The Economic Value of the Gladden Spit and Silk Cayes Marine Reserve, a Coral Reef Marine Protected Area in Belize.

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Conservation Strategy Fund.

Acronyms.

CS: consumer surplus
CPUE: catch per unit effort
CVM: contingent valuation method
FoN: Friends of Nature
GSSCMR: Gladden Spit and Silk Cayes Marine Reserve
MPA: marine protected area
MR: marine reserve
NPV: net present value
PS: producer surplus
WTP: willingness to pay

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Executive Summary.

Marine Protected Areas Maintain Economic Values

Coral reef marine protected areas (MPAs) protect ecosystem services that directly and indirectly contribute to the welfare of people, both nearby and far away. They do this by protecting species and their habitats from some of the many stressors that affect reefs. For example, they reduce the damaging effects of unsustainable fishing and inappropriate gear, as well as damage from anchors and trampling associated with tourism. Finally, by reducing immediate stress, MPAs increase resilience to damaging forces that act from beyond their boundaries. 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 studies have begun to make explicit the size and beneficiaries of values such as recreational and non-use tourist values. The full suite of economic benefits is rarely measured, as this process is time consuming, technically demanding and expensive. As a result, few policy makers are aware of the ranges of values which coral reef ecosystems and their protection generate, not to mention the number and variety of stakeholders which benefit from these values. Lack of information typically results in under-investment in reef conservation and an in overlooking the negative impacts that habitat loss will have on stakeholders, their values, and the local economy. This situation is aggravated by the scarcity of studies measuring local community values provided by intact ecosystems, which are often substantial.

Valuing the Gladden Spit and Silk Cayes Marine Reserve

This report describes research conducted to measure the economic values for the most important environmental services generated in 2007 at a coral reef MPA in Belize, Central America. This study goes beyond estimating financial impacts of the MPA, to include welfare estimates for consumers and producers related to the case study site, using extensive primary data. This research uses research methods which have been developed in the field of environmental economics to measure both producer and consumer surpluses for a variety of stakeholders. Values measured relate to several stakeholder groups:

Tourists who visit the reserve; **visitors**. Tourists enjoy three major types of value; 1) consumer surpluses associated both with day trips to the reserve and with whale shark experiences, 2) welfare gains associated with the option to visit in the future (option value) and 3) value from simply knowing these areas exist and can be visited by future generations (non-use values).

Tourists who visit the area, but not the reserve; **non-visitors**. These tourist may also want to maintain the opportunity to visit the reserve in the future, despite having no immediate plans to visit, and thus will also hold option and non-use values.

Local community residents. Local community residents enjoy consumer surplus values associated with the use, or option to use, this MPA for fishing, tourism and recreation, as well as other values associated with the reserve.

Belizean fishers. Commercial fishers travel to the reserve, from local villages and from villages much further away, to take advantage of the excellent fishing in those areas where fishing is allowed inside the reserve. These fishers enjoy profits (producer surplus) from participating in this fishery.

Local tour operators and hotels. Tourism businesses earn profits (producer surpluses) from day trip and whale shark visits to the reserve, net of business costs incurred.

The values quantified in this research were all measured net of costs. Gross values (often reported in other studies) are much larger but overstate the true economic value of the resources. The figures presented in Table 1 demonstrate the breadth of welfare gains enjoyed by people from the villages near the reserve, Belizeans in other parts of the country and by the international community. These values differ in terms of units, time periods and in terms of the level of confidence in their precision. We see that tourists and locals have a range of large values for this reserve. We also see that the closed access nature of fishing during spawning aggregations and tour trips during the whale shark season also result in significant profits for local businesses, which is reflected in the profits (producer surplus estimates) shown below. Community values for using the reserve make up a considerable part of the overall value, so omitting them would have led to a serious underestimate of the true value of this reserve.

Table 1. Summary Table of Economic Values at the Gladden Spit Marine Reserve.
* Level of precision depends both on the method used and the estimate itself. Non-use and community values are less precise since respondents are less familiar with the reserve or the decision process involved in generating value estimates. Less precise values are more variable (mean and median values are less similar).

Value category	Value	Time, unit	Mean value US$ (median value)	Beneficiary	Level of precision*
Visiting tourist values	One day visit	Per visit, per visitor	25.2 (20)	International visitors to GSMR	High
	One day visit + whale shark interaction	Per visit, per visitor	40.2 (30)		High
	Lifetime option and non-use value	Per lifetime, per visitor	68.4 (50)		Medium
Non visiting tourists	Per trip option & non-use value	Per trip to Belize, per tourist	21.1 (15)	International tourists to Placencia	Medium
	Lifetime option value	Per lifetime, per tourist	71.6 (35)		Medium
Community values	Annual fishing access	Per year, per household	103.2 (60)	Residents of Placencia	Medium
	Annual tourism access	Per year, per household	177 (68)		Medium
	Annual recreational value	Per year, per household	82.8 (60)		Medium
	Total Value Gladden Spit	Per year, per household	373.2 (180)		Medium
Fishing values	Annual fisher profits (PS) for fishing inside Gladden Spit	Per fisher day inside reserve	118 (109.5)	Local Belizean Fishers Sartenejan fishers	High
Tourism values	Annual profits (PS) for tour operator trips to Galdden Spit	Per year, per tour operator	33,900	Local Belizean Tour operators International hotel owners	High

Having measured these values (net of costs) for a representative sample group, we are able to aggregate them over one year, given the number of people who fall into each stakeholder group. This is a key process, as

aggregated values reflect the overall value of the marine resources protected and should guide policy more than individual values. For example, there were fewer visitors than non-visitors. The latter group holds non-use values for the reserve, so non-visitors may represent a major constituency for the MPA and a possible source of funding. These aggregated values (shown in Table 2), can then be converted into values over 25 years, using different discount rates, which capture more and less conservative predictions as to the relative value of money in the future.

The use values of the reserve alone are worth an estimated $1.3 million per year currently and potentially have a net present value of US$13-29 million over the next 25 years (depending on the scenario and discount rate considered). Inclusion of non-use values increases the net present value of the resources within the reserve to US$41-93 million, demonstrating the importance tourists place on making sure these areas persist for future generations. Nevertheless, these values are likely to be an underestimate of the total economic value, as there are values such as marine life nursery functions and other nearby community values which have not been included. Also, over time these values would be expected to increase, due to increasing wealth and degradation of other reef areas.

In terms of the distribution of net benefits, international tourists to the village of Placencia enjoy 71% of the values and international hotel owners 5%. Belizeans enjoy 24% of the total value measured (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 1200 people. If other villages nearby were considered, the proportion received by Belizeans would be considerably larger.

Table 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	Aggregated annual value (after costs)	Low estimate over 25 years (US$'000)10% discount rate	High estimate over 25 years (US$'000) 1% discount rate
Visitor day trip CS	4,221*	59,516	600	1,370
Visitor Whale shark interaction CS	2,032*	19,304	1.8	15
Visitor lifetime option and non-use value	6,253*	437,085	4,405	10,063
Non-visitor lifetime option & non-use value	39,570	2,354,415	23,726	54,206
Annual fishing access	180 households	28,896	291	665
Annual tourism access	180 households	49,560	499	1,141
Annual recreational value	180 households	23,184	234	534
Annual non-visitor value	180 households	2,856	29	66
Annual fisher profits (PS) for fishing inside GSMR	3453 days fishing	394,616	3,977	9,085
Annual profits (PS) for tour operator trips to GSMR	20 operators hotels	677,993	6,832	15,610
ALL USE VALUES	n/a	1,253,069	12,627	28,850
ALL VALUES (use + option + non-use)	n/a	4,047,425	40,786	93,185

We have seen that a wide range of values are generated at this one reserve, which are enjoyed by a broad variety of stakeholders. Without investment in management, threatened reefs would be likely to become highly degraded, as has occurred in many other coral reefs in the Mesoamerica region. As a result, most of the values measured here would be diminished, reducing the welfare of local stakeholders through impacts on tourism and fishing. Gladden Spit is similar to other multi-use MPAs, which could be expected to have broadly comparable economic values. However the spawning aggregations that occur there and the aggregations of whale sharks that come to feed on the spawn make this area unique and represent a 31% of the total reserve value, despite these occurring over a relatively short time period. Resource rents in this fishery are high, which is partly due to management and their remote location, which limits the fisher access. The same is true of tourism operator rents. These spawning aggregations in particular need to be preserved to ensure that their benefits are not lost through overuse. This research should be used to raise awareness as the magnitudes of these values and the number of stakeholders that benefit, to justify continued or increased investment at this reserve and to target fundraising and education.

It is the unique features of the reserve (especially the spawning aggregations and whale shark visitation) which means that there are no local substitutes for this reserve. The economic impact of the reserve could be extremely large, as it includes revenues from tourism and recreation such as those relating to international and local travel, restaurants, hotels, gift shops, insurance, sales of dive gear, boats as well as materials and labour for tourism development. It also includes revenues from fishing related activities such as fisheries permits, fishing gear and boat equipment. These revenues have a direct and indirect impact on the local and regional economy and supports a large number of jobs, usually to Belizeans. This economic impact is additional to the net values reported in this research.

Harnessing Values to Improve Park Financing

The values we estimate for the Gladden Spit Marine Reserve should be important when considering policy actions. We demonstrate 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. We include a discussion of some threats and their likely impact on the reserve and find that threats could undermine the benefits of the reserve if left unaddressed.

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. In this report we provide evidence that MPAs such as the Gladden Spit Marine Reserve are likely to be a net beneficial 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. The survey tools that have been developed here can be easily used elsewhere. We recommend that such studies include local community and non-use values. This would help to identify economic values which should be the focus of management actions and of polices to raise funds from beneficiaries or polluters.

Introduction.

This report describes the results of original research conducted at the Gladden Spit and Silk Cayes Marine Reserve (GSSCMR), a marine protected area in Belize, which identified and measured the major beneficiaries and economic values generated in 2007. The GSSCMR has long been recognised as a precious resource, which has merited funding from national and international organisations to protect the coral reef ecosystems and abundant fisheries that exist there. This reserve generates a large number of benefits, both directly for users from local villages, other areas in Belize and international tourists, for businesses linked to the reserve and for the global community, who benefit simply by knowing that these areas exist and can be passed on to the next generation. However, there is a need to explicit the types and magnitude of benefits enjoyed by all stakeholders and to quantify the economic values the reserve protects, which are safeguarded by sound management. This is essential, as the reefs in this region have suffered considerable degradation and remain highly threatened, both by human activity and ineffective management (Burke & Maidens, 2004;Wilkinson, 2004;Wilkinson, 2008). This reflects to some extent a lack of awareness of the high value of intact ecosystems and the link between healthy reefs, sustainable tourism and thriving local communities.

Sound management requires investment, which is further justified if the benefits of MPAs are demonstrated to outweigh the costs. The need for valuation data has driven an increase in the number and quality of valuation studies, which have demonstrated the enormous contributions coral reefs make to coastal communities. However, the full suite of economic benefits is rarely measured, as this process is time consuming, technically demanding and expensive. In particular, non-market values are rarely measured, despite the fact that these can constitute a large proportion of the true value of such areas. As a result, few policy makers are aware of the ranges of values which coral reef ecosystems and their protection generate, not to mention the number and variety of stakeholders which benefit from these values. Lack of information typically results in under-investment in reef conservation and an in overlooking the negative impacts that habitat loss will have on stakeholders, their values, and the local economy. This situation is aggravated by the scarcity of studies measuring local community values provided by intact ecosystems, which are often substantial. Without such estimates, small profits from damaging activities can seem profitable, despite the damage they cause to these reefs, they are not. Furthermore, values of reefs vary widely, but as yet, we have insufficient understanding the drivers of these variations and more studies are needed before benefits transfer can be reliably carried out.

An estimate of the value of the reserve was requested by the Friends of Nature, who manage this area. Different areas must compete for scarce funding. Demonstrating quantified values can help to secure such funding, by raising awareness of the value of this area, justifying new or continued investments to donors and by identifying new or enhancing current revenue raising strategies. This information would also aid in identifying marginalised stakeholders to target advocacy, education and awareness campaigns and to understand the incentives faced by those conducting illegal activities, which can help in targeting effective policies to address these issues. It can also be used when considering policy options which involve trade-offs between different types of uses, such as appropriate price setting for fees to maximise revenues or control visitor numbers. Any values demonstrated could be used to provide an argument for limiting destructive activities and provide an estimate of the magnitude of compensation that would be warranted by negligent damage, such as a ship grounding. Ultimately, valuation is a tool for maximising benefits with sound management decisions.

The aim of this research was to identify the major benefits, the beneficiaries and economic values generated at the GSSCMR in 2007. This could then be used to estimate the value of the reserve in the future, given certain conditions. We standardised and widely applied methodologies with primary data collected on site, involving hundreds of surveys of local residents, Belizean fishers and international tourists. We explicitly sought to measure economic values, which are related to human welfare for consumers and producers and are calculated net of costs, such as fishing costs or entrance fees. This contrasts to other research, which shows the financial contributions of coral reefs to local and regional economies, without taking into account the costs of securing such benefits. These costs can be large in relation to benefits, so not including them will leave to over-inflated value estimates and thus poor policy decisions.

Background.

a) Values of coral reefs

Coral reef ecosystems produce a suite of direct and indirect benefits (table 1). There are good existing research estimates for direct use values such a recreational value at many sites (Brander et al., 2007) or the gross value of fish harvested at a site or on a regional level e.g. (Bunce & Gustavson, 1998;Burke et al., 2008;Hargreaves-Allen, 2004). Non-use values are more demanding to measure, but increasingly incorporated into valuation studies, which often demonstrate that they are a large part of the total value e.g. (Spurgeon et al., 2004). Of the indirect use values, coastal protection values are the most frequently calculated e.g. (Burke & Maidens, 2004;Cesar et al., 2002). Other ecosystem services, while understood to be valuable, have yet to be measured, due to a limited understanding of the bio-physical links between changes in reef quality and the provision of these benefits, such as nursery values or waste assimilation. Overall, these studies have been important as they have demonstrated that values vary between regions and sites, but that reefs are extremely valuable. One estimate of the total net benefits of reefs globally, suggests it is $29.8 billion, of which tourism and recreation account for $9.6 billion, coastal protection for $9.0 billion, fisheries for $5.7 billion, and biodiversity for $5.5 billion (Cesar, Burke and Pet-Soede, 2003).

These goods and services depend on the existence of healthy ecosystems. However, globally reefs are declining and have suffered severe damage, which has necessitated the establishment of marine protected areas (MPAs). MPAs are sites where active management is carried out to conserve reefs. Coral reef MPAs protect ecosystem services that directly and indirectly contribute to the welfare of people, both nearby and far away. They do this by protecting species and their habitats from some of the many stressors that affect reefs. For example, they reduce the damaging effects of unsustainable fishing and inappropriate gear, as well as damage from anchors and trampling associated with tourism. They also control activities that can damage reefs and enforce bans on extracting endangered species.

By reducing the number and severity of stressors, MPAs increase resilience to damaging forces that act from beyond their boundaries. 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.

Table 1. Economic Values Attributed to Coral Reefs. Adapted from *(Moberg & 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/calcium control, waste assimilation. Social services: employment opportunities, food security Coral sand generation National coastal zone extensions
Non-Use Values	Option Value	Species, habitats, biodiversity, pharmaceutical goods.
	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 produce distinct benefits and costs which occur due to the process of active management, which have been characterized mainly qualitatively in the literature. Direct costs at MPAs are incurred when they are established and with necessary investments and running costs. Currently, there is enormous variation in the funding available for MPAs (Balmford et al., 2004). Income requirements vary with the size of the MPA, with visitor numbers and with the region, but few MPAs are adequately funded, which has serious implications for their ability to achieve even their most basic goals (Gravestock et al., 2008).

Benefits of MPAs are also numerous and include fisheries benefits from limiting or extracting fishing, sustainable harvesting of other resources, enhancing recreational experience through education and awareness, as well as social impacts such as increased local capacity, development initiatives or decreased conflict (Kechington et al., 2003;Mascia, 2004;Roberts & Hawkins, 2000). Whilst it is clear that higher quality reefs are more resilient, have greater yields and provide better recreational experiences, few studies measured the changes to the goods and services that coral reef management produces. This is difficult to do, as it requires complex ecological modelling and an understanding of what would happen if management had not occurred (Pendleton, 1995). Any estimates of this kind are less defensible, due to the large number of assumptions they must make. Therefore the aim of this research is to quantify net values associated with the protected reefs at this site, as these values are more defensible. Later we will include a discussion as to the likely effect of lack of management on the values generated.

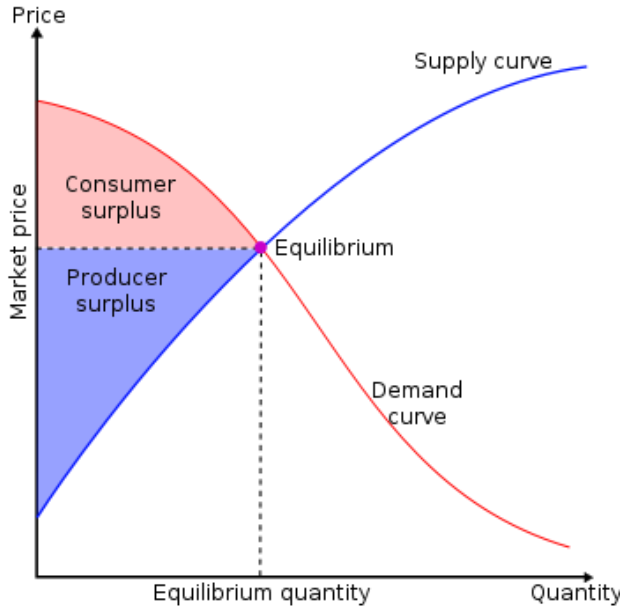
Economic values of reefs will accrue to consumers, such as visitors and producers, such as local businesses associated with the reserve. Consumer and producer surpluses measure these benefits net of the costs incurred (see box 1).

Box 1. Producer and Consumer Surplus

Producer surplus is the welfare gain that producers get by selling at a market price that is higher than the costs of production they have incurred.

Consumer surplus is the welfare gain secured by consumers by being able to purchase a product for a price that is less than they would be willing to pay.

These things are illustrated below on a supply and demand chart.



The number of buyers and sellers has important implications for each, as it determines who controls prices.

b) Marine Protection in Belize

Belize is a small subtropical country of around 23,000km² on the Caribbean coast of Central America. It has a relatively small population of 291,800 (2006). The Belize barrier reef system (BBRS) is the largest living reef in the Western hemisphere, running parallel to the coast. It was designated a world heritage site in 1996. 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. The BBRS contributes around 30 percent 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, 2005). Belize is establishing itself as a reef and rainforest eco-tourism destination, with marine ecosystems key to its tourism success. Diedrich (2006) suggests that the current rapid rate of tourism expansion in Belize means that negative impacts such a crime and pollution could soon surpass the financial benefits that tourism provides. Effective

marine conservation is very much needed, as overdevelopment and poorly planned tourism infrastructure threaten the marine resources which tourists come to see (Loper et al., 2008).

Belize has established a network of 19 marine protected areas, with various levels of protection, levels of management, sizes, zones, primary management aims and other key features. The Half Moon Caye MPA was established in 1982, which demonstrates that Belize has a long history of protecting marine resources. Management responsibility lies with different groups for the different MPAs, but is usually co-managed between a local NGO and government department. Diedrich (2006) warns that MPAs are critical for maintaining the integrity of Belize's reef tourism through the effective establishment of user fees, carrying capacities and enforcement policies. Nevertheless, many MPAs in Belize are paper parks, without any active management and others lack sufficient funds to deter illegal fishing or anchoring.

c) The Gladden Spit Marine reserve

The Gladden Spit and Silk Cayes Marine Reserve (GSSCMR) was designated in 2000, although management was not active until 2003. It falls under the IUCN category IV, which means it is a habitat management area managed mainly for conservation, but with some extraction allowed. GSSCMR is under the jurisdiction of 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, such as patrols and fee collections. The Gladden Spit Marine Reserve lies 36km offshore from the village of Placencia, which is the third most popular tourist destination in Belize (Belize tourism board (BTB), 2007). There are three times as many tourists as local residents during high seasons in December, January and March to June.

It is a multi-use reserve, of 105.1km^2, which is relatively large for a coral reef MPA, but below the average size for MPAs in Belize. A map of the reserve can be seen in Figure 1. The reserve has a small no-take area of 16.2km^2 where fishing is prohibited (outlined in red), which surrounds the silk islands, where tourists are usually taken for picnic lunches. The rest of the reserve has minimal fishing regulations and the conch restoration zone is not enforced. The whale shark zone (outlined in yellow) at the reserve elbow and is the site of spawning aggregations for over 25 species of fish, including several endangered species of snapper (*Lutjanus)* and grouper (*Epinephelus*). Here a sloping shelf drops steeply from 40 meters to over 2000m, within 10km of the reef. This area has been known to fishers for many generations, who have come to take advantage of the good catches at these times. Whale sharks (*Rhincodon typus*) come to this area, to feed on spawn for ten days around the full moon, in March, April, May and June (40 days per year). Tourist access to this area is limited during this time, but tours to see these whale sharks are extremely popular.

Gladden Spit Marine Reserve was chosen as it was in many ways typical of marine reserves elsewhere, in that it contains several zones, most with minimal regulations concerning extraction and use, and also a small no-take area. Importantly, Friends of Nature, the organisation managing the reserve, requested an economic valuation. This site was also of interest due to the unique presence of whale sharks and its importance as a traditional fishing area.

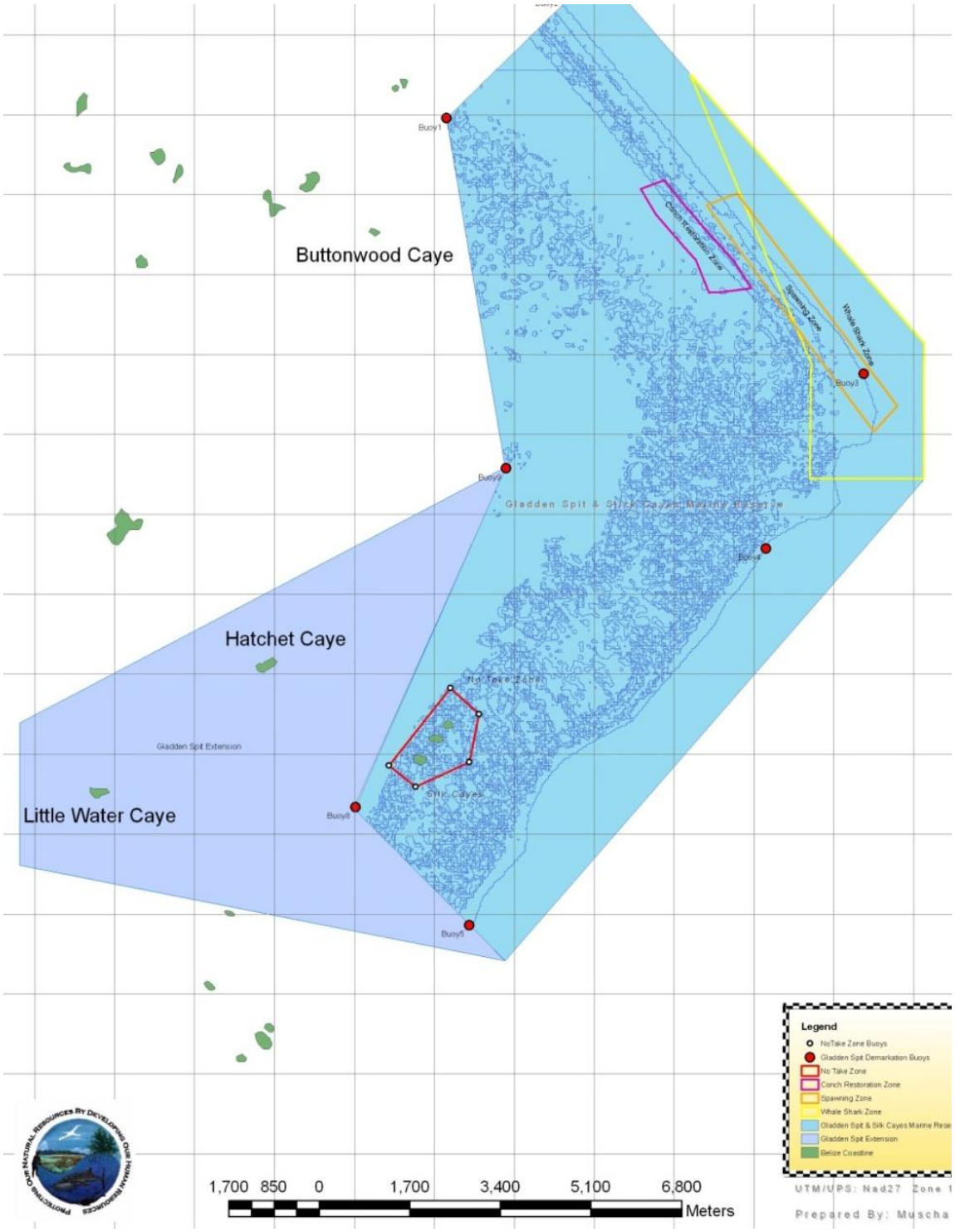


Figure 1. Map of Gladden Spit Marine Reserve (courtesy of Friends of Nature). The no-take area is outlined in red and the whale shark area in yellow.

Economic Values Measured.

Key informant interviews and focus groups were used to identify the most important benefits at the reserve. These benefits accrue to five major types of stakeholders;

- Tourists who visit the reserve; **visitors**. Tourists enjoy three major types of value; 1) consumer surpluses associated both with day trips to the reserve and with whale shark experiences, 2) welfare gains associated with the option to visit in the future (option value) and 3) value from simply knowing these areas exist and can be visited by future generations (non-use values).
- Tourists who visit the area, but not the reserve; **non-visitors**. These tourist may also want to maintain the opportunity to visit the reserve in the future, despite having no immediate plans to visit, and thus will also hold option and non-use values.
- **Local community residents**. Local community residents enjoy consumer surplus values associated with the use, or option to use, this MPA for fishing, tourism and recreation, as well as other values associated with the reserve.
- **Belizean fishers**. Commercial fishers travel to the reserve, from local villages and from villages much further away, to take advantage of the excellent fishing in those areas where fishing is allowed inside the reserve. These fishers enjoy profits (producer surplus) from participating in this fishery.
- **Local tour operators and hotels**. These included both small scale local operators and internationally owned hotels in Placencia. Tourism businesses earn profits (producer surpluses) from day trip and whale shark visits to the reserve, net of business costs incurred.

For each of these stakeholder groups, we will describe the background to the research, the values elicited, the methods used, the results and the policy implications. We begin with an examination of tourist values of visitors to the reserve.

Visitor values.

Background.

Around 30% of tourists to the village of Placencia are estimated to visit Gladden spit (McPherson, 2005). Most of the tours in the reserve involve day-long snorkelling or dive trips. Other visitors on chartered sailing trips pass through the reserve for a day or two. All tourists must pay a daily park entrance fee of US$10, a regulation which is successfully enforced, so ticket sales are a reliable estimate of actual visitation. The price of the tour depends on if it is taken through a small local operator or through a hotel and whether the visitor is snorkelling or diving. There are no limits set on tourist numbers in the main part of the reserve. Tours to the reserve have increased quickly. Over 4000 tourists took day trips to the reserve in 2007.

Roughly a third of all the visitors (an additional 2000) to the reserve come to the reserve for whale shark trips, when whale shark aggregations occur from March-June. Indeed, many tourists come to the Placencia specifically to take whale shark trips. Tourists can interact with up to 15 whale sharks whilst diving or snorkelling, as they will frequently approach divers and remain in this area. There is a fine for tourists who touch the whale sharks, as there has been some concern that less whale sharks are returning, as a result of distress from close contact with visitors. Whale shark trips were taken by around 700 people in 2000 and this had grown to almost 2,400 in 2008. FoN currently charges a US$15 entrance fee for whale shark visits.

Methods.

Visitors were defined as those people who had already visited the reserve, or planned to go in the next few days of their holiday. Focus groups conducted with visitors revealed that visitors enjoyed consumer surpluses associated with day trips to the reserve, as well as additional benefits from whale shark interactions. In addition, many tourists were known to hold non-use values, which were not related to visits, but with the option to return, and in knowing that these coral reefs are protected. To understand the magnitude of these values, we used the contingent valuation method or CVM, which has the advantage of being one of the view methods available to measure non-use values as well as use values (see box 2).

Box 2. Contingent Valuation method (CVM)

CVM is a survey based method based on utility theory economics, which is most frequently used to value resources which are not traded in market places and so no market price is available, despite the fact that these good or resources can have a significant effect on the welfare of people, such as environmental health. CVM describes a hypothetical market, including a payment mechanism (vehicle) for the good and asks the respondent what they would be willing to pay to receive this benefit, or what they would have to be paid to be compensated for its loss. Its flexibility and intuitive nature is a key strength, however, it can be less reliable in poorly designed surveys or with very goods that are very unfamiliar to respondents. There are several ways that responses are elicited, including asking an open question, asking a yes or no question for a specified amount and presenting a range of options (a payment card). Many features of the survey have been shown to be important, so it is best carried out by experts.

Contingent valuation survey design is complex and requires consideration of biases and respondent motivations. A full discussion of this is not given here, but see (Arrow et al., 1993;Bateman et al., 2002;Garrod & Willis,

1999). Briefly however, survey design including language, content, scenario, and supporting materials were designed based on key informant interviews, focus groups with major stakeholders and using pilot surveys (Arrow et al., 1993). As part of the survey, before the valuation questions, there was a background section, which included photos and maps of the reserve. It also outlined information on the reserve attributes, economic and ecological benefits, management actions and aims and the likely consequences of lack of funding, as well how monies raised would be used. Both positive and negative information was included and unique and non-unique features specified, to remind tourists of other MPAs that they could visit. All these aspects would be important in determining visitor values (Carson & Groves, 2007).

The survey included questions on various aspects of tourist holiday characteristics, reserve experiences and environmental awareness and attitudes and socio-demographic variables such as age, education and income. These questions were included, as these factors are expected to affect tourist values (Langford et al., 2001;Mathieu et al., 2003;Mitchell & Carson, 1989).

Surveys were designed to ask them what was the maximum visitors would be willing to pay (WTP) for three distinct activities associated with the reserve (scenarios);

- Reserve entrance fee a day trip reserve, payable on each visit and in addition to tour operator fees (US$10-100)
- Reserve entrance fee for reserve and whale shark area during the whale shark season, payable on each visit and in addition to tour operator fees (US$15-150)
- Donation to provide funds for long term management of the reserve, which is additional to entrance fees paid (US$0-200)

All three questions were asked to each respondent, however the order was rotated for each tourist. For each question, visitors were shown a payment card with ranges of values (given in parentheses). Entrance fees currently are US$10 for day trips and US$15 for whale shark trips, which is why these were the lowest options provided for these scenarios. Surveys took approximately 15 minutes. Sampling involved approaching every third visitor. Samples were also split between self completed and personal interview (face to face), to increase sample size.

Mean and median WTP bids were calculated for all values, once protest bids had been removed[1]. Where respondents gave 2 groups, the mid-point was used. Where costs exist, consumer surplus estimates were calculated using; consumer surplus = WTP – costs incurred (current entrance fees) (Mathieu et al., 2003). Mean WTP was then used to calculate aggregate values; aggregated value = consumer surplus * number of visitors.

Finally, this underlying model of visitor values was tested, using econometric analysis;

$$WTP = f(Sd, Tr, En, Dc) + e$$

Where Sd = socio-demographic variables, Tr = trip characteristics, Mr = reserve experience, En = environmental awareness and attitudes and e = error.

[1] Protest responses occur when respondents have values for the good in question, but give zero as their WTP, as they do not believe the scenario or take issue with some aspect of the payment vehicle. If protest responses are not removed, estimated values are too low. It is standard to remove these values, as they are not indicative of respondents' real values (Bateman et al., 2002).

Results

In total there were 302 visitor surveys and either at the airstrip or in the village of Placencia over three months. 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 high incomes (mean income was almost US$110,000 per annum). Respondents were asked why they had chosen to visit Belize. Overall, a third of responses related to the marine resources in Belize. Respondent reasons for choosing Placencia within Belize were broadly similar, as 51% of responses referred to a marine aspect such as sailing, beaches, diving or fishing, with 19% of visitors to the reserve saying they had chosen Placencia specifically because of the whale sharks.

Tourists typically stayed 11.5 days in Belize and 6.5 in Placencia. Reserve visitors had done 5 dive trips and visited 1.8 MPAs on average. Overall, 28% of GSCRMR visitors had seen whale sharks and 58% saw a large charismatic species, such as a shark, turtle or dolphin. When asked how they would rate the quality of their experience at Gladden Spit, 6% were not sure, 1% as poor, 9% as average, 38% as good and 46% as excellent. A large number of respondents (37%) did not know what the trip to Gladden Spit had cost them, indicating that current costs were insignificant to many.

Respondents who had positive values for the marine reserve were asked what they would most want to use the funds for. Education and awareness was the most popular choice (25%), followed by enforcement (19%), whale shark conservation (16%) and monitoring / research (14%).

Mean WTP values varied between the different goods (table 2)[2]. These show that visitors have a WTP of US$24, which is a consumer surplus (CS) of US$14 for reserve entry. Similarly, the change of interacting with whale sharks increases their WTP by US$15, so that their CS for these trips is US$24. WTP for donations, which were used to measure non-use values were the highest, at almost US$70 per visitor. This meant that in total, visitor consumer surplus for the reserve was US$93.5.

Table 2. Visitor WTP for the Reserve.

Estimated WTP	N	Min	Max	Mean	Median	Standard error
Reserve entry	297	10	100	24.1	20	0.85
Whale shark trip	297	15	200	38.6	30	1.53
Non-entry related donation	281	0	500	69.9	50	4.4
Total visitor WTP	281	15	700	108.5	100	5.6

Since we know the number of visitors both to the reserve for general trips, for whale shark trips (from ticket sales) we can estimate aggregate consumer surplus values, which are important, as they have more of a direct bearing as potential sources of revenue for the reserve. Aggregate visitor values for all values associated with the reserve total over US$577,000. Of this, entrance consumer surpluses are almost US$60,000 and the chance of interacting with whale sharks increases this another US$20,000. However, non-use values for visitors make up the large majority of this value (US$437,000).

[2] NB Mean values were not affected by whether the respondent had already been to the reserve or planned to go.

Econometric analyses were used to understand the drivers of these values[3]. These showed that use and non-use values were positively associated with respondent incomes, although this was not true for whale shark trips. This may be because some visitors have very high values for whale shark interactions. The longer people stayed in Placencia, the more they were willing to pay for reserve entrance fees. Those who were sports fishers had lower WTP for all reserve values, possibly due to fishing restriction imposed in the reserve. Those who had done more dive trips and made less trips to the reserve had lower WTP[4]. Those who rated their experience as excellent, who hoped to return to the reserve and had high levels of concern for coral reef health also had higher values for entrance fees.

Demand curves based on visitor values [5] show 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. These would be paid by 50% and 55% of visitors respectively. Even if maximum profits are taken, by charging profit maximising fees, only US$88,903 would be raised, which would only cover the reserve's fuel costs.

Discussion.

CVM has been successful applied here and these estimates are expected to be accurate. This is partly because entrance fees are already used, so the hypothetical nature of the scenario is reduced, which increases accuracy and reduces strategic responses. Donation values are expected to be slightly less accurate, as tourists may state higher WTP than they would actually pay for a number of reasons, for example they may not believe they would be asked to donate funds (Carson & Groves, 2007). Nevertheless, we demonstrate that visitors enjoy large benefits from this reserve and whale sharks add significantly to this value. Thus whale shark opportunities need to be preserved in the future. Current fees costs are well below cost recovery at this area, therefore there is an urgent need to increase funding and reduce reliance on external sources. Entrance fees can be used to help fulfil various reserve criteria; namely access, financial sustainability and environmental sustainability (Mourato et al., 2004). Thus increasing entrance fees could be used to increase revenues and control visitor numbers, but is not enough to fulfil income requirements. This analysis also showed that a large part of the value tourists place on this area is associated with knowing that it will continue to exist, even if they do not plan to return. As yet, these non-use values are not being harnessed in any way, but could serve as an additional source of income, through a donation mechanism or by using these demonstrated values to raise funds from international donors.

[3] A full description of the econometric results is given in the PhD thesis of the lead author.
[4] as would be expected by economic theory (therefore a test for theoretical validity (Bateman et al., 2002)).
[5] exponential function provided the best fit for the entrance fee data

Non visitor values.

Background.

Tourism is one of the fastest growing sectors of the economy in Belize, with the US constituting 61% of the visitors. The Belize Tourism Board estimated that total tourism income from spending amounting to US$200 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. Currently, all tourists to Belize must pay an environmental departure tax, each time they leave the country. This is around US$19 per person, per departure. Approximately US$3.25 of this tax is used to fund protected areas, although there is no information to inform tourists of this. Estimates based on data provided by the Belize tourism board indicate that almost 40,000 international tourists visited the village of Placencia in 2006.

Methods.

Non-use values for healthy coral reefs are held by people all over the world, but would be expected to be greater for stakeholders nearer the site. As such, many of the tourists coming to Belize could hold non-use values for the GSSCMR. These values are not linked to visiting the reserve, other than having the option to do so in the future. However, rigorous valuation requires a reasonable proportion of the population being analysed to be sampled, since this is the population mean values will be aggregated for. Therefore visitors to the village of Placencia were thought to be the largest group of non-visitors to the reserve we could feasibly survey. Non-visitors are therefore tourists, who come to the village of Placencia, but who have never and have no immediate plans to visit this reserve.

Contingent valuation (CVM) was also used for the non-visitor survey. The design was also informed by focus groups and interviews. The format and content of the survey was similar to the visitor survey. However, questions on experience at the reserve were substituted with question on awareness of the reserve and of the exit fees tourists currently pay. Non-use values are more difficult to measure accurately than use values, so the most realistic scenario is important, ideally existing markets can be used, to minimise the hypothetical nature of CVM (Carson & Groves, 2007). Since exit fees are already in place, these were used to explore non-use values.

During the survey, non-visitors were also provided with information and photos of the reserve. This emphasised that this was one reserve and that others existed which were similar in Belize. This also reduced the impact of previous knowledge on WTP bids[6]. Non-visitors were then asked to state, from a range of values from US$0-100 on a payment card, which amount was closest to the maximum they would be WTP each time they left Belize, if this was used to provide funds for management at the GSSCMR and no other reserves, and if everyone leaving was required to pay. Since the number of times respondents expected to return varied widely and would be likely to affect the stated bid, they were also asked to estimate the number of times they would visit Belize. Lifetime non-use value was then calculated using per visit WTP * expected number of visits. These values were then aggregated by the number of tourists visiting Placencia. The final survey took

[6] Familiarity with the good being valued is likely to increase the precision of valuation estimates, as respondents find it difficult to value very unfamiliar goods. Also, this reduces the impact of differences in information held by those who were familiar with the reserve and those who are not.

approximately 12 minutes and was also carried out both with face to face and self completed surveys to increase sample size.

Finally, this underlying model of visitor values was tested, using econometric analysis;

$$WTP = f(Sd, Tr, En, Dc) + e$$

Where Sd = socio-demographic variables, Tr = trip characteristics, En = environmental awareness and attitudes, Dc = decision attributes and e = error.

Results.

In total, 282 non-visitor surveys were carried out. Whilst never having been to the GSSCMR, non-visitors had done a mean of 3 dives and visited 1.2 MPAs during their holiday. Only 35% had heard of the GSMR, however, 70% of non-visitor respondents were familiar with the whale sharks that visit the reserve. Only 34% of respondents expected never to return to Belize. The mean number of number of expected visits respondents expected to make to Belize was 3.9, but estimates ranged from 1 to 31 (for those with properties, who are still required to pay exit fees).

In total, 95% of respondents had positive WTP values for the reserve, despite having no plans to visit. Of the 5% that gave zero bids to the exit fee question, 2.1% were identified as protest responses and 1.5% were left blank. Follow-up questions to explore why these non-visitors were willing to contribute were varied. A third of the answers involved making sure the area remain unchanged (these included mentioning 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.

Non-visitors had a mean value associated with the reserve of US$21.5 per trip and over their lifetime, of US$74.1 (table 3). 44% of respondents thought that other tourists would be WTP a similar amount to themselves and respondents said they chose their stated WTP based on what they thought was "reasonable" (21%) or easily affordable (13%) or based on environmental taxes elsewhere (10%).

Table 3. Non-visitor WTP, consumer surplus and aggregated consumer surplus for the GSSCMR reserve.

Value	N	Mean WTP	Median	Standard error	Individual CS	Aggregated CS
Per visit exit fee	275	21.52	15	1.5	21.75 *	860,648
Lifetime exit taxation	277	74.1	40	6.4	59.5*	2,354,415

The econometric analysis[7] showed that those with higher incomes were WTP more and those who planned to return to Belize more had lower WTP[8]. Those with strong environmental opinions, with high concern for reefs

[7] A full description of the econometric results is given in the PhD thesis of the lead author

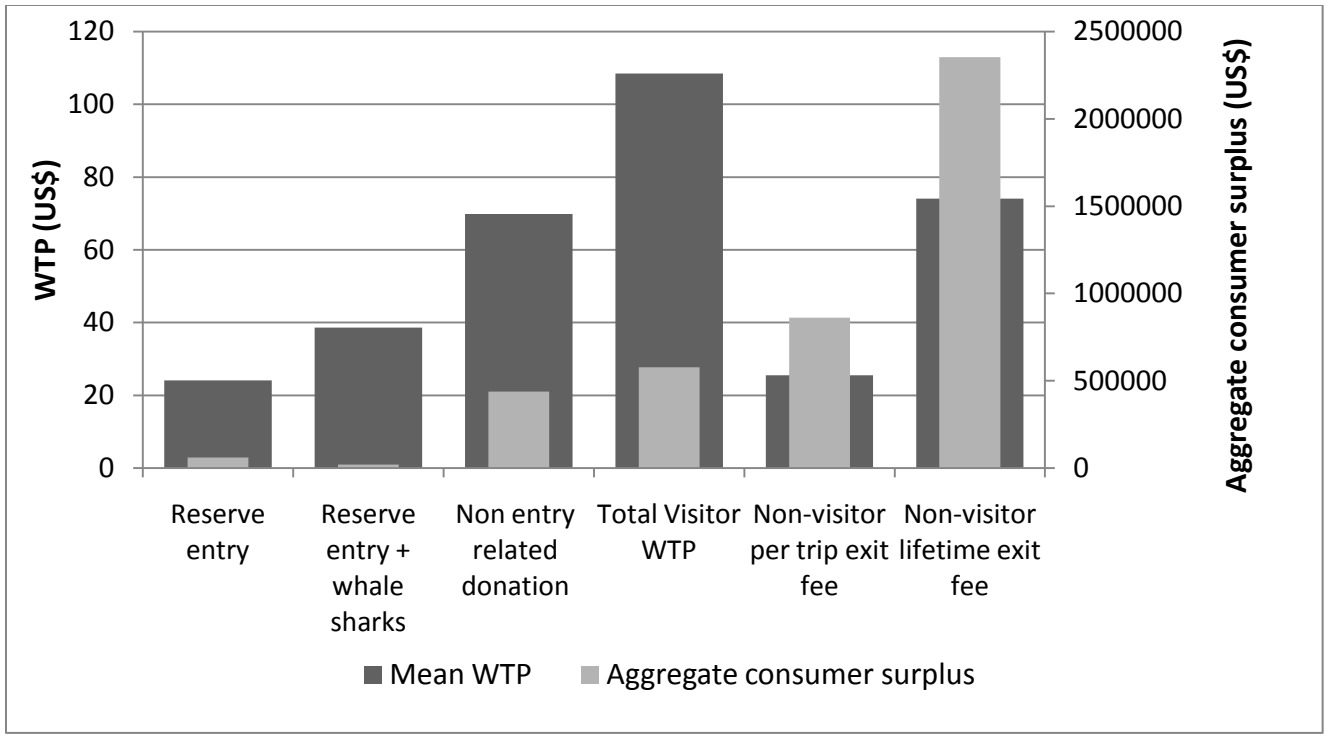
and who were members of environmental groups also had higher WTP, as did those who had previously heard of the whale sharks at the reserve.

Demand curves based on visitor values [9] show that if profit maximisation was the sole goal, the exit fee should be US$35 per trip, although only 26% of tourists would pay this, which would have negative implications for local businesses that depend on tourism. However, the full budget of the reserve could have been met if an additional exit fee of US$17.5 was added to the current exit fee, although only 45% of visitors would pay this.

Mean and aggregate tourist values.

Figure 2 show the magnitude of WTP for both visitors and non-visitors and these values in aggregate. We can see several interesting things. First, although total visitor values are greater than non-visitor values, non-use values for the two groups are similar. WTP per exit fee and WTP for reserve entrance are also similar. However, the different populations to which these values apply means in aggregate, non-visitor values are much greater than visitor values.

Figure 2. Tourist WTP and aggregate consumer surplus for the GSSCMR.



[8] These are a good test of the validity of the valuation survey, as they would be expected based on economic theory.
[9] linear function provided the best fit for the exit fee demand

Discussion.

Non-use values are difficult to measure and are likely to be less accurate than use values or values elicited from tourist who are familiar with an area. Nevertheless, this research was aided by the fact that an exit fee is already in place in Belize. Tourists coming to the village of Placencia are WTP to preserve the GSSCMR, even though they have no plans to go there. Whilst a lifetime non-use value of US$74 may seem high, it is tiny in proportion to both respondent incomes and other costs incurred on their holiday, so it is not unreasonable. Many of these were concerned that these areas were being damaged and needed to be protected. We find that exit fee from the local airstrip would be acceptable, as a way to raise funds for management for 95% of the surveyed respondents. Although the aggregate values estimated here should be considered the maximum that could be raised, if these non-use values could be captured, they would be able to cover the costs of reserve management. The implications for local businesses could be severe and undermine management, so there is no easy solution. Nevertheless, the large majority of visitors would be happy to pay something towards this reserve. FoN should consider a fund-raising strategy for tourists waiting to leave the village at the local airstrip.

Community values for residents of Placencia

Background.

The site of the community survey is the village of Placencia, which is the closest village to the reserve, which lies 36km offshore. Although there are several other smaller villages who use the reserve (principally for fishing), the majority of local stakeholders are found in Placencia, as fuel costs make the GSSCMR expensive to access. Placencia contains approximately 280 households. There are in addition to Belizeans of from several ethnic groups in the village, increasing number of retirees from the US who now live permanently in the village, as well as others who have holiday homes there. 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. There are 139 registered fishers in the village (they have paid for fishing licenses), which is 7% of all fishers in Belize. Many fishers also act as fishing guides at certain times of year and some are used as guides for researchers visiting the reserve. 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 approximately 65 hotels and 600 beds.

Friends of Nature, who manage the reserve interact with residents of Placencia in many ways. At the reserve, they enforce fishing regulations and check sizes of fish and sell special licenses for fishers to use the whale shark zone, during the spawning aggregations. They also check that tour operators have purchased tickets for each visitor. Finally, they have various community outreach programs, including a scholarship for school children, school trips to the reserve and alternative livelihood schemes, which are designed to retrain fishers as tour guides. Thus local community members are likely to enjoy both direct benefits from using the reserve and indirect costs and benefits as a result of interactions with the management body. Local and Belizean visitor numbers at the GSSCMR are unrecorded, as Belizeans are not required to buy entrance fees, but probably in the region of 200 per annum (FoN, pers comm.).

Methods.

Focus groups and in depth discussions with different groups of community members helped to identify three major uses residents[10] have for these areas; fishing in the reserve, tour trips to the reserve and recreation at the reserve, involving swimming, socialising or camping. The survey was designed based on and focus groups with different community members and pilots used to ensure language, length, etc. were appropriate. We were also interesting in knowing if residents held significant non-use values for these reserves, thus we used CVM (see box 2).

Before being asked the valuation questions, respondents were given background information, as well as photos of the reserve, to inform them of what was there, and of why money was needed to protected these reefs. The scenarios were designed to measured several distinct WTP[11] values, which reflect resident consumer surplus (see box 1) associated with the reserve;

[10] Residents were defined as people who live permanently in the village, which included people who are not Belizean.

[11] WTP is more conservative than willingness to accept, as it is more incentive compatible (Carson & Groves, 2007).

- Yearly fee per household[12] per year to be allowed to fish in GSMR
- Yearly fee per household per year to be allowed to tourist trip in GSMR
- Yearly fee per household per year to be allowed recreational access to GSMR
- All access for any use in GSMR

The same payment card was used for all questions, which ranged from Bze$0 to Bze$300 per week (US$150), although amounts were given in weekly, monthly and yearly amounts to help understanding of the magnitude of such values. It was made clear in each valuation that unless respondents paid these fees, they would be excluded from each use, but that substitute marine reserves in other parts of the country were not affected. Again, the order of the questions were rotated.

A map of the village was drawn and each household given a number. These were picked randomly, with the first adult encountered at each house interviewed. The survey was conducted by a local data collector, to reduce the number of refusals and to ensure respondents that their responses would be confidential. It was also completed face to face, to increase the quality of responses. The survey was conducted over 2 months, in November and December of 2007.

Mean WTP values for each benefit were used to calculate aggregated values based on the number of households in the village. Econometric analysis was used to understand the factors which affect community values for the reserve[13]. These took into account various things on which data was also collected during the survey. These included a large household socio-demographic variables and attitudes towards conservation and reserve management as well as use of this and other nearby reserves, as these were expected to influence resident values.

Results.

The household survey was carried out on 152 households (54% of those in the village), representing 535 people. 52% of respondents were female and there was a wide range of ages and incomes. Respondents had spent a mean of 28 years in Placencia and were a mean age of 38. 69% of respondents own their property and 47% are self employed. Mean annual household income was US$24,200 (Bze 48,400). Households whose primary income was fishing (5% of households) had mean incomes of US$20,544 (Bze$41,088) compared to US$33,288 (Bze$66,576) for those whose primary incomes were from tourism (45% of households).

In terms of using the reserve, 68% of respondents had been to Gladden spit. Whilst many households had been a few times for recreational trips, a few households used the reserve on a weekly basis for fishing and tourist trips. Annually, there were a total estimated 3000 tourist trips, over 1100 fishing trips and just over 1000 for recreation for the sample households and a mean of 32 visits per households (ranged 1 to 320 visits per households). The reserve was also providing secondary benefits in terms of links with residents. Seven percent of households reported having benefitted from a school trip there, almost 16% of households from fisher workshops or exchanges, 12% from alternative livelihood initiatives and 10% had done the whale shark training

[12] 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.
[13] A full description of the econometric results is given in the PhD thesis of the lead author.

course and 43% had attended an environmental talk given by FoN. However, only 6% of respondents said that a member of the household had been consulted in relation to the reserve and only 4% when it was established.

Residents were in general very positive about the GSSMR's ability to help manage tourism, to help manage fishing, to protect coral and to help reduce threats. Figure 3 shows the perception of the community of likely impacts of closing reserve. The large majority of respondents feared that dissolving the reserve would have highly negative consequences. 55% reported a personal positive impact of the reserve establishment on their households, compared to 14% a negative impact (these were largely linked to fishing restrictions). A small minority of respondents did however express mistrust of the management of the reserve, citing uneven enforcement of rules and lack of transparency and accountability to local communities. Also, when asked about the benefits produced by reserves, local people referred to tourism, rather than fisheries benefits and there is an overwhelming perception that fishers are the main losers from GSSCMR. In terms of how management should be improved, 38% said having less aggressive rangers, 34% increased patrols, 34% increased education and 23% increased consultation and transparency.

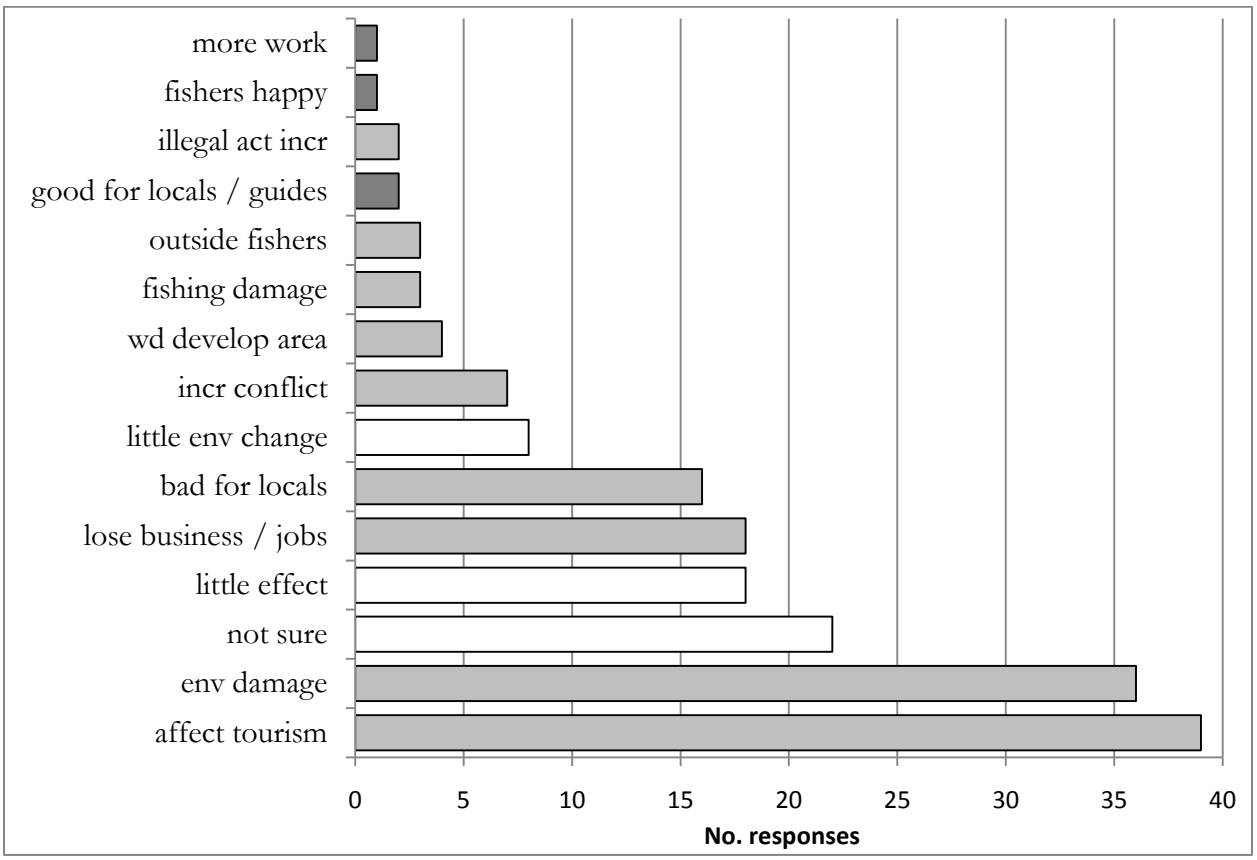


Figure 3. What would be the effect of dissolving the marine reserves? Note: positive effects are denoted by dark bars, neutral responses in white bars and negative responses in grey bars.

The valuation questions produced very few either protest responses or legitimate zero responses, although these varied by type of use. Payment for recreational access produced the most protest responses (6%). Zero responses, which show that the good has no value to the household were given most for fishing access produced (20%), followed by recreation (5%) and tourism access (7%). Resident mean values for the 4 areas for each

household are given in figure 4 below. The percentage of household income that the total bid for Gladden Spit represents represent in 2.1% of household income, which whilst being large, is not unreasonable. Fishing and tourist access accounted for 0.55% and 0.9% of household income respectively and recreational access for 0.45%.

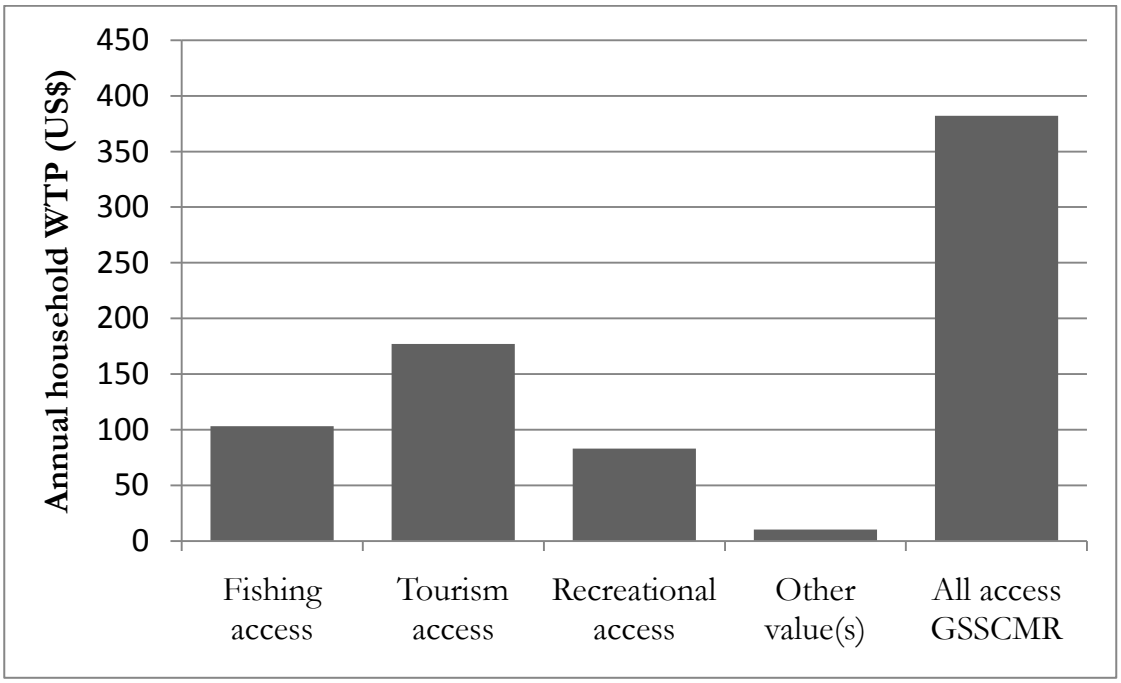


Figure 4. Placencia Resident WTP in US$ for the Gladden Spit Marine Reserve.

We used econometric analysis to see what affects local values for the reserve. People with higher values for general access to the reserve are those with higher incomes[14] and wealth and who think that tourism has a very positive effect on the village. Those with higher values are also more likely to have fished inside gladden spit, attended workshops and attended environmental talks by FoN. However, those who take tourist trips often to the reserve or who have paid for special fishing license already, had lower WTP which is likely to be linked to the costs incurred in such activities. Similar analyses for each use value again demonstrated the link between income and WTP. There was also evidence of a trade-off between fishing and tourism uses, which is unsurprising, given that most residents are specialised in one or the other. Recreational values were also often related to secondary benefits which respondents perceived the reserve to provide, such as improvements in coral cover, tourism as education. There was also some evidence that those who were less certain of the WTP bids they choose had lower values, which means that these WTP estimates may be marginally upwardly biased.

Aggregated values for the village of Placencia amounted to almost US$104,500 (Bze$209,000) for the reserve[15], of which only US$2,856 (Bze$5,712) was made up of values other than the three use values. Tourism was seen

[14] This effect is non-linear, meaning increased incomes stop increasing WTP at a certain point.
[15] There is no reason that high values given by some respondents are not reflections of their true values, as some respondents rely almost solely on these areas for their income and loss of access would threatened their livelihood. However, if median resident values were used, annual resident, the total aggregated values for the reserve would be US$525,000 for 2007.

as the most important benefit, followed by fishing. Whilst recreational benefits were smaller than those related to employment, they nevertheless were over US$23,000 (Bze$46,000) for the village.

Discussion.

Local community values are rarely measured for coral reef MPAs, despite the fact that they are likely to determine MPA outcomes (Mascia, 2004). Here we see that management at this reserve is having a positive influence on the residents of Placencia, both directly and indirectly. Local residents value access to this area, even if they do not use it regularly. Recreational value is lower than income associated uses, which is not unexpected. Fishing at the reserve entails high fuel costs and a smaller proportion of the village still fish than in the past. Nevertheless, it is worth a mean of US$100 per household per year. Recreation is worth a mean of US$83 per household per year, but evidence suggests that part of this value is linked to secondary benefits that these reserves provide to the community. It is tourist access which emerges as the most valuable value for residents, especially for those who are involved in tourism at the reserve, but also for those that are not. This is because the whole village is aware of the fact that the reserve and the whale sharks bring tourists to the village, which benefits many local businesses and because most residents believe that management is helping to protect these reefs and control tourism.

The econometric results and the fact that the values measured are statistically distinct[16] suggest that CVM can be usefully applied to measure local values and we recommend that it should be used more, so that local values can be fully incorporated into policy decisions at marine protected areas. The level of precision of these is therefore not low, which is aided by the fact that they are highly familiar with the reserve. However, the impact of certainty estimates suggest on WTP that results are not perfectly accurate. A higher sample size would have helped to increase accuracy.

Whilst we would not recommend asking local community members to pay for access rights, we would say that these values can be used to demonstrate the value of this reserve, not only to tourists, but also local people, who want management to continue. 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.

If other nearby villages were also to be included, such as Seine Bight (which is a largely subsistence village close to Placencia) independence and monkey river (where many fishers use the reserve), whose residents also use the reserve (although a smaller percentage of residents do), the estimate of aggregated local values would be higher, but budgetary constraints meant it was not possible to include further villages. Therefore, the annual value of US$104,500 is a significant underestimate of local values for this reserve.

[16] This was confirmed by t-tests at the 1% level.

The economic and financial values of fishing inside Gladden Spit.

Background.

Belize relies heavily on fishing for subsistence and primary income for a significant section of the population and the export market is dominated by lobster (Panulirus argus) and conch (Strombus gigas) and increasingly with aqua cultured shrimp (Penaeus spp,) (Gillet, 2003). Fisheries have generally have been declining since the mid 1980s and overfishing of conch and lobster was already evident by the mid 1990s, though price increases have tended to mask the effects of declining catches in weight. Concern is growing for the future viability of the fishery which is compounded by the destruction of critical habitats for fish stocks, such as mangrove habitats (McField et al., 1996), and the depletion of stocks as illustrated through declining catches at known fish spawning aggregation sites (Gillet, 2003). Marine protected areas are thus a potentially crucial part of fisheries management, if they can reduce fishing pressure on key commercial fisheries inside their boundaries.

The fisheries department gave out a total of 2,131 fishing licenses in 2006 (which corresponds to approximately 1% of the population). Many fishers sell many of their catches through local co-operatives, of which 13 operate. However, substantial catches of subsistence and artisanal fisheries, and tourist-based recreational catches and local direct sales to restaurants, remain unaccounted for. In addition, fishers from Honduras and Mexico are known to come into Belize and fish without fishing licenses and sell their catch at home. As a result, the volume and value of fish sold in the village or caught in the reserve is unknown.

There are no limits set on fishing numbers in the reserve most of the year. However FoN restricts access to the whale shark zone during spawning times. Fishers using this area must apply for and pay US$25 for a "special" license, which should only be sold to local residents. There are two distinct types of fishers that use the reserve, "local fishers" and Sartenejan fishers. They are distinct in almost every way and so necessitate individual analysis. The best estimates of the number of fishers in Sarteneja are in the region of 700 fishers (Brown, 2004).

Local fishers come from villages nearby, most notably Placencia, Independence and Monkey River. They own small motor rigs, which they use to vary fishing locations over the year, often close to the shore. They usually fishing with a small number of family members and predominately using hand-lines, to catch fish from the boat. They will also dive for conch and lobster periodically and increasingly use lobster traps. Local fishers use the reserve most during spawning times in the December and in March to June. Local fishers monopolise the reserve aggregations, due to the requirement for special licenses and their skill with handlines. Even fishers who don't fish much the rest of the year will travel an hour or 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 only around 20 fishers from Placencia who travel to the reserve all year. These tend to be those who own 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 impossible.

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 diving for lobster and conch. They rarely change routes, so that there are about 10 min boats using the reserve, who spend at least one day inside the reserve, each trip, which is usually three times a month.

Fisheries yields are difficult to measure accurately and sustainable yields will vary by region and type of reef, gears used etc. Coral reef fisheries yields have ranged from 100 – 50,000 kg per year, with an average of 6600 per kg per year, which may be higher than sustainable levels (McClanahan, 2004). (Koslow et al., 1994) report yields in 7 sites in Belize, from surveys in 1991, which ranged from 78-2929 kg per year, with a mean of 340kg per year. The highest yields were from the Gladden Spit area (almost 3000 kg per year).

Methods.

There exists no estimate of the volume or value of fisheries inside the marine reserve, despite the fact that fisheries are recognised as a major part of the value of this site. Therefore we sought to measure the producer surplus or profits associated with fishing over one year inside the reserve, net of costs involved, such as equipment and fuel. Several methods were necessary to gather data related to gross and net values of the fishers using the reserve. These were a detailed fisher survey, 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 large reserve in 2007.

The catch survey was done at randomly selected dates over the course of a year. The lead researcher set it up, but it was continued by the rangers, who patrol the reserve each day. It involved approaching fishing boats noting the time the number of hours or days had been fishing, and weighing and counting all fish caught, plus noting the number of fishers, areas fished and the gears used. Landings surveys were used to calculate mean catch per day for local fishers (a) during the spawning aggregations and (b) during the rest of the year and for Sartenejan fishers (a) when all fisheries were open, (b) when the conch fishery was closed and (c) when the lobster fishery was closed. These figures were then used, by incorporating the number of fishing days recorded in each season, by type 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.

The fisher survey was not done randomly, as it targeted those fishers using the reserve. Initially, a list was made with all fishers who had used the reserve at least twice over the previous 2 years, which resulted in a list of 85 fishers. Every fisher was approached and 52 surveys were completed. The fisher survey took just over an hour and contained questions relating to household income sources, their use of the Gladden Spit reserve and attitudes towards the reserve and conservation. There were also detailed questions relating to the type of fish that they catch, the 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 incomes and catches were estimated assuming that fishers had good days 20% of the time, bad days 20% of the time, and "typical" levels the remaining 60%. These were based on the descriptions of fishers as to their 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 that they would last 12 years, at which time they could be re-sold at 10% of the initial costs. This assumption was based on responses from in depth surveys, which show that this is the pattern which boat sales follow, although the 10% value is highly conservative. Mean values were used to calculate catches, as we wanted to reflect the full range of fishing at the reserve, including both highly skilled fishers and those who catch very little.

This information was used to calculate average daily producer surplus over the course of a year (including fishing done outside the reserve) for each type of fisher, using the following equations;

1) Total annual revenues = probable gross annual product revenue[17] + annual earnings from crew[18].
2) Total costs = annualised boat and equipment costs + annual boat and equipment maintenance + annual boat use costs + annual variable (per trip) costs per fisher

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

Results.

GSSCMR's excellent patrol records enabled a good understanding of the number and type of fishers visiting the reserve (figure 5). In total, in 2007 there were 556 boat, with 3453 fishers. Local fishers who fish in small numbers from small boats, made up 33% of the boats days, 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.

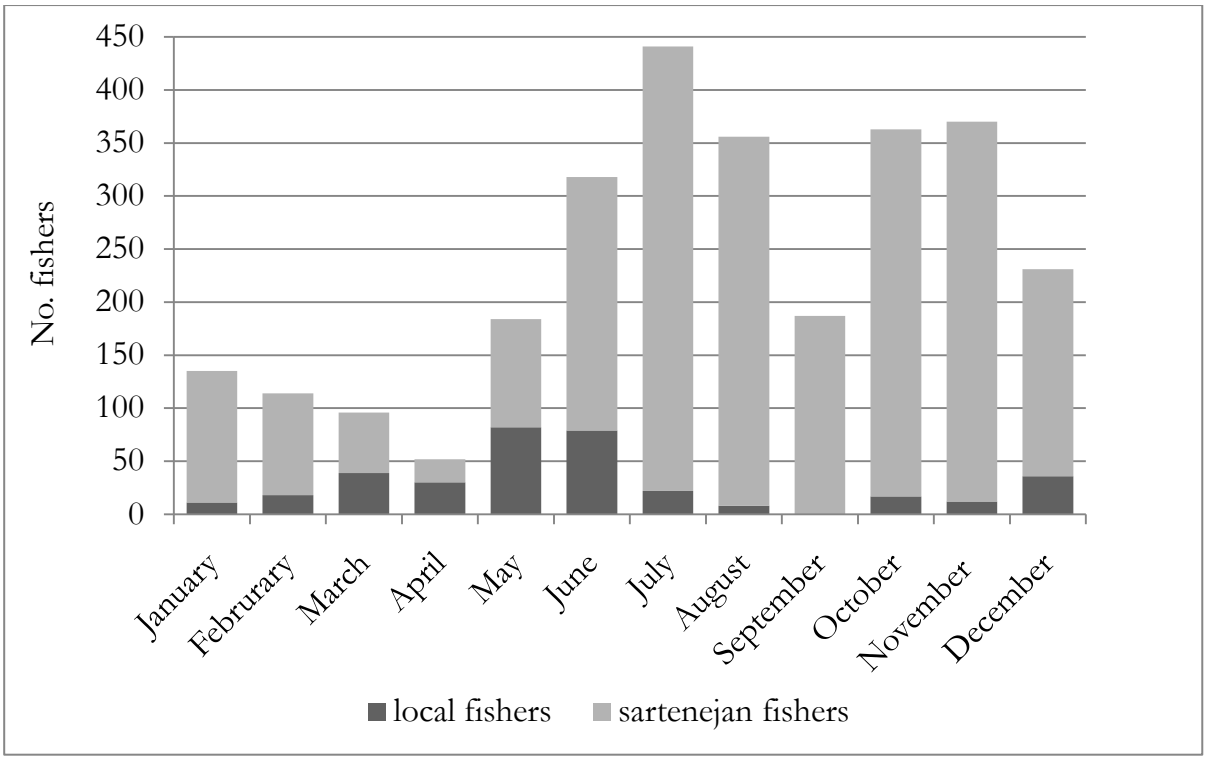


Figure 5. The number of fisher days inside the GSSCMR each month in 2007.

[17] Payments to boat owners were 1lb of lobster per day on the boat, for each crew member. These were subtracted from the crews gross revenues when PS was calculated.
[18] Crew payments can sometimes be excluded from PS estimates, as they are transfers between groups. However, for Sartenejan fishers they 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 not correct.

Fisher surveys.

In total, 56 fishers were interviewed. Fishers lived a mean of 35 years in their villages and been fishing for 27 years. There were a mean of 4.5 people in each household. Respondents reported that that 40% of fish and 10% of conch and lobster is sold locally (informally), meaning that fisheries estimates made solely from co-operative data[19] will underestimate yields considerably. Fishers fillet on average 56% of fish and 75% of conch and lobster, which increases the value of their catch by approximately double, compared to unprocessed produce.

Whilst 62.4% of their individual income came from fishing (ranging from 5-100%, SD=62), this represented 45% of the total household come (range = 3.8- 100, SD=31), due to other household members. For local fishers who benefit from tourism related work, fishing was only 56% of personal and 37% of household income. Indeed local fishers however reported an average of 17 days of work (as boat captain, guide or research guide), inside the reserve each year, although this was highly variable. However, for Sartenejan fishers, who have fewer employment possibilities (including no other type of work in the reserve), fishing accounts for up 89% of personal and 76% of household income.

Feelings towards the reserve were mixed, with 61% saying that the catches were best near the no-take zone, but 67% agreeing that there is a lot of illegal fishing inside the reserve and 39% saying that the reserve had initially had a negative effect on their income. However 97% thought that reefs need to be protected. 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 ($z= -3.496$, $p= 0.000$), which indicates that fishing inside the reserve is more profitable than fishing elsewhere.

Fisheries are usually highly variable, as was the case with the minimum, maximum and typical catches reported by fishers in this survey. The number of annual fishing days ranged from 8 to 300, with a mean of 177. Details as to all the costs and revenues related to fishing throughout the year, for all fishers and by each type of fisher are given in table 4. Total costs for fishers were an average of Bze$11,379 per annum and total revenues were Bze$51,395. If percentages of income from catches inside the reserve are used to calculate gross revenues inside the reserve, local fishers were almost Bze$13,000 per annum, compared to Bze$7,500 per annum. This is because a significant part of Sartenejan fisher revenue was made up by boat earnings from crew who pay to stay on the boat. However, it is likely that only 10% of Sartenejan fishers own boats, whereas 80% of Satenejans interviewed here owned boats. As a result, the Sartenejan PS estimates are likely to be upwardly biased.

In terms of producer surplus per day[20], older fishers had higher profits, as did those for whom fishing made up more of their income. Those who had longer fishing trips had higher profits, as did those who spent more months fishing for conch, and those who used lobster traps or shades, perhaps due to the time required to check them. There was a strong effect of fishing inside the reserve. Those who spent a higher number of days over less months, had higher profits. Local fishers who spent more time inside the reserve had a lower PS. This is likely to be due to the reserve having higher catches in general, but due to local people profiting most when they concentrate their time over the spawning aggregation period, as travel costs can be too expensive at other times. 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

[19] Local fisher co-operatives sell fish to buyers in the capital and to international buyers, so these data are often use to estimate fisheries catches.
[20] However we were only able to explain 8% of the variation in producer surplus.

this fishing. It is interesting to note that fisher PS for each type of fisher is significantly different (z = 3.86, p=0.000).

Table 4. Annual Gross Costs and Revenues for Fishers using the GSSCMR (in Bze$).

NB exchange rate is Bze2-US$1. * 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. This is based on detailed information about what fishers report about their catches.

		All fishers	Local	Sartenejan
Fishing effort	Percentage household income from fishing	62	56	89
	No dependents supported by fishing	2.9	2.5	4.4
	No. trips per year	71	82	28
	No. days fishing per year	177	160	241
Catch revenues	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**
Fishing costs	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**
	Costs per fisher day	**79**	**91**	**32**
Producer surplus	**Mean annual producer surplus**	**40,016**	**36,096**	**55,342**
	Mean producer surplus per fisher day	**235.5**	**237.5**	**227.3**

We have been able to use the fisher survey to incorporate detailed information on fishery costs and benefits, to estimate producer surplus for those fishers who use the reserve most. If we aggregate annual gross revenues and annual PS estimates against the estimated number of fishers in Placencia, the gross value of the fishery is in the region of US$3million (Bze6 million) and the net value is in the region of Bze$2.5 million (Bze5 million). However these numbers are based on fishers using the reserve and may not reflect other fishers well. Since such a small proportion of Sartenejan fishers were interviewed, using these date to extrapolate for fishers not using the reserve would be inaccurate. Since we know that fisheries inside the reserve differ from those outside, we need to use catch data from inside the reserve, to calculate the volume and value of fisheries at the reserve.

Catch Survey.

The landings survey which covers 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. They were carried out randomly over the course of a year, including during spawning aggregation times.

Detailed estimates from the landings surveys are not reported given here, but the survey showed that during the spawning aggregations, local fishers caught a mean of 10.1lbs per hour and a median of 8.5 per hour, (valued at Bze$228 per day whole) compared to the rest of the year when they caught a mean of 8.4 and a median of 8lbs/hour (valued at Bze$190 per day whole). For Sartenejan fishers, there were three major seasons, when everything is open (6 month of the year), they catch a mean of 3.4 lbs conch and 1 lb of lobster per hour. When conch is closed (over 3 months), they catch a mean of 1.1lb/hour of lobster and when lobster is closed, they catch a mean of 3.6lbs per hour of conch. Typical daily earnings for unprocessed (whole) product are therefore much higher when all seasons are open (Bze$268) compared to when lobster is closed (Bze$184) and when conch is closed (Bze$127). These data were used to estimate volumes of catches and their values inside the reserve, based on mean estimates (table 5). This means that the total annual product taken from inside the reserve is likely to be from 67,000lbs (conservative estimate) to 105,210lbs (mean estimate). Given the size of the reserve, we can estimate that these waters are producing roughly 10,000lbs (4,500kg) of catches per km^2 per year.

Table 5. Fish catches and gross values for fisheries within Gladden Spit Marine Reserve using catch data.

Estimate uses landings mean / median	Fisher type	Product quantity (lbs)	No. Fisher days (% of total)	Value if whole (Bze$)	Value if filleted (Bze$)
Mean	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
Total for 2007	**all**	**105,210 product**	**3453 (100%)**	**737,760**	**1,184,980**

We can use the detailed PS information from the fisher survey to calculate the annual PS associated with the number of fishing days that were carried out in the reserve in 2007 (table 6)[21]. We find that Sartenejan fishers are seen to accrue 87% of the fishing profits in the reserve, which is almost identical to the proportion of fisher days they account for.

Table 6. Annual producer surplus estimates from the reserve in 2007, based on average PS per fisher day, by type fisher.

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**	

[21] This is acceptable, as fishers derive on average 26% of their income from fishing inside the reserve.

Discussion.

Fisheries are highly variable, as was the case here. Poor data exist on fisheries volumes generally due to the cost and logistical difficulty in obtaining accurate data. Even less information exists on the profitability of fisheries inside reserves, as detailed cost data are costly to obtain. The estimate here of fisheries value is thus limited by the available information. Nevertheless, we were able to obtain good estimates of fisher profits both annually and per day, for those fishers using the reserve most. We were also able to use catch data to estimate the volume and gross value of fisheries inside the reserve. Yields recorded here are below average for global coral reefs, but much higher than those reported elsewhere in Belize or recorded in this site in 1991. In addition, there are likely to be illegal catches, which could mean that the actual catches are even higher. This is of concern in the context of the general decline of fisheries in Belize and may indicate that current levels are unsustainable. Declines in these fisheries would have serious consequences for local fishers using the reserve. However it would be even more grave for fishers from Sarteneja, who rely heavily on fishing for their income and have few alternative employment options. FoN should continue to enforce bans on certain types of non discriminatory gears and should monitor off-take from the spawning aggregations, as well as monitoring and enforcing size regulations, to ensure that these fisheries do not collapse. Whilst the naturally high productivity of this area has been known for some time, the no-take area may also be contributing to high lobster and conch yields. Patrols should continue at this area, particularly at night, when fishers report most illegal fishing occurring.

There have been no previous estimates of the volume of fish caught inside the reserve, since it was established. The annual PS of almost US$400,000 may seem high[22], but it is likely to be due to the reserve being inaccessible to many fishers and the limited access to the spawning aggregations, which mean that fishers using the reserve enjoy large catches. This is reflected in the fact that local fisheries are willing to pay for licenses for the whale shark zone and hold significant values for fisheries access in this area (see above). Producer surplus estimates calculated here are also very close to the mean income reported by fishers in the community survey (see above). It is important to note that costs associated with fishing absorb at least 50% of the revenues, which suggests that studies which calculate fisheries values based on gross value will over-estimate the true value of the catch significantly.

[22] In an open access fishery, profits can be zero or even negative.

The economic and financial values of tour operations.

Background.

Most people coming to Belize and to Placencia take at least one marine tour. Gladden Spit is a popular destination because of the whale sharks and the white sandy islands were tourists can picnic and excellent diving and snorkel sites. The great majority of tourists visiting the reserve originate in Placencia, which therefore captures almost all the tour operator and tourist spending benefits. This is partly a function of the fact that the reserve is far out to sea and fuel costs are high. Twenty two tour operators offer trips to GSMR, of which only 3 are not in Placencia. There are two types of operators. Small locally owned and managed operators, with small offices in the village, who own or hire boats and hire boat captains and guides per day, when they have enough visitors. Some of these run several trips a week to the reserve. There are also 4 hotels, which are owned by non-Belizeans which have dive centres that offer trips to the reserve. These own their boats and have some permanent staff. Prices tend to be higher for their tours which reflects the larger and faster boats, more staff and better equipment.

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 (each with up to 12 divers) can be in the whale shark zone at one time, minimise whale shark disturbance. FoN organizes 5 shifts of boats, for 1 ½ hours in the whale shark zone. 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 Gladden spit, of which 13 had put down a deposit. Guides must have completed a special course, run by FoN. Tourism is highly seasonal in Belize and low from April-November, so these whale shark trips are extremely important to the local economy. Tour guides must be Belizean, and have tour guide licenses and training.

Methods.

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 in 2007. Tourists that dove versus those that snorkelled were noted, as well as those who travelled with local operators and those that came through their top-end hotels, as these distinctions were known to affect both prices charged and costs incurred for operators. This enabled the numbers of each type of trip to be known.

To gather detailed cost information from tour operators, face to face open ended interviews were conducted, each of which took around 40 minutes. These gathered information on operator specific costs and prices. Cost information was gathered in two categories; (a) trip related costs associated with trips to the reserve, including as necessary boat hire, crew payments, food, fuel, etc. And (b) related to 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 to larger investments of boats and engines and building of the shop. For large investments such as boats, it was assumed that they would last 12 years, at which time it could be re-sold for 10% of the initial price. This assumption was based on responses from operators, who said that this is the pattern which most boat sales follow, although the 10% value is conservative.

Annual gross revenues at the reserve were calculated using the following equation;

Gross revenues =

Sum No. Tickets sold (by type operator and type trip) * mean price (by type operator and type trip).

Producer surplus was then calculated using the following equation;

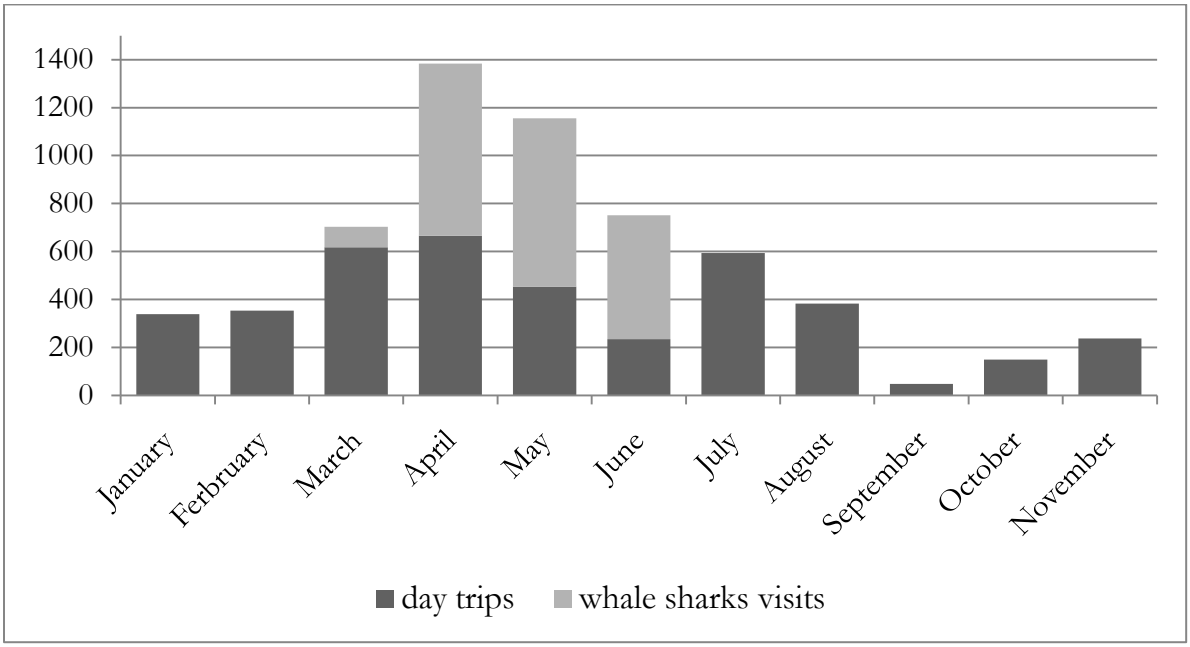
Producer surplus = gross revenues
– sum (trip costs per passenger[23] * number of passengers)
– sum (mean annual recurring costs, by type operator * no of operators)
– sum (mean annualised investments, by type operator * no of operators).

This enabled an estimate of aggregate PS for the operators using the reserve.

Results.

The number of tourists coming to the reserve was taken from ticket sales and showed a total of 6253 international tourists in 2007, an average of 521 per month (figure 6). Of these tourists 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 tourists, those on self catering yachts (16%), those doing day trips with local operators or hotels (51%) and those coming to do whale shark trips (33%). This year was typical of the previous years, although there is an upward trend over time in the number of visitors to this area.

Fourteen operators who used Gladden Spit were interviewed, who reported that a mean of 73% of their business came from marine activities. In terms of Gladden spit, all those who did diving, took trips there. Another 93% took snorkelling trips to the reserve, 57% sports fishing trips, 1% kayaking trips. Whilst they estimated the tourist high season to last a mean of 6 months, most were closed for one month, usually in August or September. Tour prices for regular trips to Gladden Spit depended on the activity done and the type of operator running the trip. These are given in table 5. Many operators commented that income from the reserve was vital for them to survive, especially during the whale shark season, when the village has fewer tourists.



[23] This included costs such as food and dive tank refilling.

Figure 6. Tourist Visitors to the Reserve in 2007.

Table 7 shows tour sales for the reserve for 2007, by type of operator and trip. We see that 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. These costs include transport to the site, equipment, guides and lunches. They do not include ticket sales, as these do not go to the operators. Total revenues are therefore US$1,069,767.

Table 7. Revenues for trips to Gladden Spit in 2007 by operator and type of trip.
*charted boats going into the reserve pay entrance fees to FoN, but not to any operator.

	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**	

For trip related costs (table 8), mean cost per trip was given by adding together gallons of gas used (which carried with the number and type of engine), the fees for each captain and guide, food costs per person and equipment costs (e.g. tank filling or equipment rental). Hotels had significantly higher costs due to having more staff, food and more engines (meaning higher petrol costs). Day trip costs were US$255 for operators and US$417 for hotels. Whale shark trips also produced higher costs, mainly due to higher fuel requirements and higher staff costs[24] ofUS$331 for local operators and US$453 for hotels.

Table 8. Trip related costs for tour operators.

Costs	Day trips		Whale shark trips	
	Tour op.	Hotel	Tour op.	Hotel
Number trips in 2007	166	70	180	88
Mean per trip costs (US$)	255	417	331	453
Annual trip related costs	42,330	29,190	59,580	39,864
Non refunded whale shark lottery payments			4,000	
Total annual trip related costs for all operators(US$)			**174,964**	

Annualised business investments were also estimated using detailed information from the tour operator survey. These differed between hotels and local operators, in some aspects (table 9). For example, hotels invested more in equipment and operator offices. However, less hotel tours went to Gladden Spit than did local operator tours, so that less of their costs were attributed to the reserve in total in 2007. In total, trip related costs and business related costs sum to over US$390,000.

[24] guides need to have completed the whale shark course, which they must pay for.

Table 9. 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 Gladden spit	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**	

Using detailed estimates from both reserve related revenues and costs, we estimate a tour operator of almost US$678,000 for 2007 (table 10). This would be shared between the 23 businesses, giving a mean producer surplus of just under US$30,000 per operator. Since local operators are able to capture many of the trips to the reserve, this means that local people benefit significantly from reserve tourism, in addition to hotel owners abroad, who capture less of the producer surplus.

Table 8. Producer surplus estimates for Gladden Spit Tour operators.

Revenue / Cost	***US$***
Gross revenues from tours	1,069,767
Total annual costs	391,774
Tour operator producer surplus 2007	**677,993**

Economic Values for the Gladden Spit and Silk Cayes Marine Reserve.

This report describes research conducted to measure the economic values for the most important environmental services generated in 2007 at a coral reef MPA in Belize, Central America. We have been able to estimate a large range of values enjoyed by five major types of stakeholders; visitors to the reserve, tourists to Placencia, local communities and fishers and tour operators who use the reserve. Table A summarises the findings of each valuation, with mean consumer and producer surplus estimates for each value we measured. The contrast between visitor and resident non-use values is notable. Whilst some of this could be explained by differences income (tourist incomes are extremely high), this is unlikely to account for such a difference in magnitude. Some non-use values may be reflected in community WTP values elicited (as was suggested in the econometric analysis for the recreational WTP). Also, non-use values may only be fully reflected when basic income requirements are met.

Table A. Summary Table of Economic Values at the Gladden Spit Marine Reserve.
* Level of precision depends both on the method used and the estimate itself. Non-use and community values are less precise since respondents are less familiar with the reserve or the decision process involved in generating value estimates. Less precise values are more variable (mean and median values are less similar).

Value category	Value	Number surveys	Time, unit	Mean value US$ (median value)	Beneficiary	Level of precision*
Visiting tourist values	One day visit	302	Per visit, per visitor	25.2 (20)	International visitors to GSMR	High
	One day visit + whale shark interaction		Per visit, per visitor	40.2 (30)		High
	Lifetime option and non-use value		Per lifetime, per visitor	68.4 (50)		Medium
Non visiting tourists	Per trip option & non-use value	282	Per trip to Belize, per tourist	21.1 (15)	International tourists to Placencia	Medium
	Lifetime option value		Per lifetime, per tourist	71.6 (35)		Medium
Community values	Annual fishing access	152	Per year, per household	103.2 (60)	Residents of Placencia	Medium
	Annual tourism access		Per year, per household	177 (68)		Medium
	Annual recreational value		Per year, per household	82.8 (60)		Medium
	Total Value Gladden Spit		Per year, per household	373.2 (180)		Medium
Fishing values	Annual fisher profits (PS) for fishing inside Gladden Spit	56	Per fisher day inside reserve	118 (109.5)	Local Belizean Fishers Sartenejan fishers	High
Tourism values	Annual profits (PS) for tour operator trips to Galdden Spit	18 (out of 20)	Per year, per tour operator	33,900	Local Belizean Tour operators International hotel owners	High

Aggregated values apply to different populations and so show different magnitudes to individual values and have more importance in terms of fund raising. Table B shows all the aggregated values measured. In total, we see that in 2007, we measured US$4.05 million in values, of which direct use values make up a third. In addition, we can attribute 31% of the value of this reserve to the existence of the spawning aggregations and the whale sharks that feed on them. When looking at net present values, the choice of discount rate will affect

estimates substantially. 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 look at sensitivity of the NPV, to the discount rate applied. Here we were interested in estimating net present values over the next 25 years, as it was felt that beyond this, habitat and economic conditions are likely to change substantially. Of this value, direct use values of the reserve alone are worth an estimated $1.3 million per year currently and potentially have a net present value of US$13-29 million over the next 25 years. Inclusion of non-use values increases the net present value of the resources within the reserve to US$41-93 million.

Table B. 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	Aggregated NET annual value	Value (US$'000)	Value (US$'000)	Value (US$'000)	Value (US$'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 profits (PS) for fishing inside GSMR	3453 days fishing	394,616	3,977	4,993	6,559	9,085
Annual profits (PS) for tour operator trips to GSMR	20 operators hotels	677,993	6,832	8,579,041	11,269,654	15,610
ALL USE VALUES	n/a	1,253,069	12,627	15,855,813	20,828,613	28,850
ALL VALUES (use + option + non-use)	n/a	4,047,425	40,786	51,214,429	67,276,622	93,185

In terms of the distribution of net benefits, figure 7 shows how these are apportioned between different groups of stakeholders. Belizeans enjoy 24% of the total value measured (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 1200 people. If other villages nearby were considered, the proportion received by Belizeans would be considerably larger. There is also relatively little leakage of profits associated with the reserve to international hotel owners. Of the tourist values, non-visitors account for 61% off measured consumer surplus.

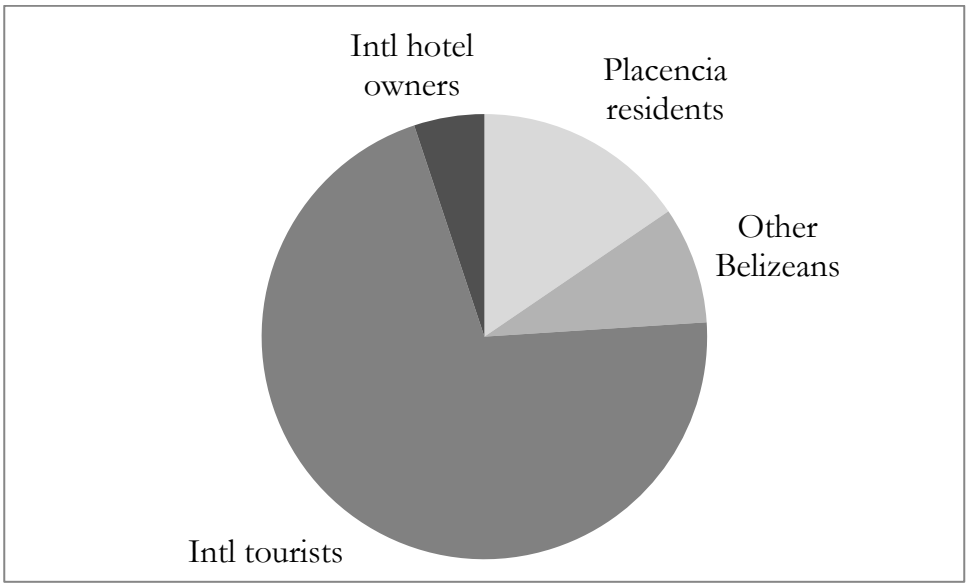


Figure 7. The distribution of net values generated by the Gladden Spit and Silk Cayes Marine Reserve in 2007.

Conclusions.

This report describes the results of original research conducted in a marine protected area (MPA) in Belize, which identified and measured the major economic values generated in 2007. Coral reef marine protected areas (MPAs) protect ecosystem services that directly and indirectly contribute to the welfare of people, both nearby and far away. 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. Lack of information typically results in under-investment in reef conservation and an under-appreciation of the negative impacts that habitat loss will have on stakeholders, their values, and the local economy.

We demonstrate that management of this area has enabled the GSSCMR to support many values which produce welfare gains enjoyed by people in the villages near the reserve, Belizeans in other parts of the country and by the international community. Non-use value constitute a significant part of this value, demonstrating the importance visitors place on making sure these areas persist for future generations, as do local community values. Indeed visitors, whose values are most frequently measured in the literature, only make up 21% of the values measured here. Omitting non-use and local community values, as other research has done, would have led to a serious underestimate of the true value of this reserve, which could result in too little investment.

This reserve generated over US$4 million in net economic values in 2007, which is equivalent to US$41-93 million over 25 years (depending on the discount rate applied). These values are likely to be an underestimate of the total economic value, as there are values such as marine life nursery functions, waste assimilation and consumer and producer surpluses gained in other nearby community values which have not been included due to time and budget constraints. Important, over time these, the value of high quality coral reef habitat would be expected to increase sharply, due to increasing wealth and degradation of other reef areas.

Gladden Spit is similar to other MPAs, which could be expected to have broadly comparable economic values. However the spawning aggregations that occur there and the whale shark aggregations that come to feed on the spawn make this area unique and add a significant proportion to the reserve 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 in the future. Many tour operators are able to remain open and employ staff in part due to the whale shark and day trips to the reserve. The limited access to fishing during spawning aggregations and tour trips during the whale shark season also result is also likely to be a key factor in determining the magnitude of producer surpluses we measured for local fishers and tour operators.

The economic impact of the reserve could be extremely large, as it includes revenues from tourism and recreation such as those relating to international and local travel, restaurants, hotels, gift shops, insurance, sales of dive gear, boats as well as materials and labour for tourism development. It also includes revenues from fishing related activities such as fisheries permits, fishing gear and boat equipment. These revenues have a direct and indirect impact on the local and regional economy and supports a large number of jobs, usually to Belizeans. This economic impact is additional to the net values reported in this research.

The values we estimate for the Gladden Spit Marine Reserve should be important when considering policy actions. Whilst demand curves have proven unreliable in practise at some sites, we have 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. We demonstrate that the GSSCMR generated almost US$1million in welfare benefits for Belizeans in 2007 and consumer surplus values that local residents gain per individual 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 should be used to maintain government support for this area and to justify keeping these funds for management.

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. In this report we provide evidence that MPAs such as the Gladden Spit Marine Reserve are likely to be a net beneficial 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 survey tools that have been developed here can be easily used elsewhere. We recommend that such studies include both local community and non-use values. This would help to identify economic values which should be the focus of management actions and of polices to raise funds from beneficiaries or polluters.

Contingent valuation proved to be highly flexible and intuitively simple to understand, especially as existing markets were often used. The methods used here have been successful applied to enable quantification of these values and they could be used as MPAs elsewhere, to do the same. We have presented the values separately, as the values measured differ in terms of units, time periods and in terms of the level of confidence in their precision. The given precision determines the confidence with which we can specify the magnitude of values. Specifically, non-use values are difficult to measure accurately. Community values were also more uncertain, possibly due to the unfamiliar nature hypothetical questions and the payments required[25]. The values quantified in this research were all measured net of costs. Gross values (often reported in other studies) are much larger but overstate the true economic value of the resources.

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. Indeed, these estimates make clear the potential economic losses that could occur, which would reduce the welfare of local stakeholders through impacts on tourism and fishing. The maintenance of the current values depends to what extent these reefs are protected from overfishing and overuse, including by tourists, which can also contribute to reef resilience, which will be increasingly tested by warming and acidifying seas. 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.

[25] Sensitivity to scope shown by the significantly different values elicited during the community survey is a good indication that respondents understood the valuation scenario. However uncertainty in some responses did also reduce the precision of the estimates.

Recommendations for management and future research include;

- Raise awareness as the magnitudes of these values and the number of stakeholders that benefit, to justify continued or increased investment, to target fundraising and education
- Use the values elicited here to build local support for management, through targeted education and outreach initiatives
- Consider the distribution of costs and benefits when understanding user behaviour
- Consider the ability to pay and values in aggregate when designing revenue raising strategies.
- Increase protection of the no-take area and ensure fishers observe the closed seasons and minimum sizes for conch and lobster
- Determine carrying capacity for tourists, both in the reserve in general and during whale shark seasons and use demand curves to set fees around the level that will produce the correct levels of visitation
- 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.
- Use net economic values, rather than gross financial values to understand the overall impact of values

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