	◻	◻	◻
Oil exploration	◻	◻	◻	◻	◻
Dredging, diking or filling	◻	◻	◻	◻	◻
Trawling	◻	◻	◻	◻	◻
Blast fishing	◻	◻	◻	◻	◻
Cyanide fishing	◻	◻	◻	◻	◻
Coral mining	◻	◻	◻	◻	◻
Catching endangered species	◻	◻	◻	◻	◻
Other __________________	◻	◻	◻	◻	◻

Since the MMA was set up, have these activities OUTSIDE the MMA (this is the same list):

	Increased	Decreased	Stayed the same	Don't know	None when estab.
Unsustainable/destructive fishing	◻	◻	◻	◻	◻
Large scale aquaculture	◻	◻	◻	◻	◻
Mangrove clearance	◻	◻	◻	◻	◻
Seabed drilling or mining	◻	◻	◻	◻	◻
Oil exploration	◻	◻	◻	◻	◻
Dredging, diking or filling	◻	◻	◻	◻	◻
Trawling	◻	◻	◻	◻	◻
Blast fishing	◻	◻	◻	◻	◻
Cyanide fishing	◻	◻	◻	◻	◻
Coral mining	◻	◻	◻	◻	◻
Catching endangered species	◻	◻	◻	◻	◻
Other __________________	◻	◻	◻	◻	◻

27) What do you consider to be the main threat to the MMA? Please note, this may be a threat not listed above.
Please describe ____

What, if any actions (if any) are being currently taken to address this threat? Please describe:
____

MMA manager feedback.

28) Have these ecological and socio-economic aspects changed within your MMA, in your opinion as result of the existence of the MMA?

		Improved	Worsened	No change	Not sure
(a)	Habitat quality	◻	◻	◻	◻
(b)	Fisheries	◻	◻	◻	◻
(c)	Species conservation	◻	◻	◻	◻
(d)	Local economic development	◻	◻	◻	◻
(e)	Education and research	◻	◻	◻	◻
(f)	Cultural heritage	◻	◻	◻	◻
(g)	Other ___________________	◻	◻	◻	◻

29) What percentage of the MMA rule infractions (illegal activities) would you estimate are:
(a) Detected by MMA staff _________% (b) Punished _________ %

30) To what extent do you think the primary aim of the MMA, has been achieved, since the MMA was set up?
Not at all □ To limited extent □ To large extent □ Fully □
Do you think the MMA is currently a success in general?
No □ Partially □ Mainly □ Very □

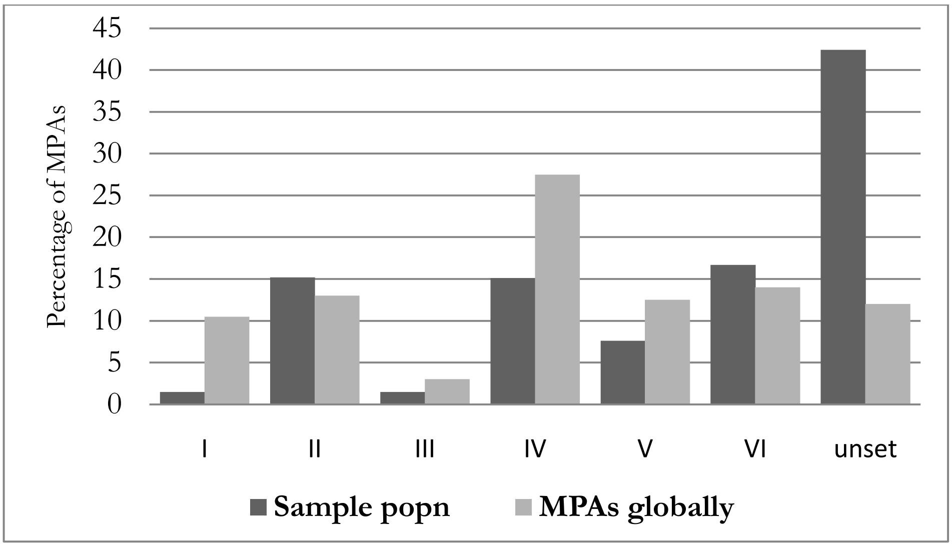
Do you have any additional comments you would like to add? ____
Please add your email address, if you would like a copy of the report: __________________________________

Thank you for your time.

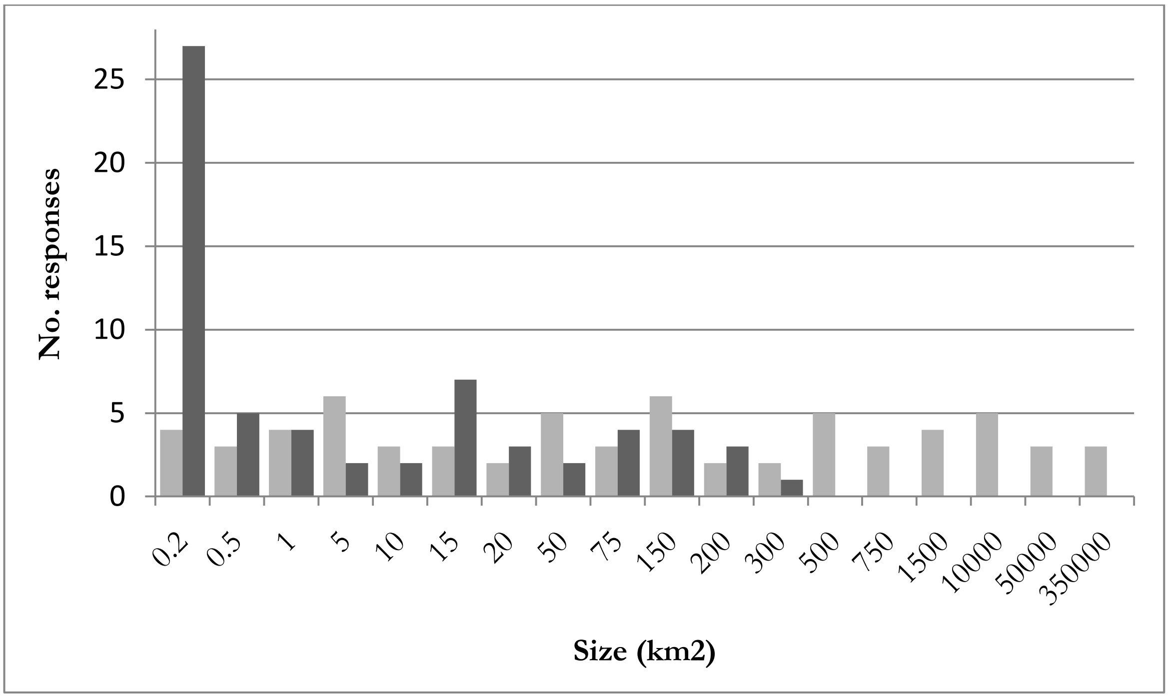
Appendix 3.3 MPA who completed Evaluations by Region

Africa	Pacific	Americas	Asia
Aldabra	Hanauma Bay Nature	Bacalar Chico Marine Reseve	Balingasay MPA
Aliwal Shoal	Reserve	Bacalar Chico National Park	Biga Marine Reserve,
Chumbe Island	Kubulau, Vanua Levu	Bermudan network	Lobo
Madagascar	Nguna-Pele MPA	Blue Hole	Gilutongan marine
Mnazi Bay-Ruvuma	North Efate MPA	Bonaire National Marine Park	sanctuary
Estuary Marine Park	Network	Cabo Pulmo	Great barrier reef MP
Moheli Marine Park	Rock Islands and	Caye Caulker	Gulf of Manai Marine
Ras Mohammed NP	Southern Lagoon area	Corumbau Marine extractive	National Park
Sharma Jethmon	Waialea bay marine life	reserve	Hambongan, Inabanga,
Tanga	conservation district	Dog Island Marine Park Dominica	Bohol
Velondriake		marine reserves	Illana Bay
		Flower Garden Banks National	Komodo National Park
		marine sanctuary	Mabini marine reserve
		Galapagos	Masinloc, Zambales
		Gladden Spit Marine Reserve	Mu Koh Chang National
		Half moon caye	Park
		Isla de Mona Natural reserve	Nhu Trang
		Laughing bird caye NP	Padre Bugos, So Leyte
		Little Bay Marine Park	Poblacion marine reserve
		McBean Lagoon	Rani Jhansi Marine
		Negril Marine Park	National Park
		Port Honduras Marine reserve	Sangat Declave MPA
		Pricky Pear marine park	Siete Pecados Marine
		Resexmar	Park
		Roatan marine park	Suaka Marga Satwa
		Sandy Island Marine Park	Pasoso
		Santuario de Malpelo	Sugud Islands Marine
		Sapodilla Cayes	Coservation Area
		Shoal Bay Island Harbour MP	Tioman Island
		Sian Ka'an Biosphere reserve	
		Soufriere MMA	
		Virgin Islands national monument	

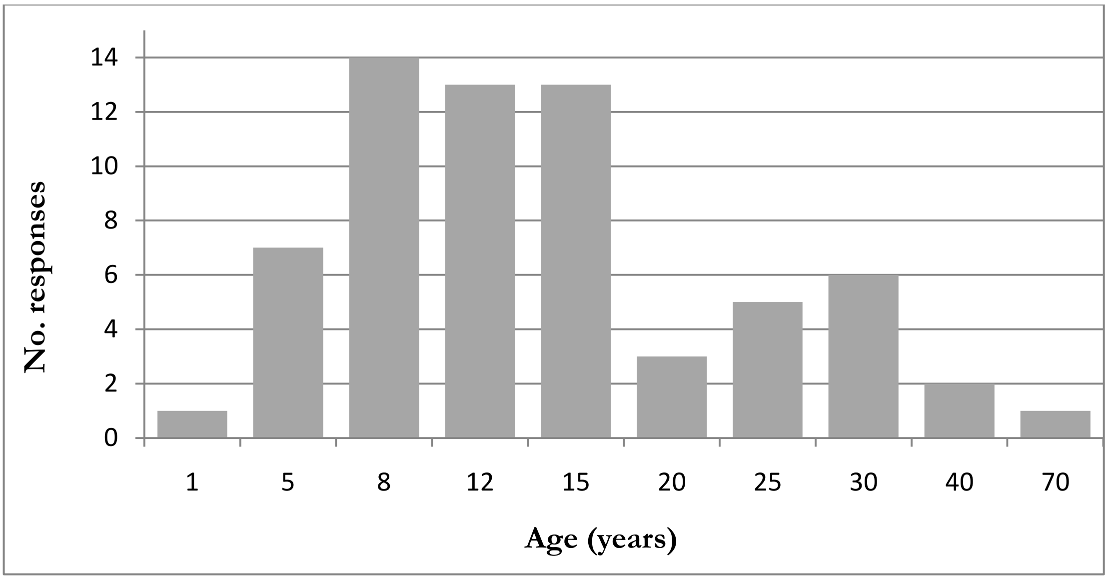
Appendix 3.4 Global and sample distribution of MPAs by IUCN Management Category. Global data from WCPA database on protected areas with coral reefs.



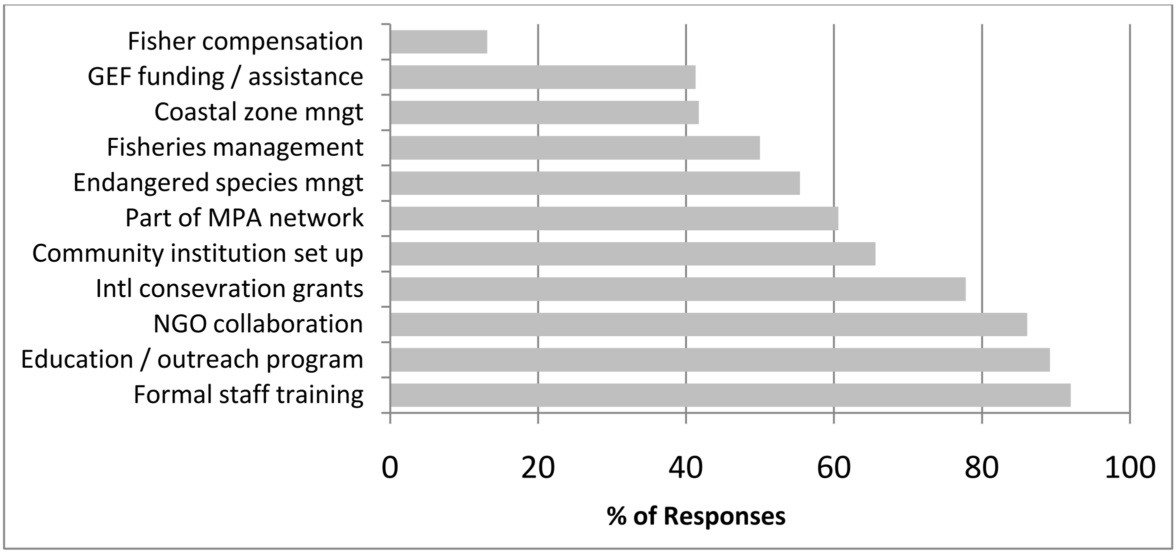
Appendix 3.5. Sample MPA size distribution. MPA size is denoted by light grey bars, no-take area size in dark grey



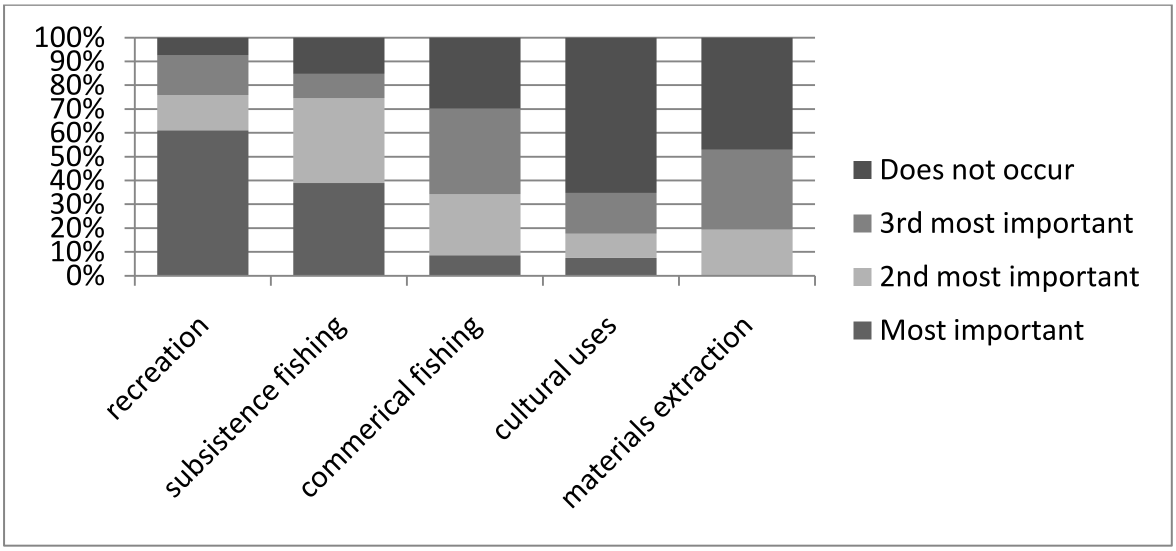
Appendix 3.6 Sample MPA age distribution (yeas since designation)



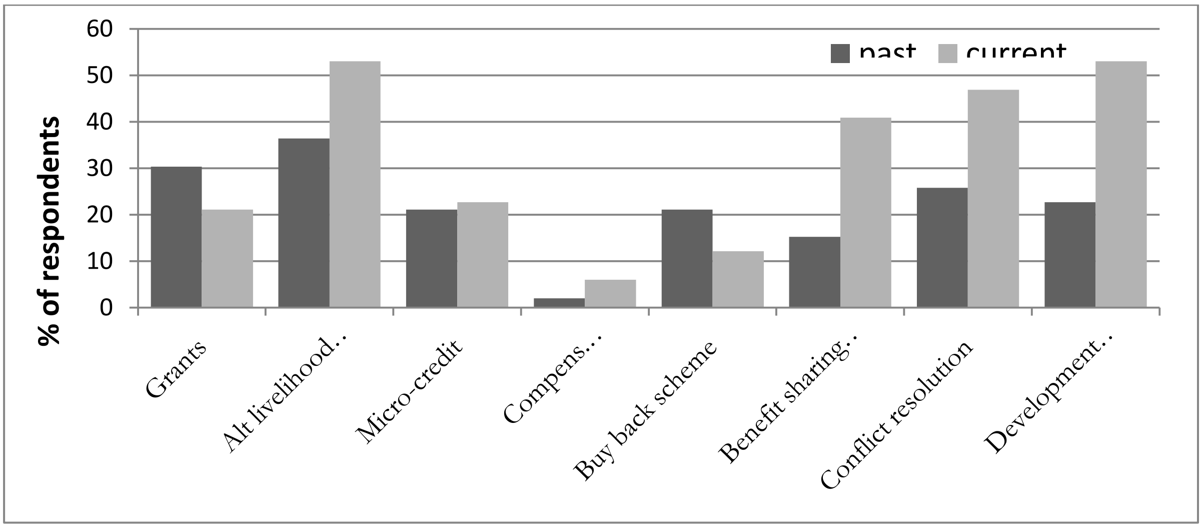
Appendix 3.7 Management regimes at the MPAs



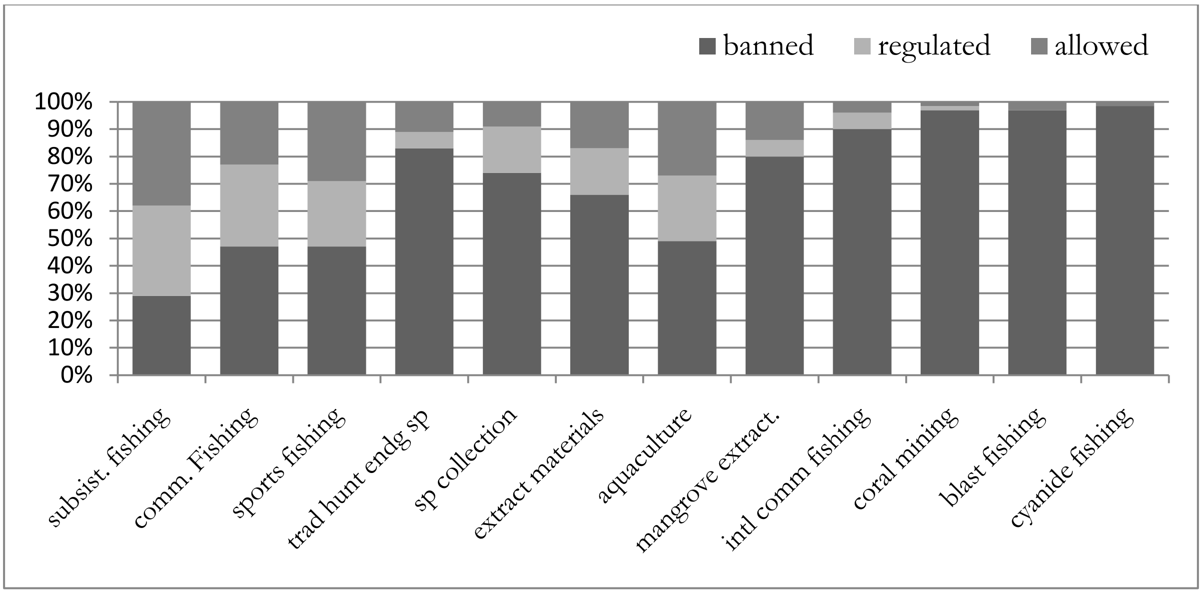
Appendix 3.8 Rank of importance of Use of MPAs by Local Communities



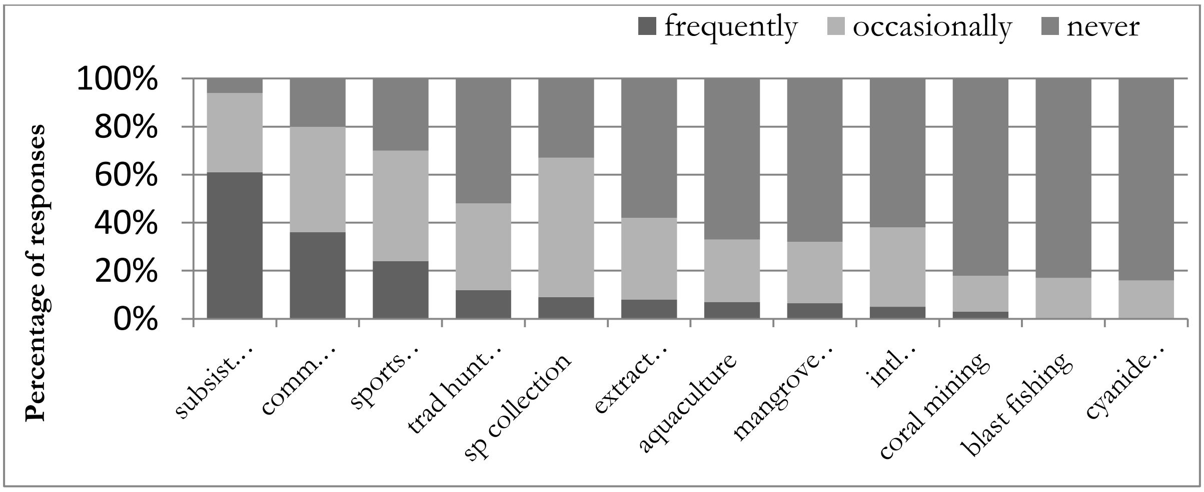
Appendix 3.9 The local community related initiatives being undertaken in reserves



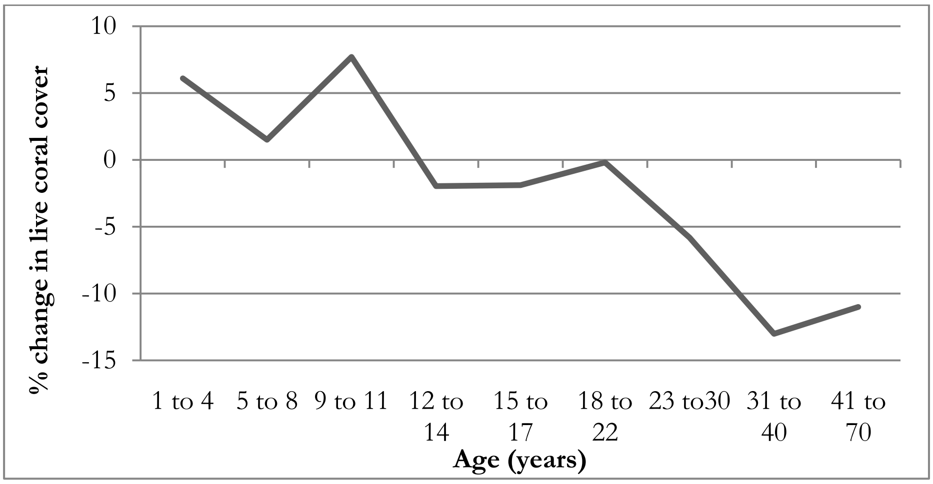
Appendix 3.10 Regulations for different destructive activities



Appendix 3.11 Frequency of potentially damaging extractive activities inside the MPA



Appendix 3.12 The temporal change in live coral cover given MPA age



Appendix 3.13 Logistical Regression of Variables Related to having the main threat inside the MPA

Variable	Main threat inside MPA Logit
Constant	2.04 (0.420)
Developing country	3.699 (0.021)**
Age (years)	-0.493 (0.051)*
Age 2	0.017 (0.033)**
% illegal activities punished	-0.034 (0.092)*
Primary aim habitat conservation	-1.789 (0.030)**
N	56
LR chi^2	29.33
Prob > chi^2	0.000
Pseudo R^2	0.409

Appendix 3.14 Regression of MPA features and management related to number of large scale threats inside the MPA

Variable	No. threats inside MPA OLS regression
Constant	3.173 (0.000)***
Size (km^2)	0.0003 (0.002)***
No. staff	0.024 (0.006)***
NGO managed	-0.718 (0.091)*
In Asia	1.761 (0.005)***
In Americas	1.761 (0.019)**
No. banned activities	-0.173 (0.016)**
GEF financial assistance	0.995 (0.013)**
% funding used for community projects	0.031 (0.011)**
N	55
F	5.55
Prob > F	0.0000
Adj R-Sq	0.403

Appendix 3.15 Logistical Regression of Variables Related to Coral Reef Damage from MPA Users or Visitors

Variable	Coral damage by users Logit
Constant	0.999 (0.579)
Tourism as primary aim	3.631 (0.014)**
In Americas	2.679 (0.025)**
Fisher compensation	-4.25 (0.025)**
Education initiatives	-2.67 (0.073)*
Mooring buoys	-3.16 (0.058)*
% jobs in tourism	0.0233 (0.079)*
N	49
LR chi^2	22.74
Prob > chi^2	0.000
Pseudo R^2	0.379

Appendix 4.1 Explanatory variables used in regressions. Dummies are denoted by (d)

MPA attributes
Size (km^2)
Size no-take area (km^2) / no take area (d)
Age (years)
Management: Government, community, NGO, multiple (d)
Low / high IUCN number (d)
No. zones
staff / staff per km^2
WHS (d)
Developing country (d)
Region: Pacific, Asia, Africa, Americas
Primary aim of MPA: habitat protection, fisheries, tourism etc (d)
Management activities
Past / current development related tools: business grants, alternative livelihood schemes, micro-credit, compensation, fishing buy-back schemes, benefit sharing projects, conflict resolution measures, development projects (d)
Past or current management activities e.g. fisheries management, international monitoring program, education/ outreach, etc (d)
Management plan (d)
No. regulated activities, No. banned activities
% illegal activities detected, % detected punished OR % illegal activities punished
Financial aspects
Value initial investment (2005 equivalent)
Current budget (2005 equivalent), budget per km^2
% budget from government, revenues, donations, national & international NGOs
% funds used for management costs, local projects, returned to government
Social aspects
Tot no. businesses
% management jobs to locals, % jobs to locals
Change in economic development
Change in cult heritage, erosion of local culture (d)
Number fishing jobs, Fishing pressure (number of fishers per km^2)
No. visitors, Visitor pressure (number tourists per km^2)
greater availability of goods (d), higher prices for local goods (d)
Rank of local uses (subsistence fishing, commercial fishing, recreational)
Threat
No. large threats inside
Main threat originates inside MPA (d), Main threat originates outside MPA (d)
Suitability of action to threat (ordinal)
Coral damage from tourists (d)
Frequency of sports fishing
Mooring buoys
Other
respondent job type (management, government body, NGO or other)
coral data source type for past and current coral cover (monitoring, study or manager estimate)
coral cover data supplemented (d)

Appendix 4.2 Coding of the performance measures

Outcome	Measures gleaned from questionnaire	Coding
Ecological	Change in live coral cover since established	Current cover – initial cover
	Live coral cover compared to country average	Current cover- country average
	Perceived changes in fisheries	- 1 = worse, 0 = no change, 1 = improvement
	Perceived changes in species conservation	- 1 = worse, 0 = no change, 1 = improvement
Social	Perceived change in stakeholder conflict	- 1 = worse, 0 = no change, 1 = improvement
Economic	Perceived greater wealth for local communities as a result of MPA	0 = no change, 1 = improvement
	Estimated Number jobs supported per km^2	Total of jobs supported by each industry
Threats	Number of destructive activities that have decreased inside the MPA over time	Number when established – current number
	Difference between number of large scale threats inside and outside MPA	Number outside – number inside
	Number of destructive activities to stay the same / decreased inside, but not outside MPA	Number decrease inside – number to decrease outside
Goals	Number of banned activities occurring	No. Banned activities – number occur occasionally or frequently
	Perceived extent of primary aim achieved	Ordinal scale, 1 to 4
Perceived Success	Perceived success of the MPA in general	Ordinal scale, 1 to 4

Appendix 4.3 Relationships between overall perception of success and extent of achievement of MPA's primary aim and other measures of success. Co-efficients are followed by p=values in parentheses. *=p<0.1, **=p<0.05, ***=p<0.001.

Overall perception of success. Ordered Logit		Extent primary aim achieved Ordered logit	
Change in species conservation	1.56 (0.051)**	% change in live coral since established	0.041 (0.083)*
Change in fisheries	0.97 (0.069)*	Change in species conservation	2.304 (0.002)***
Extent primary aim achieved	3.44 (0.000)***	Increased wealth (dummy)	1.627 (0.012)**
N	64	N	49
F	81.21	F	26.27
Prob > F	0.0000	Prob > R Sq	0.0000
Adj R-Sq	0.479	Adj R-Sq	0.228

Appendix 4.4 Regression analysis of the different success variables related to temporal improvements in live coral cover and conflict. Co-efficients are followed by p=values in parentheses. *=p<0.1, **=p<0.05, ***=p<0.001.

Temporal comparison of live coral cover OLS		Improvement in conflict (dummy) Logit	
Constant	-4.882 (0.026)**	Constant	-3.219 (0.003)**
Spatial comparison live coral cover	0.168 (0.008)***	Change in species conservation	1.845 (0.091)*
Difference in no. threats from outside MPA	1.744 (0.014)**	Difference in no. of threats	0.477 (0.063)*
No. destructive activities to decrease	1.481 (0.026)**	Number jobs supported	0.005 (0.061)*
N	47	N	59
F	6.9	LR chi^2	12.57
Prob > F	0.0007	Prob > chi^2	0.006
Adj R-Sq	0.278	Pseudo R^2	0.194

Appendix 4.5 Ordered logit regressions to determine significant endogenous and exogenous variables related to achievement of MPAs aims and overall success. *=p<0.1, **=p<0.05, ***=p<0.001.

	Achievement of Primary Aim		Perceived MPA success	
MPA features	No. zones	1.286 ***	No. zones	3.405 **
	Age (years)	-0.115	No take area	-7.856 **
	Size (km2)	0.0002 **		
	Age * size	-0.0001**		
Region			In Asia	14.131 **
Aims	Tourism primary aim	3.15 **		
	Multiple aims	-3.89 ***		
Management actions	Staff per km²	0.14***	% illegal activities punished	0.2098 **
	Benefit sharing project(s)	5.72***	Affiliated community institution(s)	7.498 **
	Development initiative(s)	4.31***		
	No. banned activities	0.99***		
Financial			% funding returned to government	-0.119 **
			% funding from donations	0.264 **
			Funding per km²	0.001*
Threats / uses	No. threats inside MPA	-0.712 **		
National context	GDP pc ppp	0.0002 ***	GDP pc ppp	0.0002*
	% reefs at high risk	-0.068 ***	% reefs at high risk	-0.165**
	N	60	N	46
	LR chi²	97.74	LR chi²	91.53
	Prob > chi²	0.000	Prob > chi²	0.000
	Adj R²	0.671	Adj R²	0.773

Appendix 4.6. Regression to determine significant endogenous and exogenous variables related to temporal changes in live coral cover (ordinary least squares) and improvements in fisheries (logistic). *=p<0.1, **=p<0.05, ***=p<0.001.

	Temporal change coral		Improvement in fisheries	
	Constant	-2.001	Constant	-91.4*
MPA features	Age	-0.44***	No-take area	-11.27**
	No. staff	-0.12***		
	No. zones	1.77**		
	Co-management	-9.04***		
Region	Asia	15.44***	Americas	-15.47*
Management actions	Management plan	13.41***	Compensation	16.81*
	Fisher compensation	5.85***	% illegal activities detected	0.27*
			Community institutions	18.6*
			No regulated activities	1.217*
Financial	% funds used for management costs	0.10**		
Threats / Use	No. threats inside	-3.84***	No. threats inside	-1.75**
	Rank subsistence fishing	-2.62**		
Local context	Coastal zone management	5.85**	Increased tourism	19.48*
National context			Human development index	98.98*
Model Parameters	N	40	N	59
	F	8.47	LR chi²	59.96
	Prob > F	0.000	Prob > chi²	0.000
	Adj R²	0.678	Adj R²	0.769

Appendix 4.7. Logit regressions to determine significant endogenous and exogenous variables related to increase in wealth and decrease in conflict at MPAs. *=p<0.1, **=p<0.05, ***=p<0.001.

	Increase in wealth		Conflict has decreased	
	Constant	-9.78	Constant	-8.78**
MPA features	No-take area	-11.98*	Size no-take	0.0002**
	High IUCN category	-16.98*	Community managed	3.99*
Region	Pacific	46.56*		
Primary Aim	Multiple aims	-38.46*		
Management actions	Fisheries management	15.01*	Alternative livelihood project	7.31*
	No. activities banned	-4.73*		
	Management plan	39.39*		
	% illegal activities detected	0.26**		
Financial			% funds from intl. organizations	0.084**
Threats / Use			No. threats inside	-3.06**
National context	LDC	17.69**	% reefs at high risk	0.090**
Model Parameters	N	57	N	48
	LR chi^2	64.4	LR chi^2	47.8
	Prob > chi^2	0.0000	Prob > chi^2	0.0000
	Adj R^2	0.826	Adj R^2	0.745

Appendix 4.8 Ordinary Least Squares Regressions to determine significant endogenous and exogenous variables related to the natural log of the number destructive activities to decrease over time and the number of large scale threats inside the MPA compared to outside. *=p<0.1, **=p<0.05, ***=p<0.001.

	No. destruct. activities to decrease		No threats compared to outside	
	Constant	-0.67***	Constant	-1.86***
MPA features	Age	0.009***	Age^2	-0.00004***
	Size	0.0002***	Size no-take	0.0004***
	Age * size	-0.0002***		
	Size no-take	0.002***		
	Mooring buoys	0.297***		
Region	Asia	0.19***		
Management actions	Freq. research / monitoring	-0.163***	% illegal activities punished	0.013**
			Staff per km^2	0.050***
			Fisheries management	1.29***
Financial	Intl conservation grant	0.195***	(Funding per km^2)^2	-0.000001***
			% funds used for management costs	0.010***
Threats/Use	Rank commercial fishing	0.04**	Rank commercial fishing	-0.145**
Local context			Coastal zone management	-0.59**
National context	% Reefs at risk	0.007***		
Survey variables			NGO employee	0.795***
Model Parameters	N	49	N	39
	F	10.7	F	14.6
	Prob > F	0.0000	Prob > F	0.000
	Adj R^2	0.668	Adj R^2	0.839

Appendix 5.1 Visitor Survey

Introduction.

Hello. I am part of a research group at Imperial College London and we are conducting questionnaires related to marine conservation in this area, which will be used to help inform local and government management. I would very much appreciate it if you could take 10-15 minutes to answer some questions. Yours answers are very important to us and are both confidential and anonymous. You will not be contacted again. Would you do this?

A. General questions (motivations, expectations, attitudes);

- Which country are you from?
- Including this trip, how many times have you been to Belize?
- How many nights will you spend in Belize?
- What other places have and will you visit on this trip?
- Why did you choose to come to Belize?

Tick: Weather, Local culture(s), Cost, natural scenery, marine life, jungle, travel time, ruins, beaches, food, less developed, other.

- How many dives/snorkelling trips will you do in Belize? Which sites?
- Why did you choose to come to Placencia (open)
- How many nights will you spend in Placencia?
- Is your trip in Placencia part of a hotel or tour operator package?

Yes/No/Partially/Not sure.

- Are you a certified diver? Yes, No, Not sure. If yes; what level?

B. EITHER

Gladden Spit Marine Reserve - NON VISITOR QUESTIONS

- Have you heard of GSMR? Yes/No/Not sure
- Do you plan to go? Yes/No/Not sure
- Have you heard of the whale sharks here? Yes/No/Not sure

OR

GSMR; - VISITOR QUESTIONS

- Why did you choose to go to Gladden spit? (open)
- How many times have you visited Gladden Spit?
- How long ago did you last visit Gladden spit?

Tick: Today, Yesterday, in the last week, this month, previous trip, other.

- Did you (a) dive, (b) snorkel, (c) kayak, (d) sport fish, (e) whale shark (f) other?
- What marine life did you see during your trip?

Tick all mentioned: turtles, whale sharks, sharks, coral reefs, other.

- Who did you arrange your trip through? (open)
- Did you pay an entrance fee? Yes/No/Not sure. How much?
- What did you pay for your total reserve trip?
- How would you rate the quality of the marine life inside the reserve?

Code as: Poor, Average, good, excellent.

- Do you expect to return to this reserve in the future?

Box 1. Visitor valuation scenario script.

Gladden Spit Marine Reserve contains white sand beaches, islands, coral reefs with excellent dives sites and lots of wildlife, including rare and endangered species. Its habitats are known to support other ecosystems and economic activities, both directly through supply of seafood and indirectly, through biological services such as biodiversity maintenance.

Efforts are in place to manage the reserve, including efforts to manage fisheries, minimise visitor impact, create better tourist facilities, support monitoring and research, enforcement patrols, local and tourist education schemes, all of which could help to ensure the future of these vulnerable and threatened ecosystems. However current funding is severely limited and future funding is uncertain and serious threats remain to these habitats and in the absence of increased funding, these areas are likely to become severely degraded.

[Randomly rotate order of valuation questions A, B and C]

A. Entrance fees, including any paid by you, are used to help pay for all these management activities. The current fee is US$10. I am going to show you a set of numbers in US$. Please tell me what is the maximum total you would be willing to pay as a **daily entrance fee to enter the reserve**? Please note, this figure does not include tour operator fees for the trip, food or equipment hire.

[Present card] US$ 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 or more.

B. At certain times of year, whale sharks are known to regularly visit this reserve. At these times, the entrance fee is US$15. If you were able to visit the reserve at these times of year and therefore have a strong likelihood of **seeing whale sharks**, what is the maximum you would be willing to pay as a daily entrance fee?

[Present card] US$ 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 120, 150 or more.

C. In addition to an entry fee, there is a proposal to establish a **conservation fund**, to ensure the long term management of the marine reserve, to enable continued conservation and habitat protection and research, tourist visitation, fisheries industry supervision and whale shark protection for many years. I am going to show you a set of numbers in US$. I would like to know what is the payment closest to the maximum onetime payment that you would donate towards this fund?

[Present card] US$ 0, 10, 15, 20, 30, 40, 50, 65, 80, 100, 120, 150, 175, 200 or more.

Non-visitor valuation scenario script.

"Belize's coastline currently has 14 marine reserves. The Gladden Spit Marine Reserve lies of the coast of Placencia and makes up 4% of this total area. It contains white sandy beaches, islands, coral reefs with excellent dives sites and lots of wildlife, including rare and endangered species. Its habitats are known to support other ecosystems and economic activities.

Gladden Spit is similar to other Belizean marine reserve, as it is a multi-use reserve with a small no take fishing area and provides many benefits to local communities and tourists. It is different however, as it has a higher level of active management and unique, as over 18 fish species spawn here, making it an important fishing ground and because groups of up to 12 whale sharks come predictably to the reserve for 40 days each spring.

Efforts are in place to manage the reserve, as serious threats exist. These include efforts to manage fishing, minimise visitor impact, create better tourist facilities, support monitoring, research, enforcement and local and tourist education. All of these should help to assure the future of these vulnerable and threatened ecosystems. However, currently, funding is severely limited and future funding is uncertain.

In addition to entry fees, there is a proposal to add a compulsory contribution to the departure fees visitors pay in Belize, specifically to raise money for the Gladden Spit Marine Reserve. This would go to a conservation fund, which would be collected directly by an international NGO, so it could not be used by the government for any other purposes. This would therefore provide a considerable incentive to the government not to sell this area for tourism development. Please note, this would not replace future entrance fees for visitors.

Please could you tell me which US$ bid on this sheet if closest to the maximum would be prepared to pay each time you visit Belize, if it was used for this fund for this reserve alone. Please bear in mind your income and that may be other causes you may prefer to support."

[Present card] US$ 0, 2, 5, 8, 10, 12, 15, 20, 25, 30, 40, 50, 60, 70, 80, 100 or more

D. Follow – up / socio-economic questions;

- What would you most want money raised to be used towards?

[Options]: Enforcement, monitoring, tourist facilities, education and awareness, alternative livelihood schemes, community facilities, whale shark conservation, other.

- Do you support the current plans to bring cruise ship tourism to Placencia? Y/N/M/NS
- To what extent do you believe animals and ecosystems have a right to exist which cannot be traded against economic considerations?

Not at all, to some extent, to large extent, completely, not sure.

- On a scale of 1 to 10, 10 being the most concerned, how worried are you about the future of coral reef ecosystems?
- Who do you think should pay management and conservation costs ?

[Options]: Visitors/Government/NGOs/Local community/Co-funding/ Developed countries/Mixture/Other

- Who do you think benefits most from marine reserves like Gladden spit? [open]
- In what way?
- What are the disadvantages of marine reserves like Gladden Spit?
- Are you a member of any environmental groups? Which ones? [List]
- What is the highest level of education you have achieved?

Primary school, secondary school, undergraduate, diploma, post-graduate, dost-doctorate.

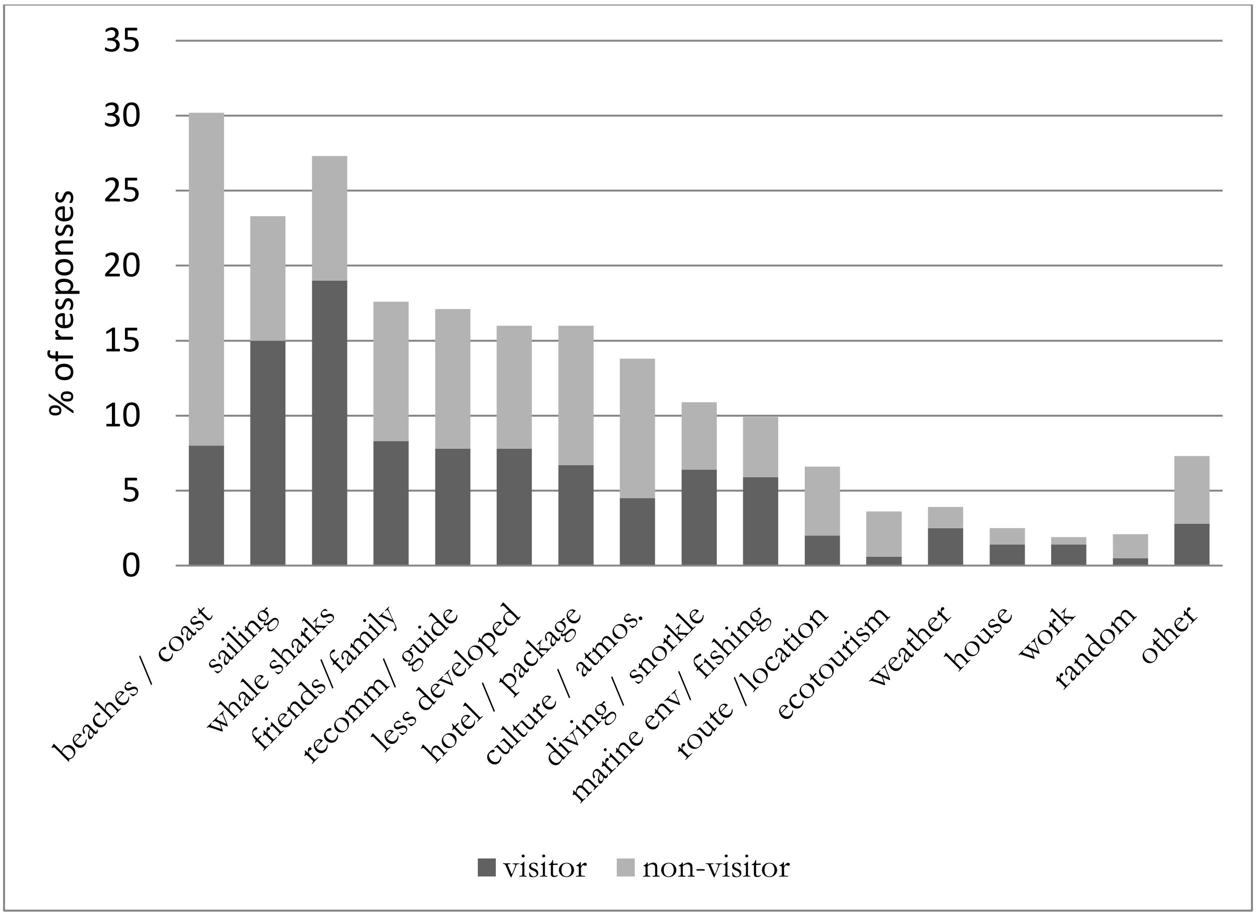
- Which age group do you belong to?
  (a) 16-24
  (b) 29 - 39
  (c) 40-54
  (d) 55-70
  (e) 70+
- Which of these best describes your housing arrangements?

[Options]: Own, rent, live with friends/parents.

- Which category does your gross annual income (before tax) fall into in US$?
  (a) Under 15,000,
  (b) 15,000-25,000
  (c) 25,000-35,000,
  (d) 35,000-45,000
  (e) 45,000-60,000,
  (f) 60,000-75,000,
  (g) 75,000-90,000
  (h) 90,000-120,000
  (i) 120,000-180,000,
  (j) 180,000+
- Would you like to add any comments?

Appendix 5.2. Respondent socio-demographic profiles.

Variable	Level	Percent Visitors (N = 302)	Percent Non visitors (N= 280)	Comparison to secondary data (CSO, 2006)
Sex	Male	49.8	44	46%
	Female	50.2	56	54%
Home Region	USA	72	73	57.6%
	Canada	11	9.8	22.6%
	Europe	14	16.1	13.3%
	Other	3	1.4	6.5%
Level of Education	Secondary sch.	9.5	6	
	Undergraduate	51	49	Not available.
	Diploma	10	12	
	Postgraduate	21.5	27	
	Doctorate	8	6	
Age category	16-29	15.5	13	<20 = 3.3%
	29-39	29	31	20-39 = 35.4%
	40-54	34.2	28.5	39-49 = 24.6%
	55-70	21	26	50-64 = 16.3%
	70+	0.3	1.5	66+ = 3.7%
Housing (wealth proxy)	Live w. others	3.4	4	
	Rent	22.3	24.4	Not available.
	Own	74.3	71.6	
Income	<15,000	6	5.2	
	15- 25,000	2.6	4.5	
	25- 35,000	4.4	8.2	Not available.
	35- 45,000	5.9	10.1	
	45-60,000	14.3	11.5	
	60-75,000	7.8	10.1	
	75-90,000	11.5	10.1	
	90-120,000	17.5	14.5	
	120-180,000	15.3	13.3	
	180000+	14.9	12.4	
Member of Environmental Group(s)	0	61	77	
	1	20	10.5	Not available.
	2	10	5.25	
	3+	9	7.25	
Dive level	Non diver	45.2	68.4	
	Open Water	31.8	22.2	Not available.
	Advanced	15.7	6.4	
	Rescue	4.7	1.1	
	Dive Master	1.3	1.5	
	Commercial	1.3	0.4	



Appendix 5.3. The reasons respondents choose to come to Placencia.

Appendix 5.4. Attitudes of respondents to conservation related questions.

Question.	Response	Visitor (%)	Non visitor (%)
How concerned are you about the future of coral reef ecosystems?	1 (not at all)	0.7	0
	2 - 5	10.8	8.7
	6	5.5	4
	7	9	14
	8	18	21.3
	9	17.5	13
	10 (extremely)	38.5	39
Extent agreement with statement; "animals and ecosystems have a right to exist, which cannot be traded against economic considerations"	Not at all	1	2
	To some extent	12	16
	To large extent	44.3	37
	Completely	41	44
	Not sure	1.7	1
What would you like the funds used to be used towards?	Education / awareness	24	25.5
	Regulation/ enforcement	19.4	18.3
	Whale shark conservation	17.7	14.2
	Monitoring / research	13.8	15.1
	Alternative livelihood training	7.2	11.1
	Community facilities	3.5	8.8
	Management	3	3.9
	Tourist facilities	3.1	1.9
	Remove waste	1.6	0.7
	Limit tourism development	0	0.5

Appendix 5.5 Voluntary donation bids and reasons for 0 bids for non visitors with zero WTP.

Reason given for zero response	donation WTP	Why different?	Original interpretation	Final interpretation
Should be voluntary	20	Prefer voluntary	protest	protest
Should be voluntary	25	Dislike taxes	protest	protest
Should be part of air and hotel fee	75		protest	protest
Misuse of funds	?	n/a	protest	protest
Can't afford and corruption – Belize is notoriously corrupt	10	-	Both	protest
Only users should pay	5		zero	protest
exit fees are already too high	0	-	protest	zero
exit fees are already too high	0	Non divers	protest	zero
Entrance fees should be enough	0	-	protest	zero
Entrance fees should be enough	0	-	protest	zero
Other more pressing problems and money wouldn't actually go to this cause	0	-	both	zero
Prefer other causes and not sure government is effective	0	?	both	zero
If I go there, then I will pay	?	-	zero	zero
Prefer other causes	0	-	zero	zero

Appendix 6.1 Local community survey.

Data collector:	Date:	Location:	
House ID:	Resp gender: m / f	Qual resp: poor/avg/good	Wealth rank: I / II / II

Hi. I am part of a group of researchers, who are here in Placencia to try to understand the attitudes and values that the community of Placencia have for marine management. Your opinion is extremely important for this study and to thank you for your time, we have a small gift for you from London. I would very much appreciate it if you could take 20-25 minutes to answer some questions for me. Your answers are both anonymous and confidential and no-one other than the main researcher will have access to your answers. Can you do this?

Background/ Socio-economic information.

- How long have you lived in Placencia? ____ years
- How many men, women and children live in this house for more than 6 months a year?
  Men ___ Women ____ Children _____
- What is your household's main source of income? *Fishing, restaurant, carpentry, hotel, tour oper, shop, other*
- Fill table on household occupations for all income earners in the house;

Income earner	m/f	Occupations (list)	1e occ (time)	1e occ (inc)	% income

Fishing (general).

- [SOME] Approximately what % of your total household's monthly income comes from commercial fishing?
- How many people (if anyone) in your household fish for food?
  # ______ *How much* _____ *lbs /week?*
- Where is the majority of this caught? *In lagoon, sea near village, Cayes, SCMR, other*
- [SOME] What percentage of the fish caught by all the members of the household is (a) sold to co-operative, (b) sold to local hotels and restaurants and (c) eaten or given away?
- [SOME] What percentage of the conch and lobster caught by all the members of the household is (a) sold to co-operative, (b) sold to local hotels and restaurants and (c) eaten or given away?

Tourism.

- Why do you think tourists come to Placencia?
  [Options]: Cayes, tours, weather, marine life, whale sharks, diving, beaches, peace, locals, food, hotels, atmosphere Other.
- What do you think are the main benefits to the community, if any, of tourism in Placencia?
  [Options]: More income, more jobs, more development, variety people, imported goods, better lifestyle, little/none, other

- What do you think are the main disadvantages to the community, if any, of tourism in Placencia?
- Less land, pollution, development, crime, overcrowded, overuse mar res, conflict, expenses rise, other
- On balance, do you think tourism has brought more advantages or more disadvantages to the community?
  [Show scale]: 1 very bad, 2 some what bad, 3 neither good nor bad, 4 somewhat good, 5 very good, not sure

- What % of your total household's monthly income comes from tourism, for example from hotels, tours, or the proportion of your business from tourists?
- On balance, has tourism affected you personally in a positive or negative way? [Use scale] 1 very bad, 2 some what bad, 3 neither good nor bad, 4 somewhat good, 5 very good, not sure

GSMR.

- Belize has started to create marine reserves along the coast. Which marine reserves, if any, have you heard about near Placencia? *GSMR, LBC, Glovers, LWC, Sapodilla, Port Honduras, other*
- Have you been to the Gladden Spit Marine Reserve and if so, how many times? (#)
  [If no]: If you have never visited, why not? *Too far, too expensive, no interest, not sure, other*
  [If SOME] How many times, if at all, have you done each of these activities have you done in GSMR in the last 12 months?
  [Read]: Relax with friends/fam, Swim/snorkel, Camp, Comm fish, Recr fish, Tour dive/snork, Tour fish, Other
- Have you ever participated in any of these activities linked to the management of GSMR?
  [Read] *Setting up SCMR, consultations, research, volunteering, school trips, whale shark guide training, alternative livelihood training, fishing workshops / exchanges, other*
- Do you remember when the SCMR became a reserve? *Yes, No, not sure*
  [if yes] Did this area becoming a reserve affect you or your household personally? In what way?
- What percentage of your income from tourism is related to tourist visiting SCMR for diving or whale shark trips? % ______
- How many people, if any, in this household bought a special license for GSMR fishing this year?
- What percentage of your households fishing is done in the SCMR (a) during the snapper spawning in March-June (incl), (b) at other times? ____ %
- How has this changed from when the area was made into a fully patrolled marine reserve, 6 years ago?
- [USE MAP]How many times have you been to LBC? ____ [If yes] How many times in last 12 months for fishing, tourist trips, recreation?
- [USE MAP]How many times have you been to Glovers reef MR? ____ [If yes] How many times in last 12 months for fishing, tourist trips, recreation?

CVM valuation Script

Marine reserves like the GSMR, Laughing Bird Caye and Glovers reef contain beaches, islands, coral reefs and wildlife, including whale sharks. The GSMR is particularly famous, because of the spawning aggregations and whale sharks that visit. [Show photos.] A healthy coral reef could provide a number of benefits to the people of Placencia. Healthy reefs help to promote successful commercial fishing and recreational fishing for locals and tourists. It also improves the tourist experiences for diving and recreation for both Belizeans and tourists. Finally it is a resource that the communities may want to protect for itself and for future generations. Management tries to promote healthy reefs, but may not always be successful.

Illegal fishing and pollution are thought to threaten these reefs. Funding is needed for key activities like monitoring, research, enforcement patrols, local and tourist education, to help reduce tourist damage to the coral and to manage fisheries. Without properly funded and working reserves, these reefs may be damaged, so that the benefits I have described might not be there for your children and grandchildren.
If the current management of various reserves, was not able to continue due to lack of funds, the people of Placencia could be asked to contribute to allow the reserves to continue to be managed. I am going to describe 3 situations that could potentially happen, in turn related to the reserves near Placencia. Suppose that, in order to raise funds for the protection and management of the reserves, ALL users, such as your household, would be asked to pay yearly license fees, to use certain reserves for certain or all activities. You would not be able to carry out the specified activities in the specified reserves without paying this fee. I would like you to think for a moment, about how much each situation would be worth to you and your household, before answering each question. [Rotate order each person].

Suppose that all users would now be required to pay separate yearly fees in order to be able to continue to use Gladden Spit MR, for tourist trips, for fishing or for visiting the reserve for recreation. [use map with reserve in red and picture card]. You would not be allowed to carry out these activities without paying the respective user fee. However, you would still be able to use the Laughing bird and Glovers reefs for free as you would any of the other reserves in the North and South of Belize. Please think about how much each of these activities in Gladden Spit MR is worth to you and your household.

[RANDOMLY ROTATE THE FOLLOWING 5 VALUATION QUESTIONS]

Looking at this card, can you please tell me approximately how much would your household be prepared to pay, if anything, as a yearly fee to be allowed to carry out tourist trips into the Gladden Spit MR? The fee would not cover fishing or recreational visits rights. The payment could be made as in yearly or monthly or weekly instalments. [Show payment card].

Looking at this card, can you please tell me approximately how much would your household be prepared to pay, if anything, as a yearly fee to be allowed to fish in the Gladden Spit MR? The fee would not cover tourist trips or recreational visit rights. The payment could be made as a yearly amount or in monthly or weekly instalments. [Show payment card].

Looking at this card, can you please tell me approximately how much would your household be prepared to pay, if anything, as an yearly fee to be allowed to visit the Gladden Spit MR for recreation? The fee would not cover fishing or tourist trip right.s The payment could be made as an yearly amount or in monthly or weekly instalments. [Show payment card].

How sure are you that you would actually pay this? 0-25%, 25-50%, 50-75%, 75-100%.
[if zero, ask why] ____

Suppose that all users would now be required to pay one yearly fee in order to be able to continue to use Gladden Spit MR, for tourist trips, for fishing and for visiting the reserve for recreation. [use map with reserve in red and picture card]. The fee would allow you and your household to carry out all three activities. But you would not be allowed to carry out the activities without paying the user fee. However, you would still be able to use the Laughing bird and Glovers reefs for free as you would any of the other reserves in the North and South of Belize. Please think about how much these activities in Gladden Spit MR are worth to you and your household.

Looking at this card, can you please tell me approximately how much would your household be prepared to pay, if anything, as an yearly fee to be allowed to carry out all three activities (fishing, tourist trips and recreational visits) in the Gladden Spit MR? The payment could be made as a yearly amount or in monthly or weekly instalments. [Show payment card].

How sure are you that you would actually pay this? 0-25%, 25-50%, 50-75%, 75-100%.
[if zero, ask why] ____

Suppose that all users would now be required to pay one yearly fee in order to be able to continue to use all the 3 marine reserves in the area—the Gladden Spit MR, the Laughing Bird Caye AND the Glovers reef MR--, for tourist trips, for fishing and for visiting for recreation. [use map with reserves in red and picture card]. The fee would allow you and your household to carry out all three activities in all three reserves. But you would not be allowed to carry out these activities without paying the user fee. However, you would still be able to use the other reserves in the North and South of Belize for free. Please think about how much these activities in the 3 local marine reserves are worth to you and your household.

Looking at this card, can you please tell me approximately how much would your household be prepared to pay, if anything, as an yearly fee to be allowed to carry out all three activities (fishing, tourist trips and recreational visits) in the 3 local reserves -- Gladden Spit, Laughing Bird Caye AND Glovers reef MRs? The payment could be made as an yearly amount or in monthly or weekly instalments. [Show payment card].

Attitudinal Questions.

- In your view, is the condition of the coral reefs near Placencia currently threatened in any way?
  [Options] 1-Not at all threatened, 2- hardly threatened, 3 –neither, 4- threatened, 5-very badly threatened, Not sure
- What, if anything is the main threat to coral reefs?
  [Options] Tourists, fishers, pollution, development, weather, other
- Are marine reserves helpful to (a) manage fishing, (b) manage tourism, (c) protect reefs (d) addressing the threat above ?
  [Options] 1 –Not at all helpful, 2-unhelpful, 3- neither, 4-helpful, 5-very helpful,6- not sure
- How would you improve the current management of Silk Cayes MR?
  [Options] Incr patrols, incr research, incr comm outreach, incr edu, friendlier rangers, other
- Who do you think should carry out day to day marine management of Silk Cayes MR, such as the patrols and research? *Placencia, Bel govnt, Intl govnt, NGOs, tourists, fishers, scientists, all, other.*
- Which of these groups should pay towards costs of SCMR management should be paid by each of these groups? [Note groups from list].
- What proportion of the costs should each group you mentioned cover?
  [Options] Local people, tourists, the Gov of Belize, International governments, NGOs, tourists, fishers, other.
- Who do you think are benefits most from Silk Cayes MR?
  [Options] Placencia, Bel govnt, Intl govnt, NGOs, tourists, fishers, scientists, all, other
- What do you think are the main benefits to the community, if any from marine reserves like SCMR?
  [Options] Fishing, tourist control, attract tourists, coral health, bringing funding, less foreign fishers, money for govnt, other
- What do you think are the main disadvantages to the community, if any from the Silk Cayes MR?
  [Options] Expensive, corruption, bad management, too restrictive, conflict, unfriendly rangers, other
- Who do you think is most disadvantaged by the SCMR?
  [Options] Placencia, local businesses, tourists, fishers, other
- In your opinion, is the Silk Cayes MR currently successful in (a) improving fisheries and (b) attracting tourism, (c) protecting the reefs, (d) addressing the threat above (specify)?
  [use scale] 1-Very unsuccessful, 2- unsuccessful, 3-neither, 4-successful, 5-very successful, 6-not sure.
- If the management of Belize's marine reserves were to disappear completely and they were simply open water, how would this affect you personally, if at all? [open]

Follow-up questions.

- What is the highest level of education you have finished?
  [Options] None/ Primary school certificate/ high school diploma / university education/ diploma/other
- Which age category do you fall into?
  (a) 18-25, (b) 26-35, (c) 36-45, (d) 46-55, (e) 56+
- Are you a member of any organisations?
  [Tick all that apply] *Vill council, Humane soc, PCSD, Rotary club, PMM, BTIA, BTB, fishing co-op, other.*
- Have you ever attended any environmental talks or courses? *Yes /No /Not Sure*
  [If yes]; Who were they given by?
- How many (if any) boats with motors are owned (not borrowed or used) by your household? ___
- Do you currently rent, own or live in your household? *Rent, own, live in, other* _____
- Are you currently employed? *Full time/ Self employed/Part time/ Unemployed*
- Which category is closest to the total household income you receive per week before expenses and taxes. Please include income from all members, including children and financial payments from relatives.
  Bze $ (A) 0, 0-100, (B) 100-200, (C) 200-250, (D) 250-300, (E) 300-350, (F) 350-400, (G) 400-500, (H) 500-600, (I) 600-800, (J) 800-1,000, (K) 1,000-1200, (L) 1,200-1,400, (M) 1,400-1,600, (N) 1,600-1,800, (O) 1,800-2,000, (P) 2,000-2,300, (Q) 2,300+

Appendix 6.2. Fisher Survey

[Filter question: Do you ever fish within Gladden Spit MR? If no, do not continue].

Hello. I am a student from the UK studying the marine reserves here in Placencia. I am particularly interested in Gladden Spit MR. As part of my research, in addition to tourist and tour operator surveys, I am doing a fisher survey for all fishers using the reserve – both part time and full time. I am trying to find out more about patterns of fishing in the reserve, your opinions about the reserve and how valuable it is to you. Your knowledge and experiences are extremely important to me and my research. Your answers would be confidential and would not be linked to you or passed on to any other people. To thank you for time, every person who helps with the survey gets a t-shirt. Will you take 20 minutes to answer these questions?

General income and fishing questions.

- Where do you live? [Tick]: Placencia, Sartineja, Seine Bight, Independence, Hopkins, Riversdale.
- How long have you lived there? __ years.
- What is *your* main occupation in terms of time?
- Please list all *your* sources of income? Please divide 100 points between their importance as incomes?

Income source(s)							
Points (income)							

- How many (a) adults and (b) children live in your household for over 6 months a year?
- __ adults (b) __ children
- What other sources of income are there in your household?
- What percentage of your household income comes from you?
- Why do you fish? (Open) [Opntions]: Income, food, enjoyment, other.
- How many years have you been fishing for? ____ years.

[Fill table]: Which type of seafood do you catch? For each fish caught, establish months not caught (despite season being open), max, min and average volume per day, gears used, if certain habitats are specifically targeted and expected price. NB establish if they segregate fish catch by season (high / low), or by type (finfish, conch, lobster). Make notes on whichever is appropriate, including seasonal variation by fish.

Type fish / season				
Catch? Open months don't fish Est max vol /day Est min vol /day Est mode vol/ day Gears used Habitats visited Price per lb (Bze)	Y/N J F M A M J J A S O N D	Y/N J F M A M J J A S O N D	Y/N J F M A M J J A S O N D	Y/N J F M A M J J A S O N D

Key: FD = Free dive, Sp = spear, HS = Hawaiian sling, GN = gill net, HL = hand line, TP = traps, SD = shade, SF = sport fishing. SB = sand banks, lg = lagoon, mg = mangrove, cr = coral reefs, sg = sea grass, al = algae

- What are the most important things that deicide which location you go to fish at? (Open)

[Tick]: travel time, habitat, lunar cycle, tides, currents, weather, trap location, camping grounds, fishing companion, other.

- What percentage of the fish you catch is (a) sold to co-operative, (b) sold to local hotels and restaurants and (c) eaten or given away? [Use 100 cents exercise if not familiar with percentage].
- Does this change at different times of year? Please explain.
- What percentage of the lobster and conch you catch is (a) sold to co-operative, (b) sold to local hotels and restaurants and (c) eaten or given away?
- Does this change at different times of year? Please explain.
- Do you belong to a fishing co-operative? Which one(s)? [Tick]: Northern, National, Independence, Placencia.

Fishing costs and earnings.

- [Fill table]: By season: How many days a month do you fish? How many hours a day? What are (a) maximum, (b) minimum and (c) average earnings (before costs), per trip at these times of year?

	All fisheries open	**Lobster closed**	**Conch closed**
Trips fishing per month Days or hours fishing per trip Most earnings per trip per fisher Min earnings per trip Average earnings per trip per fisher			
	J an, Feb, June, Oct, Nov, Dec	July, Aug, Sept	march, apr, may

- What do you personally need to make to break even for a trip? Bze ______
- Do you own a boat? When did you buy it?
  Year _____ Price? Bze ____ Rental contribution Bze ______
- Who do you usually fish and share costs with? [Note name(s)]
- What are you major costs per fishing trip?
- [Note price for each mentioned]: Ice, gas, food, boat rental or contribution, cow hide, bait, other.
- How much do you spend on fishing equipment each season/year for each gear?
  Gear ____ Bze ______

Fishing and working in GSMR.

[Use map of GSMR to remind of location and to be clear about reserve boundaries.]

- Why do you fish at Gladden spit marine reserve? [Open].
- Which months did you fish within the reserve over the last year?
- Tick as appropriate: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sept, Oct, Nov, Dec.
- What do you catch inside the reserve?
- Where do you catch this? [Note habitat and area from map].
- What percentage of the overall time you spend fishing is spent fishing inside GSSCMR?
- What percentage of your income from fishing comes from fishing inside the reserve over a year?
- [Fill table]: Have you do you work as any of these occupations, within GS? How frequently? ___ days a month/year

Activity	fly-fishing /deep sea fishing guide	Dive / snorkel / tour/boat guide	Research guide
Work?	Y / N	Y / N	Y / N
Days per month/yr			

Attitudes.

- **Who** do you think benefits from marine reserves?
- What are the disadvantages created marine reserves?
- Would you change the management at GSMR and how?
- Do you think the no take area should be made bigger, moved to another area or better enforced?

➢ Can you answer how much you agree with these statements?
[Possible answers for each: show scale; Strongly agree, agree, neutral, disagree, strongly disagree and don't know].

- When the MR opened, I noticed a decrease in my overall catches
- Catches are better near the no-take zone in GSSCMR than they are in other nearby fishing areas
- GSSCMR is helping to improve and maintain local fisheries
- There is a lot of illegal fishing within the reserve which limits its usefulness
- Tourism is a very good thing for every person within the village and should continue to grow
- Coral reefs do not need to be studied and protected
- Tourists visiting GSMR reduce my catches inside the reserve
- Even if the reefs become very badly damaged, it won't affect me personally.
- Do you have any comments you would like to add?

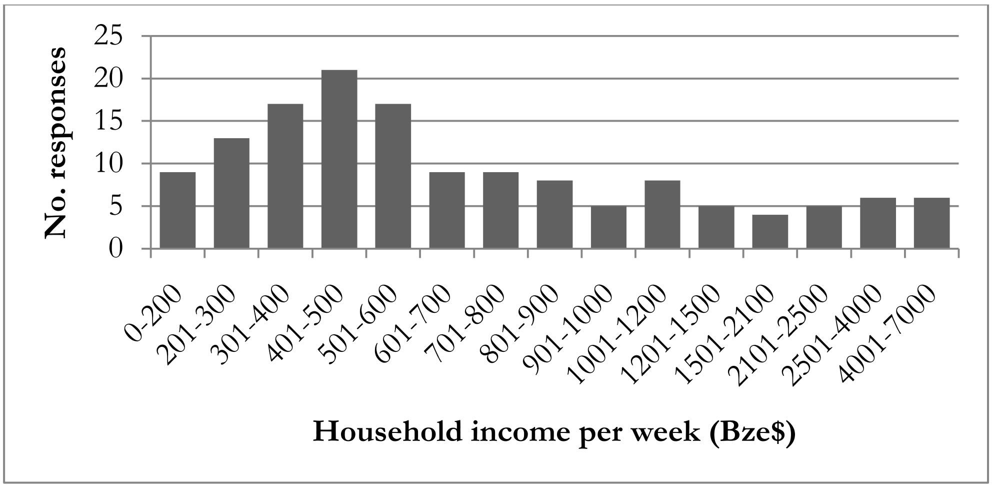
Appendix 6.3. Respondent socio-demographic profile.

Question	Option	Response
Respondent gender	Male	48%
	female	52%
Age categories	18-25	14.6%
	26-35	29.2%
	36-45	28.4%
	46-55	19.2%
	56+	8.6%
Household members	Total	Mean = 3.5 (range 0 -11)
	Men	Mean = 0.9 (range 0 –3)
	Women	Mean = 1 (range 0 –3)
	Children	Mean = 1.7 (range 0 –9)
Member of an organisation	Tourism organisation	14%
	Environmental organisation or fishing co-operative	17%
How many boats does your household own?	0	54%
	1	36%
	2	8.5%
	3	0.7%
	4	0.7%
Wealth	Low	8.3%
	Medium	70.2%
	High	21.5%
Main income source	Fishing	5.3% of households
	Tourism	45.4% of households
Income sources	Fishing	3.2% of income
	Tourism	66.3% of income

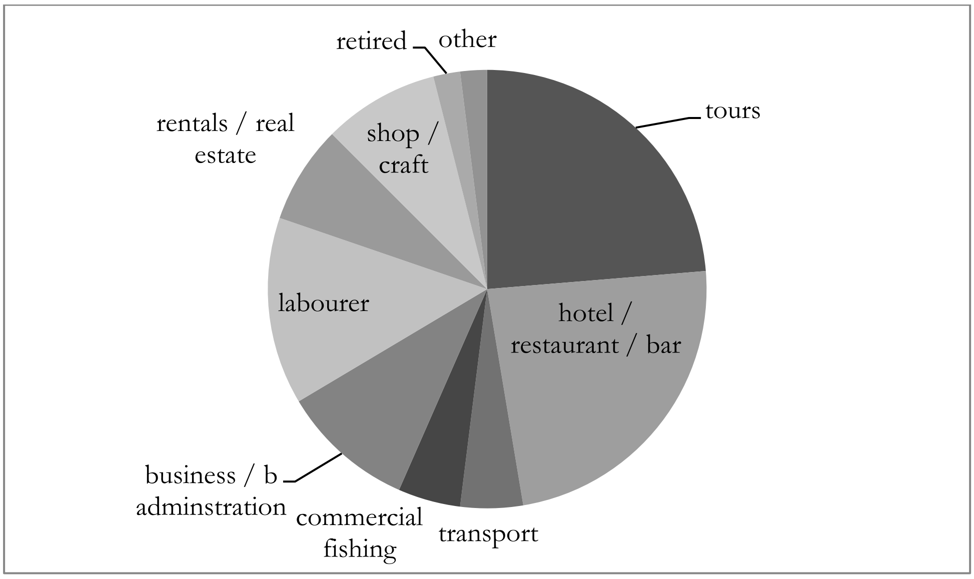
Appendix 6.4. Characterisation of Community Wealth categories

Low	Medium	High
Small house	Hardwood house	Hardwood or concrete house
Wooden windows	Wooden louvers	Glass / aluminium windows
Under 3 rooms	3 -5 rooms	4-6 rooms
Little / no holiday	Vacations in Belize	Own a business
No car	Poor condition car	Vacation overseas
No computer	2nd hand computers	Good condition car
Rent / borrow boats	Own 1-2 boats	Laptop
Rent house	Own a house	Rent out boats
Little / no games and hand me down toys	2nd hand video games and old toys	Have several homes
		New toys and games

Appendix 6.5. Weekly household incomes. Bze$2 = US$1.



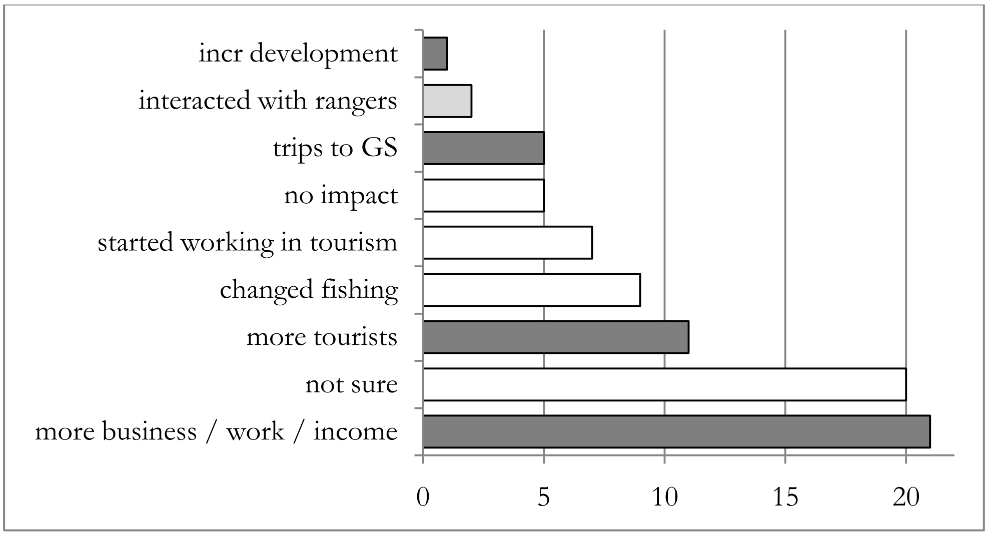
Appendix 6.6. Sources of household income for the sample population.



Appendix 6.7. Negative Binomial Regression of Determinants of Household Incomes (N = 133, LR chi2= 144.4, Pseudo R^2 = 7%, Prob > chi2 = 0.000).

Variable name	Weekly income per household
Constant	5.876 (0.000)***
Respondent age	-0.015 (0.003)***
Years in Placencia	0.007 (0.042)**
No adults in the household	0.275 (0.000)***
Low wealth*	-0.597 (0.002)***
High wealth*	0.519 (0.001)***
Own household	0.448 (0.002)***
Self employed*	0.269 (0.028)**
% income fishing	-0.008 (0.037)**
Main income tourism	0.235 (0.047)**
Member tourism organization	0.674 (0.000)***

Appendix 6.8. How did the formation of GSMR affect you personally?



Appendix 6.9. T-tests to compare stated WTP for different levels of respondent certainty.

WTP type	Test value	Degrees of freedom	P-value
Fishing access	0.55	3	0.652
Tourism access	1.10	3	0.352
Recreational access	0.70	3	0.552
All access GSMR	0.93	3	0.430
Access 3 marine reserves	0.71	3	0.550

Appendix 6.10. T-tests to compare the different WTP values stated.

Value compared	t-stat	df	p-value
Fish and tourism wtp	-5.15	150	0.00000
Fish and recreation	3.093	150	0.0003
Tourism and recreation	-6.106	150	0.0000
Fish and all GS	-9.44	150	0.0000
Tourism and GS	-8.899	150	0.0000
Recr and all GS	-9.701	150	0.0000
All GS and all MRs	10.01	150	0.0000

Appendix 6.11. Percentage of responses for attitudinal questions relating to the reserve and tourism.

Statement	Strongly disagree	disagree	neutral	Agree	Strongly agree	Not sure
When the reserve opened, I noticed a decline in my catches	1.9	48.2	5.5	31.5	7.4	5.5
Catches are better near the no-take zone in GSSCMR than they are in other nearby fishing areas	5.7	26.3	2.9	44.3	17	3.8
GSSCMR is helping to improve and maintain local fisheries	1.9	15	5.7	69.8	7.6	0
There is a lot of illegal fishing within the reserve which limits its usefulness	7.4	20.4	5.5	35.2	31.5	0
Tourism is a very good thing for every person within the village and should continue to grow	5.5	13	0	38.9	42.6	0
Tourists visiting Gladden Spit marine reserve reduce my catches inside the reserve	14.8	37.1	0	22.2	22.2	3.7
Even if the reefs become very badly damaged, it won't affect me personally	57.4	27.8	1.8	9.3	3.7	0
Coral reefs do not need to be studied and protected	42.6	53.7	1.8	0	1.8	0

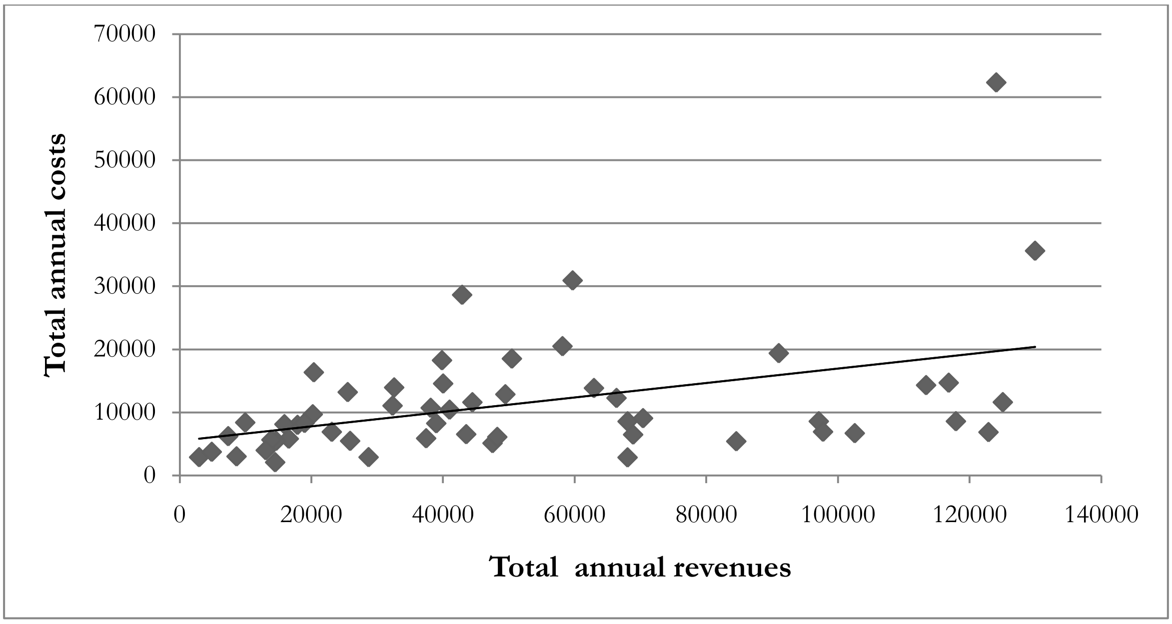
Appendix 6.12. Summary information on fish caught.

Type of fish	Fin fish (snapper, grouper)	Game fish	Conch	Lobster
Seasonal?	No	No	season closed July to September (inclusive)	season closed mid February - mid June
Gears used.	Hand line, hawaiin sling	Handline, Rods and reels	Free dive	Stick with hook, shades, traps & drums
Price per lb (whole)	Bze$ 3-4	Bze$ 4-5	Bze$ 5.00 – 6.50	Bze$ 16 - 20
Price per lb (processed)	Bze$ 7-8	Bze$ 9 - 10	Bze$ 7 - 10	Bze$ 25 - 30

Appendix 6.13. Daily catches for local and Sartenjan fishers.

Variable	Local fishers	Satenejan fishers
Mean number of months doing commercial fishing for fish	9.5	11
Minimum daily catch of fish (lbs)	42.2	7.4
Maximum daily catch of fish (lbs)	216.2	52.2
Typical daily catch of fish (lbs)	104.8	25.8
Mean number of months doing commercial fishing for lobster	6	9
Minimum daily catch of lobster (lbs)	5.2	4.9
Maximum daily catch of lobster (lbs)	46.9	23.7
Typical daily catch of lobster (lbs)	18.5	12.7
Mean number of months doing commercial fishing for conch	4.8	8.3
Minimum daily catch of conch (lbs)	17.7	12.2
Maximum daily catch of conch (lbs)	95.9	54.1
Typical daily catch of conch (lbs)	41.0	26.3

Appendix 6.14. Annual revenues and annual costs for fishers using the reserve. y = 0.1144 + 5499.5, R^2 =0.183.



Appendix 6.15. Catch data for local fishers during spawning aggregations and at other times of year.

Type of fishing	Handline (spawning aggregations)	Handline (rest of year)
Range per day	7 to 245 lbs	18 to 125 lbs
Mean lbs per hour	10.1	8.4
Median lbs per hour	8.5	8
Dt deviation	7.2	4.5
Mean lbs per day	76	63.3
Median lbs per day	64.1	59.3
St. deviation	54	33.6
Expected mean value catch per day (Bze $)	243.6	524
Mean value catch per day whole (Bze $)	228	190
Mean value catch per day processed (Bze $)	684	520
Mean gallons Gas / day	6.3	8

Appendix 6.16. Landings data for Sartenejan fishers during different seasons. NB Calculated based on reserve catch surveys. Values in Bze$ for fish were $3.5 whole, $7.5 fillet, conch were $5.5 and $8.5 and lobster were $18 and $27.

Type of fishing	Free diving (all open)		Free diving (conch closed)	Free diving (lobster closed)
Range per day	C: 2.3 to 135	L: 1 - 59	L: 3.2 - 30	C: 3 - 94
Mean lbs per hour	C: 3.6	L: 1	L: 1.1	C: 3.4
Median lbs per hour	C: 1.3	L: 0.6	L: 0.8	C: 2.6
Dt deviation	C: 5	L: 1.5	L: 0.8	C: 3.2
Mean lbs per day	C: 26.8	L: 7.4	L: 8	C: 25.5
Median lbs per day	C: 9.6	L: 4.5	L: 6	C: 19.7
St. deviation	C: 38	L: 11	L: 6	C: 24
Expected mean value catch per day (Bze $)	268.1		132.2	183.6
Mean value catch per day whole (Bze $)	270.8		126.9	167.1
Mean value catch per day processed (Bze $)	406.3		182.5	233.7
Mean gallons Gas / day			3.6	

Appendix 6.17. Fish catches and gross values for fisheries within Gladden Spit Marine reserve using median catch data for 2007.

Fisher type	Product quantity (lbs)	No. Fisher days (% of total)	Value if whole (Bze$)	Value if filleted (Bze$)
Local	25,790 fish	428 (12.4%)	90,260	193,413
Sartenejan	29,408 conch 11,340 lobster	3025 (87.6%)	365,866	556,151
All	66,920 product	3453 (100%)	456,131	697,996

Appendix 6.18. Revenues per tourist for all types of trips.

	Regular tourist trips		Whale shark trips	
	Diving	Snorkelling	Diving	Snorkelling
Cost with tour operator	208	134	303	155
Cost with hotel	332	155	380	218
Mean cost of trip per person (US$)	236	139	329	168

Appendix 6.19. Per trip costs for Operators in the two tourist seasons.

	Regular tourist trips		Whale shark trips	
	Tour operator	hotel	Tour operator	hotel
Number trips in 2007	166	70	180	88
Gallons gas used	27.5	42	38.5	47
Cost of boat Captain	50	37.5	62.5	
Cost of guide	50	37.5	62.5	
Food per person (US$)	5	11.25	5	11.25
Tank per person (US$)	4	4	4	4
Mean per trip costs (US$)	255	417	331	453
Annual trip related costs per type operator & trip	42,330	29,190	59,580	39,864
Unrefunded payments for whale shark slots			4,000	
Total annual trip related costs for all operators			**174,964**	

Appendix 6.20. Annualised business costs for tour operators. NB earnings from boat rentals are given in parentheses.

	Tour operator	Hotel
(Annual earnings from boat rental per operator (10 days/yr))	(3,350)	
Mean equipment purchase and servicing (US$)	3,473	9,730
Annual recurring costs (insurance, advertising, overheads)	7,157	14,408
Annualised boat investments	5,100	5,100
Annual boat maintenance	7,000	7,000
Annual costs boat rental per year (35 days / year)	11,725	11,725
Annualised shop building and maintenance costs	1,225	1,225
Annual shop and land lease costs	3,200	3,200
Total annual business investments	35,530	49,038
Percentage of business related to GSMR	27%	18%
Total annual business investments related to Gladden spit per operator	9,593	8,827
Number of business	18	5
Total business related investments for all operators	**216,810**	