ECONOMIC VALUATION OF CORAL REEFS: A CASE STUDY OF THE COSTS AND BENEFITS OF IMPROVED MANAGEMENT OF DHIGALI HAA, A MARINE PROTECTED AREA IN BAA ATOLL, MALDIVES

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Abstract

Coral reefs are a vital resource in the low-island Republic of Maldives, where the sustainable use of these resources is central to the continued economic success of the country's two largest sectors: tourism and fisheries. This recognition has led to numerous reef conservation and protection activities, including the establishment of Marine Protected Areas (MPAs). As in many MPAs of the world, those in the Maldives exist only as paper parks: areas protected on paper but not in practice. Despite general recognition of the importance of reef resources, insufficient funds are allocated by government to implement these parks. This situation is compounded by the absence of specific information and detailed understanding by policy makers of the true value and economic benefits of reef resources.

This thesis examines the an economic valuation of improved management of MPAs in the Maldives using Dhigali Haa, an MPA in Baa Atoll, Maldives, as a case study. A contingent valuation survey to elicit the willingness to pay of tourists visiting Baa Atoll to see improved management at the MPA was used in estimating the potential benefits. In addition, local community consultations were conducted to understand local perceptions of MPAs and their effectiveness, and to develop a feasible improved management scenario.

The local consultations confirmed that Dhigali Haa was not effectively managed, leading to continued illegal use and degradation of the reef. The results of the CV survey revealed support from tourists visiting Baa Atoll to pay for improved management of Dhigali Haa. A one-off conservation fee per visit for all tourists visiting Baa Atoll was preferred over a user fee solely for divers visiting Dhigali Haa. The lower estimate of the mean WTP for the conservation fee was US$31 versus US$15 for the user fee. Comparisons between the cost of implementing improved management and the benefits gained from tourist fees showed that a conservation fee would be more beneficial than a user fee. The estimated net present value for funding the improved management via a conservation fee was US$7.48 million.

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Abbreviations

AEC	Atoll Ecosystem Conservation
CBD	Convention on Biological Diversity
CITES	Convention of International Trade in Endangered Species of Wild Flora and Fauna
CORDIO	Coral Reef Degradation in the Indian Ocean
COTS	crown-of-thorns starfish
CV	Contingent Valuation
EIA	Environment Impact Assessment
EPPA	Environment Protection and Preservation Act
GCRMN	Global Coral Reef Monitoring Network
GDP	Gross Domestic Product
GPS	Global Positioning System
ICRI	International Coral Reef Initiative
IMS	Improved Management Scenario
IUCN	International Union for the Conservation of Nature and Natural Resources
MPA	Marine Protected Area
NAPA	National Adaptation Programme of Action
NCSA	National Capacity Self Assessment
NMV	Non-market valuation
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
RETDAP	Renewable Energy Technology Development and Application Project
SPSS	Statistical Package for the Social Sciences
TEV	Total Economic Value
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
WTA	Willingness-to-accept
WTP	Willingness-to-pay
WWF	The World Wide Fund for Nature

1. Introduction

This thesis attempts to provide an economic valuation of improved conservation and management of coral reef resources in the Maldives. In this research I have estimated the economic benefits of the conservation of Marine Protected Areas (MPAs) in the Maldives by using Dhigali Haa, an MPA in South Maalhosmadulu Atoll (Baa Atoll), Maldives, as a case study. I have used a stated-preference valuation technique, the Contingent Valuation (CV) method for this study. The rest of this chapter provides background information outlining the goals, objectives and motivation for the research and a brief introduction to the subsequent chapters of the thesis.

1.1. Background and Motivation

Being a coastal country with a vast marine environment, coral reefs are a vital resource to the Maldives. Islands of the Maldives are formed of carbonate sediment grown in the surrounding reef ecosystem, the reefs protect these islands from ocean waves and also provide people with a living in the form of fishing or tourism for example. The foremost economic activities, tourism and fisheries, are heavily reliant on the local coral reefs, making the continued health and sustainable use of these reefs very important for the Maldives.

One of the most important conservation actions by the government of the Maldives has been the establishment of MPAs. There are over 25 designated MPAs in the Maldives. These MPAs are relatively small in area, averaging a few hectares. All MPAs in the Maldives allow recreational diving and bait fishing but prohibit any other activities that would cause harm to the reef. Like many of the conservation efforts by the government, MPAs in the Maldives lack any management or enforcement of the MPA guidelines. Therefore, it can be said that the MPAs in the Maldives are “paper parks”, that is areas which are protected only on paper but not in practice. Without proper management and enforcement it is not possible to identify the effectiveness of the MPAs in the Maldives. Studies have identified this to be a common problem faced by many MPAs in the world (Depondt and Green 2006; Pomeroy et al. 2004).

One of the main reasons for the lack of effective management, in the Maldives and also identified in other countries, is the lack of available and allocated funds by the government. A government publication also identifies a lack of information and understanding of the true value of reef resources as the main reason for the lack of management in MPAs in the Maldives (United Nations Development Programme 2004)

Although reefs are a highly valuable economic resource, there is little quantitative information on their value to the Maldives. International studies have been conducted to value global reef resources in other regions such as the Caribbean, Indonesia and Philippines (Costanza et al. 1997; Dixon et al. 1993; Fahrudin 2003; Thur 2003). A first study of this kind in the Maldives estimated the value of conserving a grey reef shark for viewing by divers to be US$3,300 per year as opposed to US$32 if it was killed by a fisherman (United Nations Development Programme 2004). There has been no subsequent research in the Maldives regarding the value of reef resources and there is no research that compares such values with the cost of implementing and/or strengthening resource management policies. Such information would enable the government to make more adequate resource use and conservation policies and also enable the government to encourage resource users to behave responsibly through education and raising awareness.

The Dhigali Haa MPA of South Maalhosmadulu Atoll (Baa Atoll) has been chosen for this study as the Government of the Maldives is currently implementing a biodiversity conservation project in this atoll, titled the Atoll-Ecosystem Based Conservation of Globally Significant Biological Diversity in Baa Atoll, Maldives or the AEC project. Appendix 1 gives a brief description of the project and its objectives. One of its many conservation objectives is to look at the establishment of MPAs and to implement an effective management system for them.

1.2. Goals and Objectives

The main goal of this thesis is to estimate the potential economic benefits from effective management of MPAs to see if they justify the funding necessary for such management. I hope that this research will benefit protection and management policies for MPAs in the Maldives and contribute to the country's overall protection of coral reefs. Another important goal of this thesis is to contribute to the research on the valuation of reef resources, particularly in the Maldives.

The primary objective of this study is to estimate the willingness to pay (WTP) of tourists visiting Baa Atoll to see improved management and enforcement of conservation guidelines at Dhigali Haa. This will involve:

1. reviewing the existing management of the Dhigali Haa MPA and proposing an Improved Management Scenario (IMS) for the MPA,
2. obtaining local community perceptions of MPAs, on the management of Dhigali Haa and of possibilities for improvement,
3. conducting a WTP survey of tourists visiting Baa Atoll and

4. conducting a comparison of the costs of implementing an IMS with the benefits obtained from the WTP estimates.

This research contributes to the literature on the valuation of reef resources, in particular in the Maldives. Dhigali Haa in Baa Atoll like all MPAs in the Maldives is a paper park. This research values a proposed policy change to improve management at Dhigali Haa. Analyses of the comparisons of benefits and costs of improving management at Dhigali Haa are conducted, the results of which may assist environmental policy makers in the Maldives so that they will develop better policies for MPA management. Given that the MPA management issues identified in this is a wider global problem, I hope the findings of this thesis would be beneficial for management of MPAs in other parts of the world too.

1.3. Thesis Outline

The rest of the chapters in this thesis are outlined as follows:

Chapter 2 gives an overview of coral reef resources and of their use and management at a global level and focuses in more detail on the study region of the Maldives and Baa Atoll. Threats to coral reefs and conservation of their resources are discussed with particular emphasis on the establishment and management of MPAs.

Chapter 3 presents the research methodology for this thesis, including discussion of resource valuation and justification of the use of non-market valuation techniques. This is followed by detailed descriptions and discussion of the methods used in this study.

Chapter 4 presents the results of the qualitative study undertaken to develop an improved management scenario (IMS) for Dhigali Haa. The chapter also gives a cost estimate of the proposed IMS. Chapter 5 gives the results of the CV survey with details of the characteristics of the survey sample, of the WTP responses, and of the regression analysis.

Chapter 6 concludes the thesis with a comparison of the benefits from the WTP survey and costs associated with implementing the proposed improved management at Dhigali Haa. The policy and conservation implications of the findings are discussed. The implications of the findings in the wider context of international research are also discussed in this chapter. The thesis is concluded with suggestions for future research.

2. Background and Literature Review

2.1. Introduction

This chapter provides background information on the research area. The chapter commences with a brief description of the physical context of coral reefs in general but more specifically relating to the Maldives. In order to present the importance of coral reefs both globally and at a local scale the chapter provides a general overview of coral reef resources, their use and management at a global level and focuses in more detail on the study region of the Maldives and Baa Atoll. The threats to coral reefs and conservation of these resources with particular emphasis on establishment and management of MPAs are discussed to help understand the need for protection of this important resource. The chapter concludes with a brief introduction to resource valuation and its role as a resource management tool.

2.2. Coral Reefs Overview: The Physical Context

Coral reefs are one of the most diverse ecosystems on the earth and Spalding et al. (2001) describe them as shallow marine habitats, defined both by the physical structure and by the organisms found on them. The basic unit of a coral reef system is a hard, reef-building or hermatypic coral, which flourish best in clear, shallow, warm water that ranges between 18-30°C. Therefore, coral reefs are mostly found in the tropical regions (Moberg and Folke 1999; Souter and Lindén 2000). Red dots on Figure 2.1 give the location of the major coral reefs of the world. As estimated by Spalding et al. (2001), global coral reefs cover an area of about 284,300 km^2. The coral reefs in the Indian Ocean, in which the Maldives are situated, make up 11.2% of the global reef area (Spalding et al. 2001).

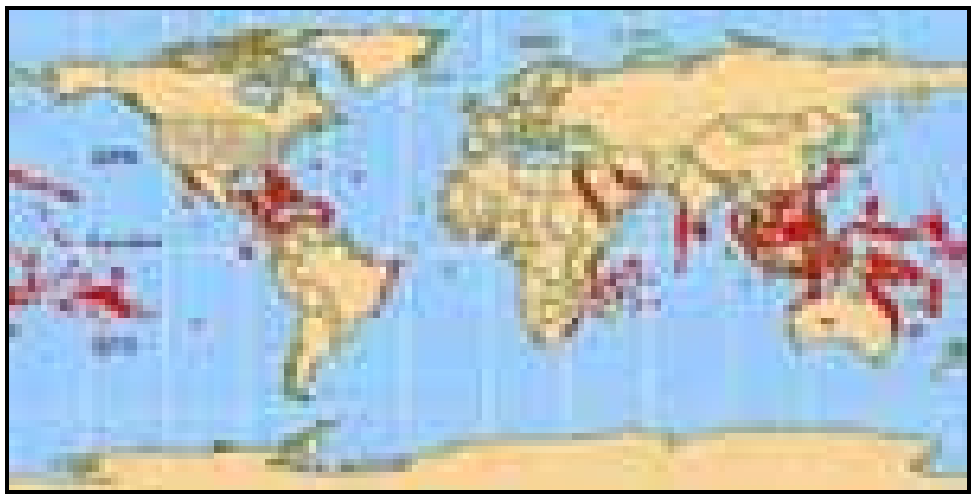


Figure 2.1. Global Distribution of Coral Reefs
(Source: www.oceanservice.noaa.gov, accessed on 20th April 2007)

The Maldive islands are a chain of tropical coral reef islands lying approximately 480 km southwest of India (Figure 2.2). The islands span 900 km from 7°06'N to 00°45'S latitude and 130 km 72°33'E to 73°47'E longitude. The coral reefs of the Maldives are characterised by the numerous atoll formations and faros. Atolls are annular or irregular oceanic reef formations which surround a lagoon and often have a discontinuous ring of islands on the reef rim. Faros are small atolls which occur within the larger lagoonal areas. The coral reef structures of the Maldives have been formally studied since the 1840s, and the reefs have been noted for their variations in size, development patterns and morphology (Darwin 1888; Naseer 2003; Stoddart 1965). The diversity of reef formations in the Maldives is captured by the richness of words used by locals to talk about reefs. Terms, such as *faru*, *thila*, *giri*, *haa* and *gaa*, coined by the locals are mostly based on the size and depth of the reefs below the water surface.

Coral reef statistics produced by the United Nation Environment Programme (UNEP) in 2003 ranked the Maldives as the seventh largest country in terms of the reef area it occupies. The Maldives is estimated to contain 3.14% of the total coral reef area of the world (United Nations Environmental Programme 2003). Recent mapping of the reefs of the Maldives by Naseer (2003) reveals that the Maldives archipelago contains 2,041±10 distinct coral reefs[1]. This includes 16 atolls, 5 ocean faros and 4 oceanic platform reefs (these resemble an atoll but are small platforms without a lagoon but often contain a central reef island). The study estimated the total area of the coral reefs of the Maldives to be 4,285.69 ±128.57 km^2 (Naseer 2003). The estimated land area is 300 km^2, but the maritime area of the Maldives' Exclusive Economic Zone is 859,000 km^2 (Ministry of Home Affairs Housing and Environment 2001).

[1] The number of reefs, in the study is based on those having a total area greater than one hectare. The definition of reefs in the study include reef passes, enclosed reef lagoons, areas of unconsolidated sediments and reef-top islands (reef platforms) down to a water depth of approximately 30m

Baa Atoll in the Maldives has been chosen as the study location for this research. Baa Atoll is located in the northern third of the Maldives archipelago, and has a total surface area of 1126.95 km^2 (Naseer and Hatcher 2004). It is located on the western side of the double chain of atolls making up the central Maldives. The atoll measures approximately 40 km both in length and width. Naseer and Hatcher (2004) recorded 105 reefs with a total reef area of 262.90 km^2 within Baa Atoll. This is approximately 6% of the reef area in the Maldives. There are 75 islands in Baa Atoll, with an indigenous population of 8, 893 living on 13 of these islands. Six of these islands have been developed as tourist resorts (Ministry of Planning and National Development 2006).

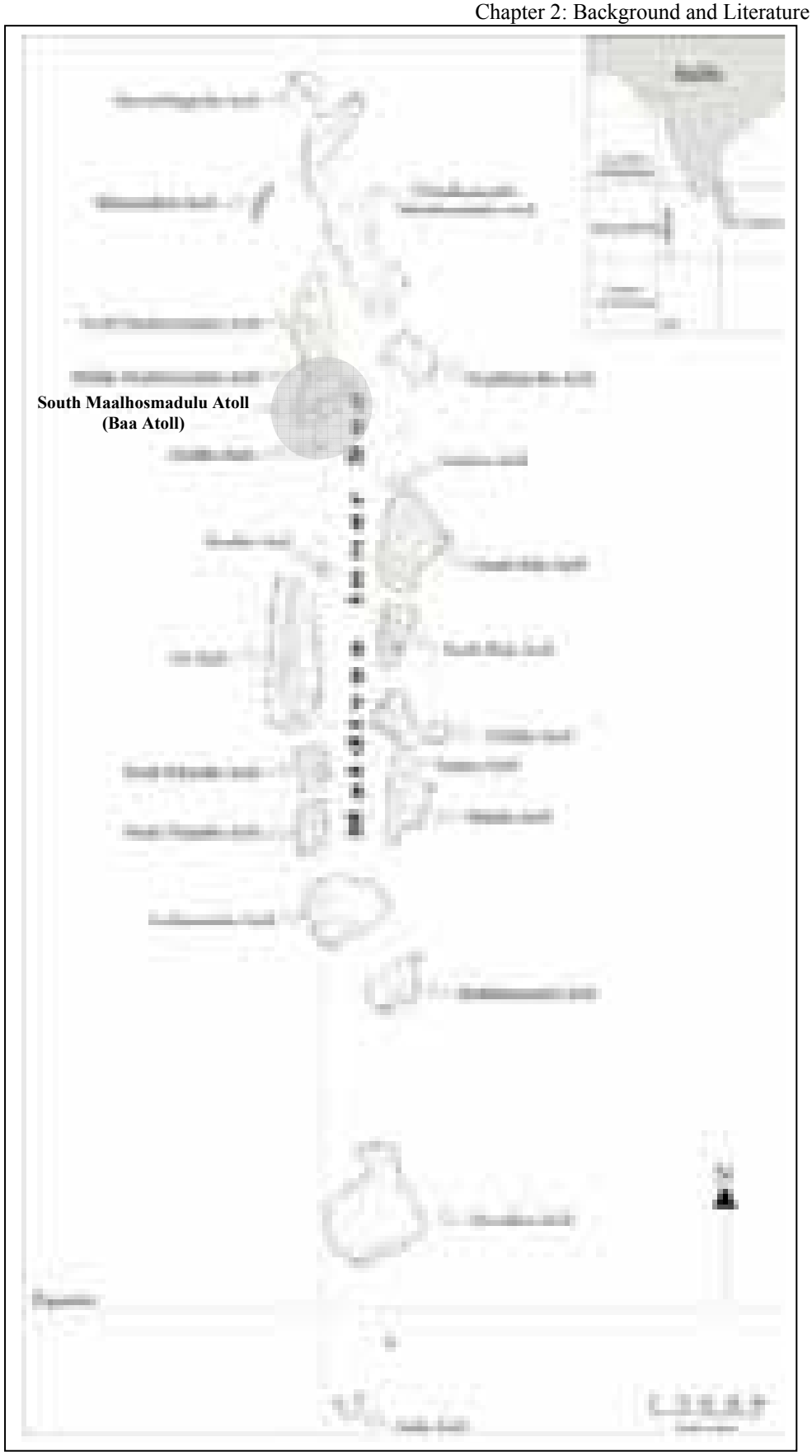


Figure 2.2. Map of the Maldives and Location.
Adapted from Naseer (2003). The annular formations are the outlines of the atolls. The shaded area in the map shows the administrative region of South Maalhosmadulu (Baa) Atoll.

2.3. Coral Reef Resources and Usage

Although coral reefs comprise less than 1% of the ocean surface, they support a variety of marine organisms and provide various ecosystem services (Thur 2003). A single reef may provide a habitat for about 200 species of coral, 300 species of fish and between 10,000 and 100,000 invertebrates (Cesar 2000). According to the United Nations Environment Programme (1988), coral reefs are essential life-support systems necessary for food production, health and other aspects of human survival and development.

Coastal populations living near reefs rely on coral reefs for their livelihood and income. There are over 100 countries that have coastlines of coral reefs and at least tens of millions of people who depend on the reefs for their food and livelihood (Moberg and Folke 1999). Bryant et al (1998) estimated that almost half a billion people live near reefs[2]. Coral reefs provide opportunities for income and employment through fishing, recreation, the aquarium trade and other extractive industries such as the live reef fish trade and coral mining.

Coral reefs also provide ecosystem services such as aiding land formation, provision of coastal protection and recreation. In addition to obvious benefits to humans, coral reefs also have many important ecological functions both within and between ecosystems. They provide spawning and breeding grounds and nurseries for many marine organisms. The migration of coral reef organisms between ecosystems establishes "mobile links" between these ecosystems. Coral reefs, thus, provide physical and biological support to other ecosystems such as mangroves, sea grass beds and the open ocean (Moberg & Folke, 1999). Moberg and Folke (1999) give a detailed description of these goods and services provided by coral reefs (Table 2.1).

[2] This estimate takes people living within 100 km of a coral reef

Table 2.1. Goods and ecological services of coral reef systems

Goods		**Ecological Services**					
Renewable resources	Mining of reefs	Physical Structure Services	Biotic Services		Biogeochemical Services	Information Services	Social and Cultural Services
			Within Ecosystems	Between Ecosystems			
Sea food products	Coral blocks. Rubble and sand for building	Shoreline protection	Maintenance of habitats	Biological support through 'mobile links'	Nitrogen fixation	Monitoring and pollution record	Support recreation
Raw materials for medicines	Raw materials for the production of lime and cement	Build up of land	Maintenance of biodiversity and a genetic library[3]	Export of organic production, and plankton to pelagic food webs	CO^2/Ca Budget Control	Climate record	Aesthetic values and artistic inspirations
Other raw materials (seaweed and algae for agar, manure, fertiliser etc.)	Mineral oil and gas	Promoting growth of mangroves and seagrass beds	Regulation of ecosystem processes and functions		Waste assimilation	Sea level change record	Sustaining the livelihood of communities
Curio and Jewellery		Generation of coral sand	Biological maintenance of resilience				Support of cultural, religious and spiritual values
Live fish and coral collected for the aquarium trade							

(Adapted from Moberg & Folke, 1999)

[3] Coral reefs are an important spawning, nursery, breeding and feeding area for a variety of marine organisms. The complexity of the coral structures together with the diverseness of the species creates opportunities for further variety and possibilities for evolution of new species.

2.3.1. Direct Uses of Reef Resources in the Maldives

Outside the Western Pacific, the Maldives is considered to be the most heavily dependent country on coral reef resources (Ghina 2003; Spalding et al. 2001). Historically, export of marine resources such as the money cowrie *Cypraea moneta* collected from reefs, dried fish, tortoise shell and black coral were a very important part of the Maldivian economy (United Nations Environment Programme 1988). Today, much of the country's exports remain marine products, to which tuna products are central. Export figures for the year 2005 show that over 98% of export proceeds are from marine products. Of this, about 5% are directly from reef related products such as live, frozen, dried or salted reef fish and shark products (Ministry of Planning and National Development 2006b). According to figures in Table 2.2, the percentage share of the Maldives' Gross Domestic Product (GDP), in the year 2005, for reef related economic activities was 33.9% (Ministry of Planning and National Development 2006b).

Table 2.2. Percentage Share of GDP in 2005 for Reef Related Economic Activities

Industry/Economic Activity	**Percentage Share of GDP (2005)**
Fisheries	10.6
Coral and Sand Mining	0.6
Tourism	22.7
Total GDP for 2005 - US$674 million	
GDP per capita(2005) - US$2,271	

(Source: Ministry of Planning and National Development 2006b)

In addition to being an important export, tuna is also a staple food of the Maldivian people (United Nations Environment Programme 1988). The Maldives is the country with the highest consumption of tuna per capita with an annual consumption of 125 kilos per person per year (Spalding et al. 2001). Although tuna is not a direct reef resource, juvenile bait fish caught from the reefs is essential for catching tuna. Compared with tuna consumption, the amount of reef fish consumed for food by locals is very small.

Baa Atoll, like many local communities of the Maldives, has an economy that centres on the coastal zone and is based directly on marine resources. While many other atolls of the Maldives are engaged in tuna fishery, the locals of Baa Atoll undertake a wide range of fishing activities (Bers 2005; Gunn et al. 2005). These include fisheries for reef fish, invertebrates such as sea cucumber and lobster and also fish for the aquarium trade. Much of the reef fishery in Baa Atoll supplies the resorts. Because of the increase in the variety of fishing activities, the contribution of Baa Atoll to the tuna fishery is declining (Bers 2005). In particular, the share of Baa Atoll's national tuna catch dropped from 6.1% in 1995 to 1.8% in 2005 (Ministry of Planning and

National Development 2006b). Table 2.3 gives a summary of the types of fishing activities undertaken in the islands of Baa Atoll.

Table 2.3. Types of Fishing Carried out in Baa Atoll

Island	Population	Fishing Activity							
		Tuna	Reef	Lobster	Aquarium	Live bait	Shark	Sea Cucumber	Grouper
Dharavandhoo	740								
Dhonfanu	305								
Eydhafushi	2409		*			*			
Fehendhoo	114								
Fulhadhoo	194								
Goidhoo	503								
Hithadhoo	758					*			
Kamadhoo	231								
Kendhoo	858								
Kihaadhoo	275								
Kudarikilu	355								
Maalhos	392								
Thulhaadhoo	1759								

Note: All information except the fishing activity in '*' is from Bers (2005). Information with an '*' is from my own field observations.

In addition to traditional fisheries, tourism is one of the main economic activities in the Maldives and the success of tourism in the Maldives is very much dependent on the coral reefs. A tourist opinion survey conducted by the Ministry of Tourism (2005), showed that the main attraction to the Maldives is its marine environment and particularly reef related attractions such as snorkelling, diving and fishing (Figure 2.3). A study by Westmacott et al. (2000) found that around 45% of all tourists going to the Maldives were divers. Of these, 69% of divers made more than five dives per visit (Westmacott et al. 2000).

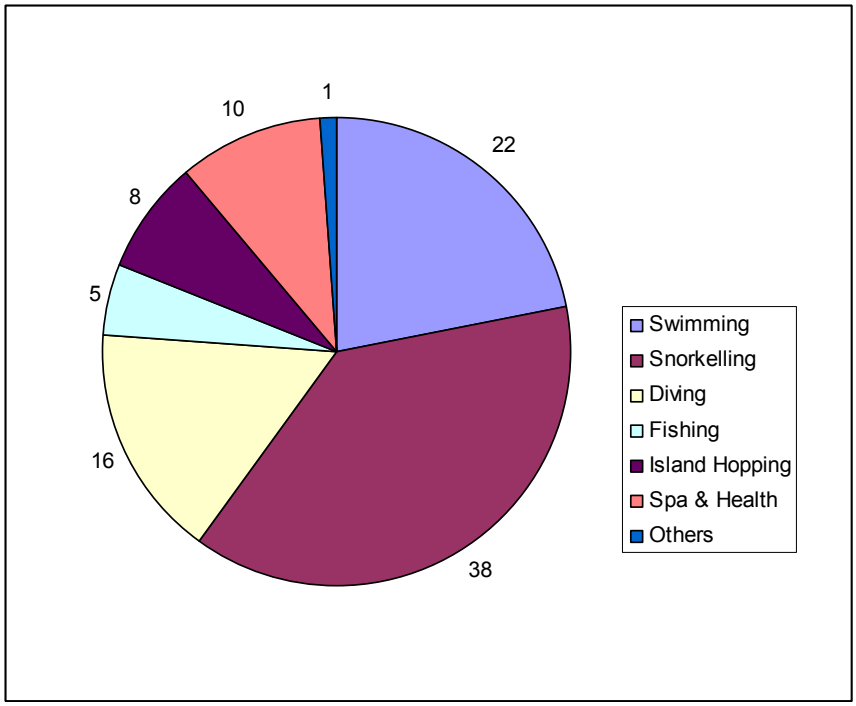


Figure 2.3. Activities enjoyed by tourists to the Maldives
(Source: Ministry of Tourism 2005)

Every tourist resort in the Maldives exists as an exclusive hotel all on its own island. Resort islands are fully equipped to cater for visitors to the Maldives. In addition to its beach encircling the island, each island has its own "house reef" which is frequently used by scuba divers and snorkellers. The islands are generally selected for resort development using criteria such as distance from the airport, size and geography of the island, bio-physical condition of the reef, beach sediment dynamics, coastal vegetation and importance to other sectors.

There are no locals apart from staff living on the resort islands as it has been a long standing government policy in the Maldives to keep western tourists separate from the local Muslim community. In addition to accommodation for tourists and staff, all support services and facilities are available on-site on the particular island. These include power generators, waste and sewerage management, food and catering, laundry, sports and leisure facilities and on-island shops.

Six of the 75 islands in Baa Atoll have been developed as tourist resorts. The first resort in Baa Atoll, Sonevafushi, was developed in 1983 with a bed capacity of 50. Since then 5 additional resorts have been opened and the bed capacity today is 1240 (Ministry of Planning and National Development 2006)[4]. Presently, Baa Atoll provides 6% of the total tourist bed capacity in the Maldives (Ministry of Planning and National Development 2006b).

[4] This figure includes the bed capacity of Four Seasons at Landa Giraavaru which was opened late 2006 and hence was not included for the CV study.

The local community in Baa Atoll benefits from direct employment in the resorts, but also from other tourism-related economic opportunities. The tourism industry provides a market for local produce such as reef fish, agriculture and locally made souvenirs. Many resorts also have excursions to visit nearby local islands.

The other direct use of coral by the general Maldivian community and also by Baa Atoll is the mining of coral and sand for the building of houses. Corals had been traditionally mined for the building of housing and construction. Lime made by burning coral in an open kiln was used as a building mortar before the introduction of cement. In more recent times, large corals have been used in the building of coastal protection infrastructure such as breakwaters, sea walls, groynes, jetties and harbours (Ministry of Environment and Construction 2005; United Nations Environment Programme 1988).

The strengthening of coral mining regulations in 1992 and the introduction of cement blocks to the building industry has resulted in a decline in the amount of coral mined in the Maldives. The amount of annual coral mined in the Maldives had reduced from 0.5 million cubic feet in the 1980s to 33, 000 cubic feet in 2004 (Ministry of Environment and Construction 2005). However, the introduction of bricks and cement for building has caused an increase in the demand for sand and coral aggregates for use in making cement blocks.

According to Bers (2005), six reefs were previously used for coral mining in Baa Atoll. Even today, sand is regularly mined from the house beach on 10 of the inhabited islands and 4 of the uninhabited islands in Baa Atoll (Bers, 2005). According to figures from the Ministry of Environment (2005), Baa Atoll contributed to 15% and 12% respectively of the total amount of reported coral and sand mined in the Maldives between 2000 and 2003[5].

2.3.2. Indirect Uses of Reef Resources in the Maldives

The islands of the Maldives have been formed by accretion of reef sediment over reef platforms. In addition to being the source for the formation of the islands, the reefs perform an important function of protecting these low-lying islands from high waves by acting as natural breakwaters, which lower the energy of incident waves. The dynamic reef environment continually contributes to erosion of the islands. Seasonal erosion is quite common as the sand spits move around islands depending on the direction of wave-current action. Reefs provide a natural barrier and protection against more serious erosion that could result in receding of island shorelines. As

[5] Due to weak monitoring mechanisms not all cases of coral and sand mining get officially reported.

the islands of the Maldives are very low lying and small, the protection provided by the reefs is very important to these islands. The average area of the islands is about 0.7 km^2 and only nine islands have an area greater than 2 km^2 (Ministry of Home Affairs, Housing and Environment 2001). More than 80% of the islands are less than a meter above mean sea level (Ministry of Environment and Construction 2005).

2.4. Threats to Coral Reefs

Many recent studies show declines in reef status (Bryant et al. 1998; Hodgson 1999; Souter and Lindén 2000; Wilkinson 1999). Stresses on the health of coral reefs can be categorised into three main groups: natural events, direct human impacts and natural impacts accentuated by human activities. Table 2.4 gives examples of these three stresses.

An assessment of risks to coral reefs showed that 88% of reefs in the Maldives are at low risk while 12% are at medium risk (Bryant et al. 1998). Globally, coral reefs of the Maldives are identified as at low risk. The main reason for this may be the geographically dispersed nature of the islands in relation to the concentrated distribution of population and hence the protection from human activity (Rajasuriya et al. 2003). Despite this, the coral reefs of the Maldives are at risk from natural and human stresses.

Table 2.4. Categories of Stresses on Coral Reefs

(i) Natural Events	- Massive climatic changes such as glacial periods, - Meteor strikes - Tectonic plate movements - Tropical storms and periodic extreme weather - Exposure during low tides - Outbreaks of predators and disease - Extreme variations in temperature
(ii) Human Impacts	- Over- exploitation of marine resources - Coastal development - Pollution
(iii) Accentuated Natural Impacts	- Temperature variations and extreme weather events due to Global Climate Change - Increased outbreaks of predators and disease due to human disturbance - Increases in radiation - Changes in sea level, weather and current patterns

2.4.1. Human Impacts

Human impacts have been identified as the major risk to coral reefs in the Maldives (Fahrudin 2003; Ministry of Environment and Construction 2005; Rajasuriya et al. 2005; United Nations

Development Programme 2004; United Nations Environment Programme 1988). According to United Nations Development Programme (2004), the social and economic changes in the Maldives are exerting pressures on the health of the country's reefs. According to Rajasuriya et al. (2003), the more damaged coral reefs in the Maldives occur near heavily populated areas such as the capital Malé. According to the Ministry of Planning and National Development (2006b), the population of the Maldives has doubled since the early 1980s. This increase in population and economic growth has caused changes in the traditional ways of interacting with the reef environment. Findings from studies such as Byrant et al. (1998), Hodgson (1999) and Kleypas and Eakin (2007) also identify overexploitation of marine resources and coastal development as the greatest threat to the reefs of the world. Reports on the status of the environment of the Maldives show that this is also true for the Maldives (Ministry of Environment and Construction 2005).

In more traditional times tuna was the main fishing catch but the introduction of tourism and the expansion of the export market has diversified the fishery to target more reef fishes (Ministry of Environment and Construction 2005; Sattar and Adam 2005). Export figures of groupers for the period 1999 to 2003 reveals that an average of 260 metric tonnes of fresh/chilled grouper and over 244,000 live groupers were exported annually, earning an annual income of over US$1.3 and US$1.5 million respectively (Ministry of Environment and Construction 2005). Export figures from the Ministry of Planning and National Development (2006b) show that over US$8 million were earned in 2005 from export of shark products. The live aquarium trade is also an emerging export product earning over US$500,000 in 2003 (Saleem and Adam 2004). Many studies report that the rapid growth of the reef related fisheries has led to overexploitation of valuable species (Anderson and Waheed 1999; Saleem and Adam 2004; Sattar and Adam 2005).

Development in many of the islands in the Maldives has led to the building of coastal infrastructure and shoreline modifications such as reclamation, building of harbours, jetties, causeways, breakwaters and dredging of boat channels. Coastal development causes considerable sedimentation in the marine environment, which can smother corals and destroy the reefs. Many studies have identified sedimentation from such activities as the biggest source of damage to coral reefs (Bryant et al. 1998; Kleypas and Eakin 2007; Wilkinson 1999).

The bulk of these modifications in the Maldives occur in tourist resorts where over-water structures such as water bungalows, restaurants and spas are popular marketing products (Shaig 2006). Data from Shaig (2006) show that there are more than 1200 over-water structures in the 87 resorts compared with less than 500 in the 200 islands of the Maldives inhabited by local people. Under the Maldives' Environment Law (Law No. 4/93), before starting such projects the

developers have to do an Environment Impact Assessment (EIA) and have it approved by the Ministry of Environment. Section 2.5 of this Chapter gives additional details of the EIA process in the Maldives.

In addition to the coastal developments, operation of tourist resorts also causes damage to the reefs. Activities which cause damage include disposal of non-biodegradable products, pollution and intensive use of the reefs by divers and snorkellers (Ministry of Environment and Construction 2005). A study on snorkeller damage on a Maldive resort reef showed that 17% of most susceptible coral cover and 7% of the total coral cover were damaged on the most intensively used section of the reef (Allison 1996).

An estimated 580,000 dives were made in the Maldives in the year 2000 (Ministry of Tourism 2003). The majority of these dives occurred in Malé and Ari Atoll because about 80% of the tourist bed capacity is in these locations. During the period Baa Atoll contributed to about 4.5% of the total tourist bed capacity (Ministry of Planning and National Development 2004). Estimates of other popular dive destinations show that coral reefs at Eliat, Egypt are exposed to more than 250,000 dives a year along 12 km of coast (Zakaia and Chadwick-Furmanb 2002). The most popular dive sites in Bonaire Marine Park in the Caribbean host over 20,000 dives a year (Thur 2003). Although there are many divers visiting the Maldives, the impact on individual dive sites is less because of the large number of dive sites available for tourists. For example, Malé Atoll, where more than 50% of tourists stayed in 2000, has about 40 dive sites for tourists to visit (Bandos Island Resort, Maldives, accessed on 8th June 2007, www.bandosmaldives.com; Kurumba Village, Maldives, accessed on 8th June 2007, www.kurumba.com). The five resorts in Baa Atoll presently have a choice of over 30 dive sites for tourists to visit (Soleni Diving Centre, Maldives, accessed on 8th June 2007, http://www.soleni.com). Hence, not all dive sites are used extensively on a daily basis.

2.4.2. Natural Threats and Accentuated Natural Impacts

Several incidences of natural threats have been reported for the Maldive reefs. Among this is the infestation of crown-of-thorns starfish (COTS) which impacted the reefs in the 1980s (Rajasuriya et al. 2003; Sluka and Miller 1999). Other natural impacts have been mostly climate and weather related impacts. Among this are the two most notable events of the December 2004 tsunami and the 1998 coral bleaching event caused by El Niño induced warming of the South Indian Ocean (Cesar 2000; Gunn et al. 2005; Ministry of Environment and Construction 2005; Rajasuriya et al. 2005).

A post-tsunami assessment showed that there was minimal damage to the surveyed reef areas (including Baa Atoll) and that there had been little impact on the bait and tuna fishery (Gunn et al. 2005). The same study also showed that the reef fishery in Baa Atoll was reduced due to the low demand for reef fish that was caused by the decline in the occupancy of resorts in the atoll. The impacts of the 1998 El Niño was much more severe. Post and pre-bleaching surveys of study sites showed that the live coral cover had dropped from 28-58% to 0-5% after the bleaching event. Recovery has been slow with a recovery rate of 3% recorded between 1998 and 2002 (Gunn et al. 2005; Ministry of Environment and Construction 2005). Figure 2.4 gives observations of live coral cover in Baa Atoll after the bleaching event and the tsunami of 2004.

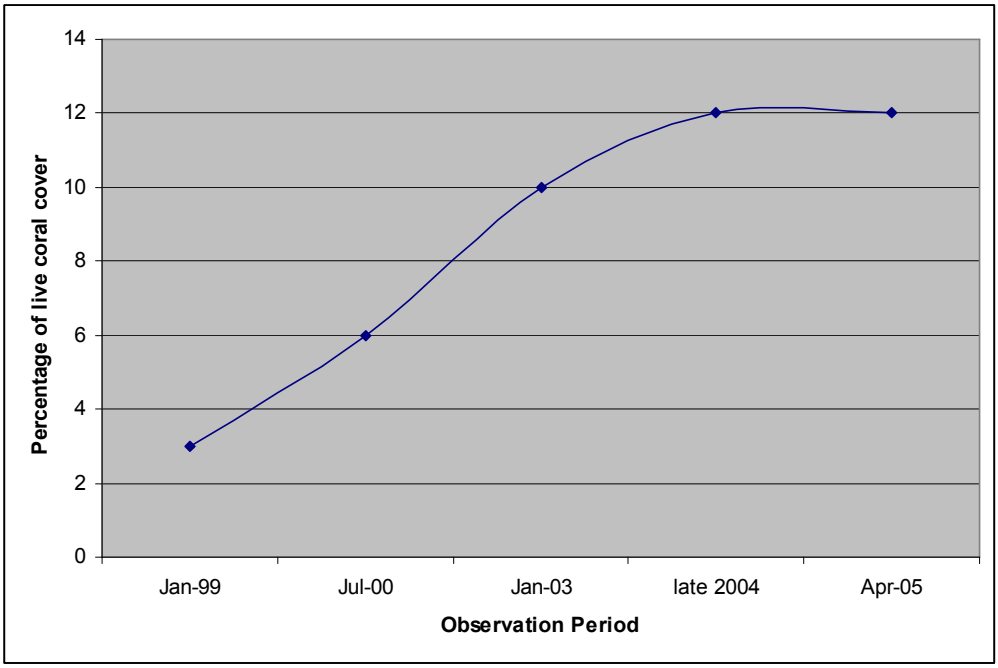


Figure 2.4. Changes in Live Coral Cover in Baa Atoll after 1998 Coral Bleaching Event. Data from Allison (2005)

2.5. Coral Reef Conservation

The concerns over the health of the world's coral reefs have translated into protection and conservation action at local, national and international levels. Some of the international level agreements and initiatives include The International Coral Reef Initiative (ICRI), Global Coral Reef Monitoring Network (GCRMN), The Convention on Biological Diversity (CBD) and Convention of International Trade in Endangered Species of Wild Flora and Fauna (CITES) (Bryant et al. 1998). The Maldives is a party to the CBD and is also involved in activities of the GCRMN, and Coral Reef Degradation in the Indian Ocean (CORDIO) (Ministry of Environment and Construction 2005; Marine Research Centre, Maldives, accessed on 8th June 2007, http://www.mrc.gov.mv/).

Under programmes such as the GCRMN, CORDIO and the Integrated Reef Resources Management, the Marine Research Centre of the Maldives monitors the status of coral reefs in various parts of the country (Ministry of Home Affairs, Housing and Environment 2001). Improving our knowledge base on coral reefs is one of the most important activities and or tools needed to protect them (Bryant et al. 1998; Souter and Lindén 2000).

According to Fahrudin (2003), many countries with coral reefs have adopted coral reef protection legislation into their Environment Protection Acts or Fisheries Laws. There are two main pieces of legislation directly related to coral reef management and conservation in the Maldives. These are 'The Fisheries Law of the Maldives 1987' and 'The Environment Protection and Preservation Act 1993' (EPPA) (Zuhair 2003). Specific regulations on coral mining from house reefs of islands and designating specific sites for mining were also introduced in 1992.

The Fisheries Law supports the EPPA by protecting numerous marine species and imposing export bans on some species and regulating different types of fisheries by prohibiting harvesting in certain areas. Reef related species protected under this law include Napoleon wrasse, giant clams (Tridacna spp.), black corals (Antipatharia), sea turtles, whales, whale sharks, dolphins, manta rays and triton shells United Nations Development Programme 2004). In 1998, the Ministry of Fisheries, Agriculture and Marine Resources banned fishing for reef shark from an area within 20 nautical miles of the outer atoll rim of several atolls (including Baa Atoll) for a period of 10 years (United Nations Development Programme 2004). Like many other conservation regulations in the Maldives, these do not have adequate monitoring or enforcement mechanisms.

The main regulation for environmental protection under the EPPA is the EIA regulation under which any development projects could only be started after an EIA of the project has been approved by the Ministry of Environment. According to United Nations Environment Programme (2005b), the EIA process is imposed mostly on private sector projects (mainly development projects by resorts) and most public sector projects do not go through the EIA process. Of 76 EIAs submitted to the Ministry of Environment, since 2001, 54 were from the tourism sector and 5 were from the fisheries sector and during the same period 74 coastal modification projects had been undertaken in the inhabited islands without any EIA approval (United Nations Environment Programme 2005a). The follow-up monitoring of EIA approved projects is also very weak due to a lack of resources by the Ministry of Environment (United Nations Development Programme 2004).

The EPPA is also responsible for declaring protected areas and there are presently over 25 MPAs in the Maldives. Establishment of MPAs is an effective conservation method adopted by

many countries in recent years. Researchers have found that MPAs are effective in protecting marine biodiversity and they also improve the diversity of adjacent reefs by export of larvae and migration of adult species (Côté et al. 2001; Halpern 2003; Polunin and Roberts 1993; Souter and Lindén 2000). A detailed discussion of MPAs and their management in the Maldives is provided later in Section 2.5.1.

In addition to the government, many non-government organisations, schools and the tourism industry are involved in awareness and education programmes relating to reef conservation. They conduct clean up programmes, workshops and field trips for schools. Some resorts are also working on restoration of degraded reefs by building artificial reefs. Clark and Edwards (1999) have successfully demonstrated recruitment of coral on artificial structures in the Maldives. Some projects in this area that are being done by resorts include the Ihuru Barnacle and Necklace Projects, the Vabbinfaru Lotus Project and the Reef Ball Project at Kuda Hura.

In addition to developing management strategies, supporting legislation and enforcement measures, the underlying economic incentives for the destruction of reefs should also be addressed. For example, people engaged in activities that are destructive to reefs need to have attractive alternative livelihoods or be trained in less destructive methods. Similarly, policy changes to be effectively implemented, they must be formulated with community participation and ownership as well as education. The AEC Project in Baa Atoll would be addressing these areas (United Nations Development Programme 2004).

2.5.1 Marine Protected Areas in the Maldives

Most MPAs in the Maldives are popular dive sites protected by the urging from the tourism industry and they are relatively small averaging only a few hectares in area (United Nations Development Programme 2004). With the exception of bait fishing and recreational diving all other activities are officially prohibited at these MPAs. The prohibited activities include anchoring (except in emergency), coral and sand mining, dumping of rubbish, removing any natural object or living creatures and fishing of any kind except traditional live bait fishing (Bers 2005).

From the large number of activities prohibited, Zuhair (2003) infers that the main purpose for the establishment of MPAs in the Maldives is likely to be for biodiversity conservation and a secondary reason may be to resolve resource use conflicts, especially between tourist resorts and fishermen. Zuhair (2003) made the following observations on the management and effectiveness of MPAs in the Maldives:

1. there are no clear and concise management objectives of the MPAs,

2. there is no community and stakeholder participation or involvement in either the establishment phase or the subsequent management phase,
3. there are no management plans including zoning plans,
4. there are no resources (such as finance, staff or equipment) allocated by the government for management of MPAs,
5. there are multi-agencies with responsibilities in establishment and management of MPAs and this hinders overall management responsibility of MPAs in the Maldives, and
6. there are no research and monitoring components to help evaluate the effectiveness of the MPAs.

In light of the above observations, I would state that MPAs in the Maldives lack the necessary elements for effective management. Without proper monitoring it would not be possible to state the effectiveness of these MPAs in protecting the reefs. The MPAs in the Maldives could be termed as "paper parks" in that they are protected only on paper and there is no real physical actions undertaken to protect them. According to United Nations Development Programme (2004), the main reason for this is a lack of information and understanding of the true value of reef resources. International studies show that this is not a problem faced by Maldives only, but is a wider global problem (Depondt and Green 2006; Pomeroy et al. 2004; Wilkinson et al. 2006). According to Depondt and Green (2006), as much as 80% of global MPAs remain protected merely on paper. Wilkinson et al. (2006) reported that only 7% of MPAs in Southeast Asia are effectively managed.

So far the only established MPA in Baa Atoll is Dhigali Haa, also known as Horubadhoo Thila, (05°08.842' N, 73°02.43' E). Dhigali Haa was established in October 1999 by recommendation from resorts and dive schools as a rich reef area where grey reef sharks, white tipped reef sharks, barracudas, jacks and turtles were frequently sighted (Bers 2005). It is situated in close proximity to all the resorts in Baa Atoll and hence is easily accessible to dive schools of the resorts in the atoll. Figure 2.5 is a map of Baa Atoll showing the location of Dhigali Haa and the resorts in the atoll.

The term "*haa"* is used locally for a deep submerged reef and is usually characterised by abundant fish life. Dhigali Haa comprises a long and narrow reef and is characterised by a colourful reef top with overhangs. The reef top at Dhigali Haa is between 12 and 16 meters deep, with slopes down to depths of about 32 meters (http://www.dlphisdiving .eu/Eng/Centers/Royal/index.html ; www.soleni.com , accessed 20th June 2007). According to

Bers (2005), red encrusting coralline algae are abundant in Dhigali Haa and there are many colonies of digitate and branching Acropora spp corals.

Dhigali Haa hosts a variety of seasonally varying, reef fish and other marine mammals. Marine animals that are often seen at the MPA include sharks (grey reef shark and white-tipped shark), spinner dolphins, schools of barracudas and fusiliers, trevally, jack fish, batfish, clouds of glass fish and sometimes eagle rays. During the wet season (roughly May to November) the reef is a popular cleaning station for manta rays.

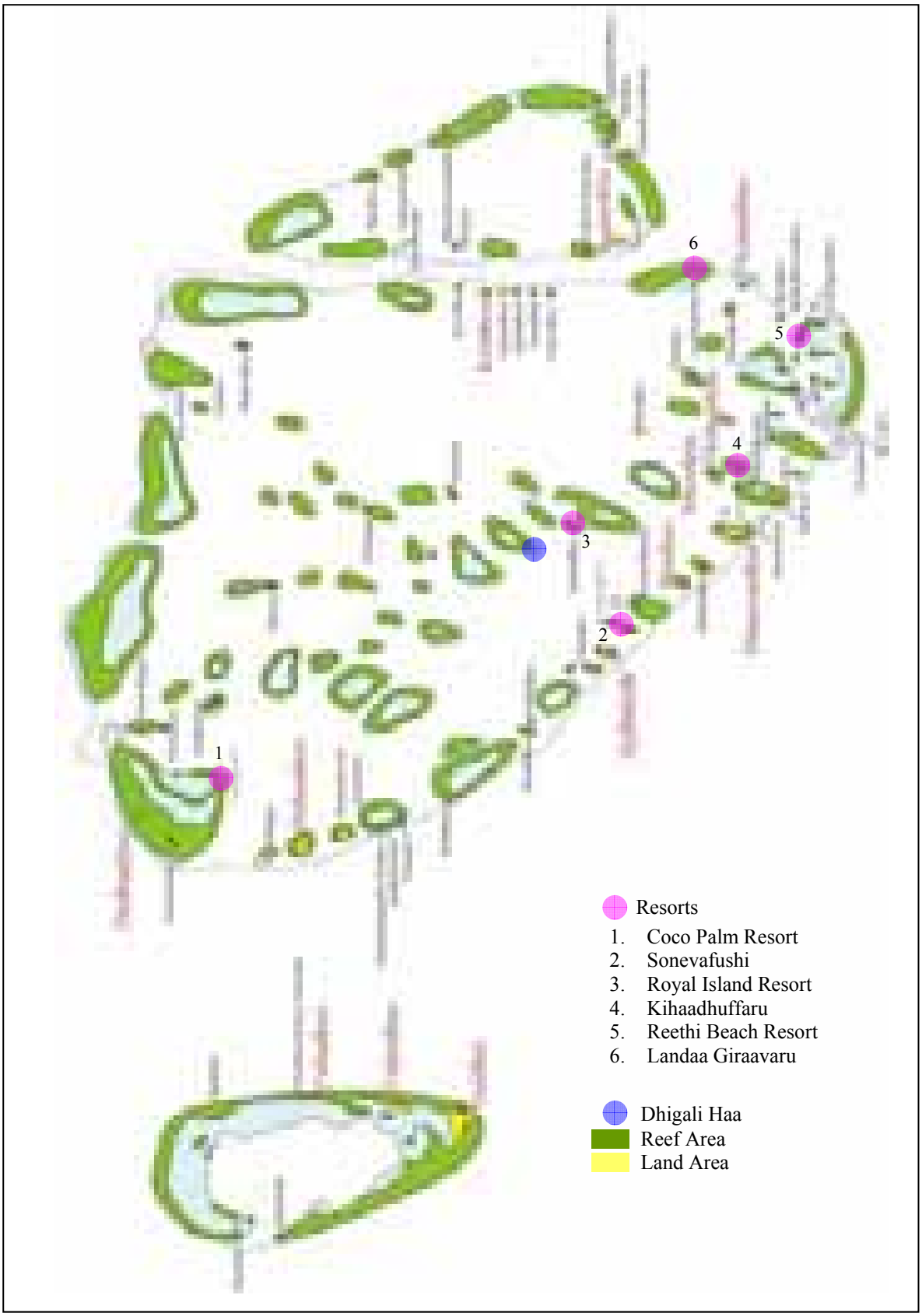


Figure 2.5. Map of Baa Atoll, showing location of Dhigali Haa.
(adapted from http://en.wikipedia.org, accessed on 23rd August 2007)

2.6. Resource Valuation

Despite their importance, coral reefs continue to be threatened by human actions. One reason for the ongoing and increasing destruction of coral reefs and the lack of political will and support to administer protection measures is that there is not sufficient figures for the value of the reefs and the added cost from destruction of reefs (Balasubramanian et al. 2003; Cesar 2000). That is, the economic value of activities that damage coral reefs, like coastland extensions, tourism and fishing can be easily measured using market prices whereas the value of preserving reefs is not easily measurable.

The concept of Total Economic Value (TEV) could be used as a valuable tool to help alleviate some of the pressures causing coral reef degradation. Cesar (2000) defines TEV as the combined value of all compatible goods and services of an ecosystem. Figure 2.6 gives the goods and services considered for a TEV of coral reefs. There have been many valuation studies conducted to value global reef resources and in other regions such as the Caribbean, Indonesia and Philippines (Costanza et al. 1997; Dixon et al. 1993; Fahrudin 2003; Thur 2003). Costanza et al. (1997) estimates the value of the world's coral reefs to be worth about US$375 billion each year. The best estimates so far would be undervalued due to difficulty in estimating the use values of those who do not visit the reefs, but value their health and existence. Table 2.5 gives some examples of reef valuation undertaken in various studies and the estimated values from these studies.

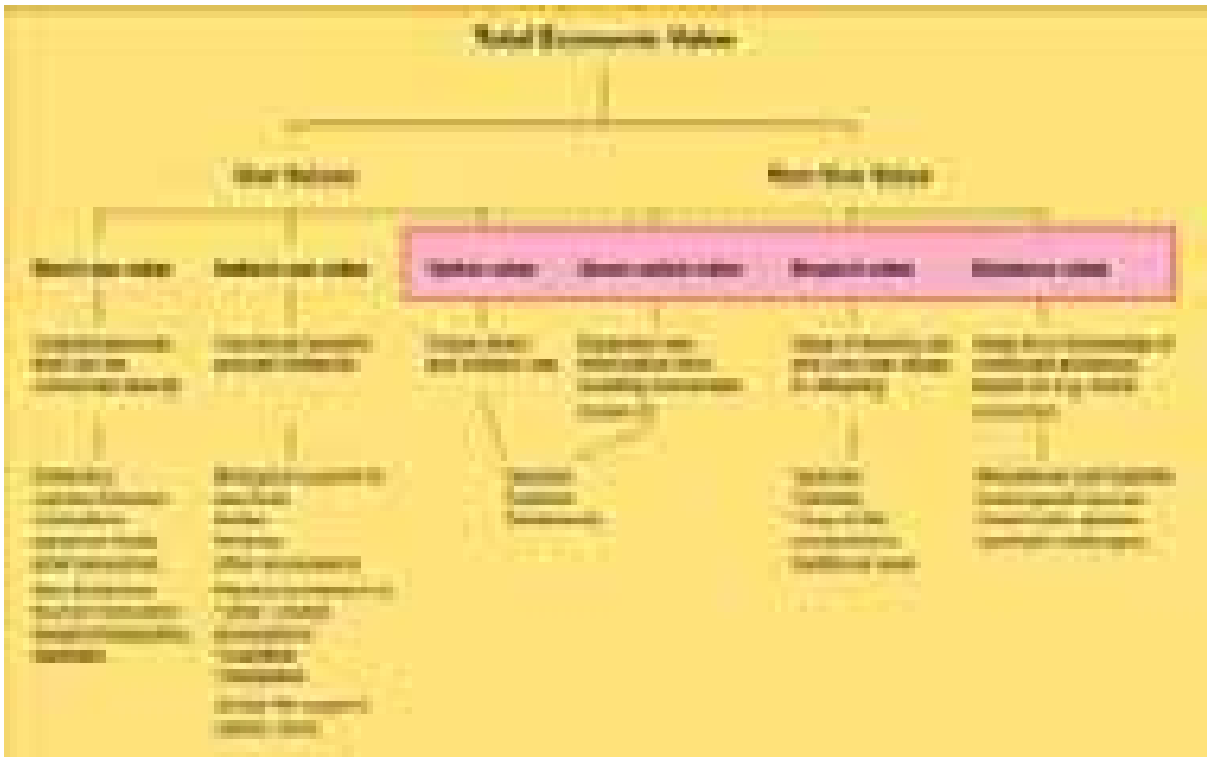


Figure 2.6. Total Economic value for Coral Reefs
(From. Cesar, 2000)

Table 2.5. Examples of Coral Reef Valuation Studies and Estimated Reef Values

Study	Use Valued	Study Location	Technique used	Estimated value (US$)
Thur (2003)	Recreational value	Bonaire Marine Park	Contingent valuation Conjoint analysis	1.7 to 3.8 million per year
Spurgeon (1998)	Habitat rehabilitation	Worldwide	Replacement Cost	10,000 to 6.5 million per hectare
Ministry of Home Affairs Housing and Environment (2001)	Coastal Protection	Maldives	Replacement Cost	9,000 per linear metre of shoreline
Riopelle (1995)	Total Economic Value	West Lombok, Indonesia	Production function	5,800 per hectare of reef
Seenprachawong (2002)	Recreational value	Phi Phi Islands, Philippines	Travel cost method	6,243 per hectare per year

2.7. Conclusion

Coral reefs are one of the most diverse and biologically productive ecosystems in the world. There are at least tens of millions of people living in coastal countries who have their livelihood dependent on reef resources. The Maldives is ranked as the seventh largest country in terms of the reef area it occupies. The study region of Baa Atoll occupies about 6% of the reef area in the Maldives.

Outside the Western Pacific, the Maldives is considered the most heavily dependent country on coral reef resources. The Maldive islands are formed of carbonate sediment grown in the surrounding reef ecosystem, the reefs protect these islands from ocean waves and the economy of the Maldives is heavily dependent on coral reefs. Fishing and tourism are the two main economic activities of the Maldives and in Baa Atoll. Fishing is the highest single generator of employment in the Maldives and tourism is the highest contributor to the national GDP.

The continued use of reef resources without sustainable use practices and conservation measures may lead to degradation of these precious resources. Increase in population and economic growth in the Maldives has changed the traditional ways of interacting with the reef environment. These changes include increases in the variety of fisheries, more intensive coastal development from introduction of tourism and tourism related recreational use of reefs. Human

impacts have been identified as the major risk to coral reefs in the world including the Maldives. An assessment of risks to coral reefs show that on a global scale the reefs in the Maldives are at low risk (Bryant et al. 1998).

Many countries are realising the risk to coral reefs and taking initiatives to protect them and introduce sustainable use practices. There are two main legislations directly related to coral reef management and conservation in the Maldives. These are "The Fisheries Law of the Maldives 1987" and "The Environment Protection and Preservation Act 1993". In addition, specific regulations such as restricting coral mining, regulating fishery and banning export of certain marine products have been adopted. Most of the conservation regulations in the Maldives do not have adequate monitoring or enforcement mechanisms.

Like many of the protected areas of the world, MPAs in the Maldives lack effective management and enforcement of the conservation guidelines. According to United Nations Development Programme (2004), the main reason for this is a lack of information and understanding of the true value of reef resources. The concept of TEV could be a valuable tool to help alleviate some of the pressures causing coral reef degradation. Understanding the economic value of reef resources could help create the political support necessary for protection of reef resources worldwide and in particular in the Maldives. Costanza et al (1997) estimates the value of the world's coral reefs to be worth about US$375 billion each year.

3. Research Methodology and Research Methods

3.1. Introduction

This chapter provides a discussion of the methodology and methods used for this research. Figure 3.1 outlines the research methodology employed in this study, nested within the broader framework of the thesis. This chapter first explains the theory behind the research approach, followed by details of the individual methods employed. The former includes:

Section 3.2 – a brief introduction of economic valuation of environmental resources

Section 3.3 – a description and critique of the techniques available to value such resources

Section 3.4 – a description of the economic theory of Willingness to Pay (WTP) and Willingness to Accept (WTA)

Section 3.5 – a description and critique of the Contingent Valuation (CV) method used in this research.

Section 3.6 – a discussion of some of the application of CV in valuing the se of MPAs

The individual methods include:

Section 3.7 – a description and discussion of focus group interviews and methods employed in the development of the proposed Improved Management Scenario (IMS)

Section 3.8 – a discussion and description of the CV survey used in this research

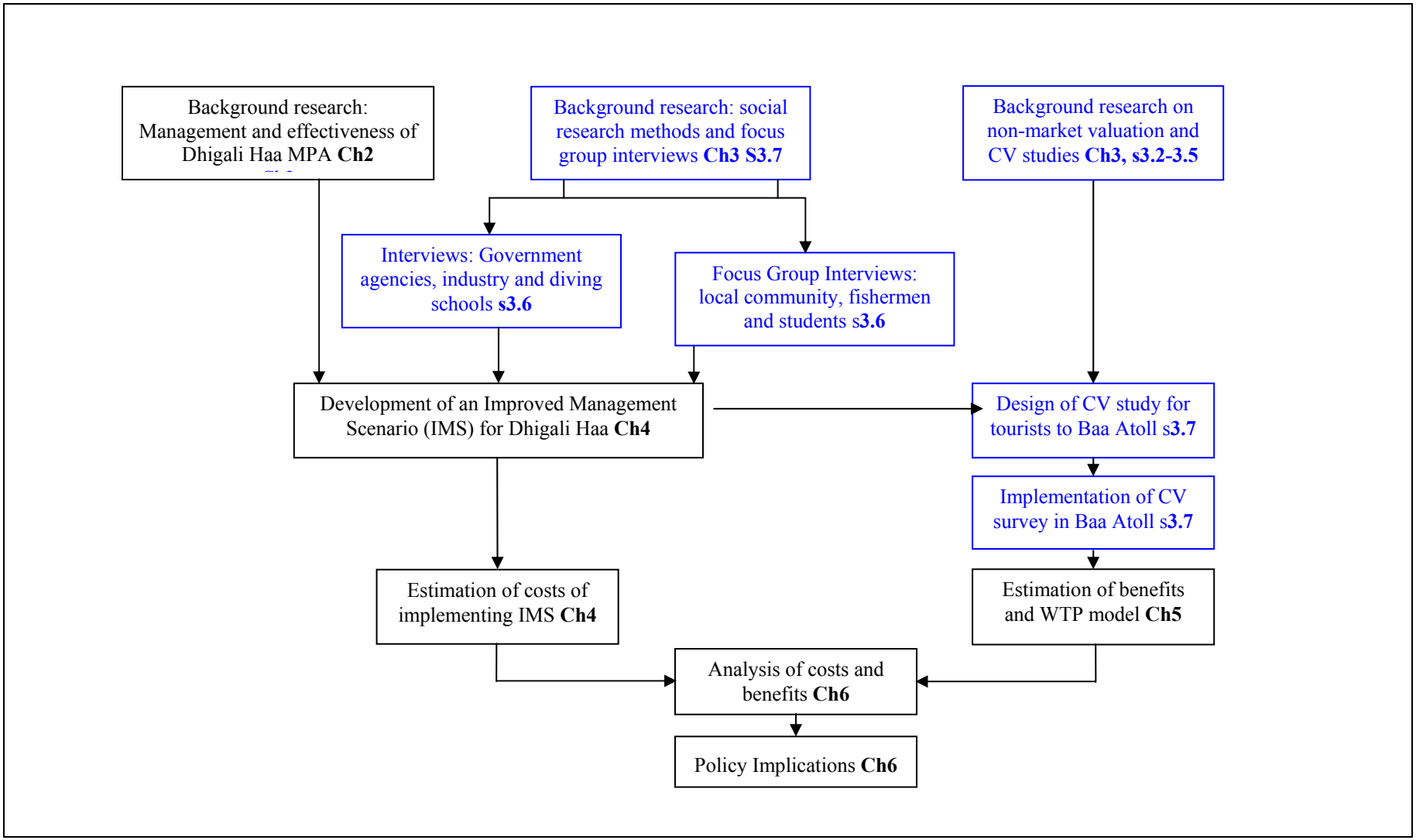


Figure 3.1. Conceptual Diagram of Research Methodology

3.2. Economic Valuation of Environmental Resources

Environmental resources provide valuable flows of services to people. Examples include:

1. providing material inputs such as fossil fuel, water and fish to our economy,
2. providing life-support systems such as a breathable atmosphere,
3. providing amenity services such as recreation, scenic view and other passive uses, and
4. dispersing, transforming and storing of waste from our economic activities (Champ et al. 2003).

In a reef environment context, these four types of services include uses such as fisheries and mining of coral, formation and protection of coastal land, recreational tourism and assimilation of waste. Environmental resources are considered public goods and are considered as 'non-rival' in consumption and 'non-excludable' in provision (Begg et al. 1987). Hence such resources have often been undervalued and at worst been treated as free goods leading to their overuse. Figure 3.2 gives a categorisation of goods and services of reefs in the context of Total Economic Valuation (TEV) for the Maldives.

The use of these resources often has to be managed by government policy determining their use and allocation. For example in the Maldives, traditionally fishing had been carried out for local use without restrictions such as access to fishing grounds or limitations of the number of fish caught. Presently the government imposes regulations such as issuing permits for fishers engaged in the yellow fin tuna fishery, setting areas where fishing is permitted and setting quotas for export (Ministry of Fisheries, Agriculture and Marine Resources, Maldives, accessed on 10 July 2007, http://www.fishagri.gov.mv/).

Any proposed policy change has the effect of changing the quantity or quality of environmental goods and services and has impacts on social welfare; which can be defined as the summation of the welfare of all the individuals in a society. For example, a policy decision to protect a coral reef by banning fishing and allowing recreational diving excludes from fisherman the fish and bait fish to which they previously had access. On the other hand divers will get more and perhaps enhanced use of the reef. This policy change may increase the number of fish in the reef but may also lead to increased damage from diving pressure. This simple example shows that there are a complex web of interconnected costs and benefits associated with any policy change. As a result, a cost-benefit analysis is often done to determine if the proposed policy is of net benefit to society.

Total Economic Value		
Use values*		Non-use values
Direct uses	**Indirect uses**	**Existence values**
Extractive: Fisheries Recreational fishing Coral and sand mining Curios for tourism	**Biological Support:** Marine and coastal habitats Marine life Sea birds	Endangered species Threatened reef habitats Charismatic species Cherished reefscapes
Non-extractive: Tourism Recreational Research Education Aesthetic	**Physical Support:** Formation of islands Protection of land Protection of ecosystems Waste assimilation	
	Global life support: Calcium store Carbon store	

* Use values include option values that reflect a premium or discount on direct and direct use values in the presence of uncertainty

Figure 3.2. Total Economic Valuation of Reefs Applied to the Maldives.
Adapted from Yeo (1998)

The theory of economic valuation is based on what people value, often expressed through market prices. Economists assume that individuals rather than the government are the best judges of what will make them better off or worse off. Individuals express their preferences through choices they make subject to constraints such as income and time. Those individuals in a given situation will tend to make choices which give them the highest level of utility (satisfaction gained). These preferences can be estimated in monetary terms or sometimes as a revealed or stated preference (Freeman 2003). The value of a reef ecosystem would be determined by what it is worth to the people who use it or at least value its existence. For example, a valuation study of sharks in the Maldives estimated that the value of a grey reef shark to fishermen was a one-off benefit of US$32 compared to a benefit flow of US$3,300 a year if conserved for viewing by recreational divers (United Nations Development Programme 2004).

3.3. Resource Valuation Techniques

There are a variety of valuation techniques developed to determine the value of environmental resources. Material resource uses can often be valued by direct market prices but with non-market goods such as environmental resources, non-market valuation (NMV) techniques have to be applied. For example, the monetary value of uses such as fishing can usually be obtained

directly and relatively easily from market prices for fish and the inputs needed to collect them. In contrast, it is not easy to assign dollar values to public environmental goods such as dive experiences in public marine parks when there are no market prices. These, less financially tangible benefits often fall into the life-supporting, amenity or waste disposal categories of resource use. Cesar (2000) identifies three methods for eliciting the value of goods and services provided by coral reefs. These are:

1. directly obtaining values or expenditures,
2. using the market data indirectly to obtain information about values and expenditures (revealed preference), and
3. survey based methods which use hypothetical markets and scenarios (stated preference).

The latter two categories given above are the main approaches for NMV, revealed preference and stated preference. Revealed preference methods are based on observing the actual behaviour of individuals. In contrast, stated preference methods are based on valuation statements individuals make in response to survey questions regarding proposed environmental policies. Table 3.1 summarizes some of the revealed and stated preference techniques used to value environmental goods.

On the basis of background information I reviewed on valuing public goods, I chose to use a stated preference method. The CV technique is used for this research as it can be used to estimate both use and non-use values while other techniques such as the travel cost method and hedonic pricing method can only be used to determine use values. In addition, CV can in principle provide estimates of theoretically correct measures of welfare change caused by changes in policy, whereas other techniques provide estimates of proxy measures of welfare change. This will be explained in detail in Section 3.4.

Table 3.1 Some Available Non-Market Valuation Techniques

Valuation Technique		Description
Revealed Preference	Production Function	Assess the direct and indirect relationship between the loss of an (unpriced) environmental resource and associated changes in (priced) economic output
	Replacement/Relocation Cost	The cost of replacing or relocating a habitat is assumed to be equal to the value of the habitat
	Aversion/Preventative Cost	The value of the habitat is assumed to be the cost of the measures needed to prevent damage to the habitat
	Travel Cost	The travelling time and cost to a site are analysed to determine a recreational value for the site
	Hedonic Pricing	This technique analyses the environmental attributes and its effect on the overall market price
Stated Preference	Contingent Valuation	A questionnaire based survey technique, asking a sample of individuals their willingness to pay for a specific change in environmental policy

Source: Ceasar (2000) and Champ (2003)

3.4. The Economic Theory of Willingness to Pay and Willingness to Accept

Compared to the traditional measure of consumer surplus used for measuring consumer benefit, Hicks (1943), proposed more accurate measures. These measures can be organized according to two criteria: whether the policy under consideration would alter price or quantity/quality and whether the individuals affected have a right to (or entitled to) the changed policy or to the status quo. Table 3.2 gives a summary of the four welfare measures proposed by Hicks. For example, compensating surplus is used when the individual only has a right to the status quo and equivalent surplus is used when the individual only has a right to the change.

These measures are defined in dollar terms, and involve either a maximum willingness-to-pay (WTP) or minimum willingness-to-accept (WTA) compensation in order to maintain utility at the specified level (Mitchell and Carson 1989). For example, divers visiting an MPA might be willing to pay an amount to improve management at the MPA and hence increase their satisfaction from the dive but this may mean excluding fishermen from using the reef. If the fishermen are deemed to have a right to the status quo, they may be willing to accept a compensation to accept changes that would otherwise make them worse off.

Table 3.2. Appropriate Welfare Measures

	Right to status quo	Right to change
Quantity/Quality improvement	Compensating Surplus (WTP)	Equivalent Surplus (WTA in lieu of)
Quantity/Quality deterioration	Compensating Surplus (WTA)	Equivalent Surplus (WTP)
Price decrease	Compensating Variation (WTP)	Equivalent Variation (WTA)
Price increase	Compensating Variation (WTA)	Equivalent Variation (WTP to prevent)

Adapted from Mitchell and Carson (1989), p25

Given that many of the reef valuation techniques are based on individuals' preferences (giving the highest utility), the maximum amount of money they would be willing to pay to get the good or service can represent the value they place on the item. Suppose that there are *n* conventional market (private) goods $x_1, x_2, \ldots . x_n$ and one non-market (public environmental) good, q^o. An individual's preferences over the consumption of combinations of these goods could be represented by a utility function, $U=U(\mathbf{X}, q^o)$. The individual's utility maximisation problem is given by:

$$\text{Max } U(\mathbf{X}, q^0) \qquad \text{subject to } \mathbf{P_X}.\mathbf{X} = M \tag{3.1}$$

Where $\mathbf{P_X}$ is the prices for the private goods and M is the income of the individual and the current level of the public good q^o is available at no cost. Solving for Equation (3.1) yields the individual's Marshallian demand functions $\mathbf{X}^*(\mathbf{P_X}, q^o, M)$. Substituting these demand functions into the individual's utility function yields his or her indirect utility function $V(M, \mathbf{P_X}, q^o)$.

In relation to my study, the compensating surplus is an appropriate measure of an individual's welfares based on the fact that tourists visiting Baa Atoll only have a right to the status quo and not to the improved management at Dhigali Haa. If an individual is asked if he or she would be willing to pay for improved management at an MPA, at a given price, P, then the probability that the individual will be willing to pay is only if his or her utility from paying for the good is greater than not having to pay. In terms of the indirect utility function this could be represented as:

$$V(M-P, q^1) > V(M-0, q^0). \tag{3.2}$$

From Equation (3.2), the respondent will answer yes only if the utility he or she derives from the improved MPA (q^1) and paying the price (P) is higher than not having the improved MPA (q^0) and not paying the price ($P=0$). The value that the individual puts on the improved management is his or her compensating surplus (assuming the individual does not have a right to the

improvement) or maximum WTP from income. The WTP can be defined mathematically as the value that equates:

$$V(M - WTP, \mathbf{P_X}, Q^1) = V(M, \mathbf{P_X}, Q^0) \quad (3.3)$$

The trade-off that an individual is prepared to make between income and environmental quality, whether as WTP or WTA should depend on (i) the initial and final level of the good in question (e.g. initial and final quality of reef), (ii) own income, (iii) the prices of all relevant substitute or complementary goods, and (iv) own preferences. While not directly observable, the preferences of a respondent can be proxied by observable characteristics such as demographics and attitudinal measures. The internal validity of the WTP responses obtained in a survey can be checked by regressing WTP on variables (i)-(iv), and showing that WTP correlates in predictable ways with socio-economic variables (Carson 2000).

3.5. The Contingent Valuation Method

The Contingent Valuation (CV) method is one of the most frequently used stated preference techniques (Boyle 2003). CV is a survey based method which presents people with proposed policies that would result in changes to environmental amenities[6]. Survey respondents are then asked to state how much they value these changes in dollar terms. In particular, a CV survey is used to estimate people's maximum WTP or minimum WTA compensation for proposed changes in an environmental amenity. The welfare estimation in this study is based on Hicksian compensating surplus (WTP). That is the amount of money that must be taken away from an individual for him to enjoy improved reef quality at Dhigali Haa.

Many applications of the CV method deal with environmental goods and services such as improvements in air or water quality and national parks, though the method is used in other policy areas such as public health care or transportation policy (Hammitt and Graham 1999; Schwab-Christe and Soguel 1995).

There are many doubts and criticism on the use of CV methods. From economists, the basic criticism is that actual monetary transactions do not occur and that respondents cannot be trusted to decide or reveal what is in their best interest unless money changes hands (Bateman and Willis 1999). As CV is based on a hypothetical scenario respondents will not give real values of their WTP. In an empirical study testing this hypothetical bias Champ and Bishop (2001), asked respondents whether they would be WTP a specified additional amount on their electric bill for

[6] Other stated preference methods, such as contingent ranking and conjoint analysis asks respondents to rank pairs of policy/cost combinations.

one year to purchase wind-generated electricity for their household. This study showed that half as many people respond positively when real donations are involved and this may be due to free-riding effects. That is, individuals could avoid voluntary payment for public goods or services because public goods benefit everyone, regardless of whether any individual has paid his or her share. On the other hand, a meta-analyses of hypothetical bias in CV studies showed that the majority of studies found that hypothetical bias may not be a significant problem with only a few finding contrary evidence (Murphy et al. 2005).

One of the main issues in the debate about the ability of CV to elicit true WTP is the so-called embedding phenomenon. In particular, when multiple policies or goods are valued, valuation is not as sensitive to scope as might be expected, and is more sensitive to order of policies presented than theory would predict (Hackl and Pruckner 2005; Nunes and Schokkaert 2001). Applied to my survey, the WTP response from respondents could be the same for conservation of one MPA, two or ten MPAs. Kahneman and Knetsch (1992) postulated that this valuation pattern was caused by CV respondents deriving moral satisfaction or a warm glow from the thought of giving per se. Prominent critics of the CV method believe that due to embedding and warm glow effects, the method does not elicit true WTP and therefore should not be used in cost-benefit analysis (Hausman 1993). This issue has been long in debate. Nunes and Schokkaert (2001) have shown empirically that the embedding problem in CV responses is not from inconsistent response behaviour, but rather a stable and measurable warm glow component in individual preferences. Hence, their results support the use of original uncorrected WTP results from CV studies. Consistent with Nunes and Schokkaert (2001), an empirical study by Hackl and Pruckner (2005) exploring warm glow effects from various payment vehicles, found that warm glow effects did not matter much in practice and, hence, did not find sufficient support for the theoretical objections against CV studies due to warm glow effects.

Another problem associated with CV surveys is the opportunity they provide for respondents to engage in strategic behaviour when responding to CV surveys. Respondents could either under-report WTP if they believed they actually have to pay the amount or over-report WTP if they believe they may not actually have to pay but hope to influence the provision of the good or service in question (Hackl and Pruckner 2005). For my application, tourists visiting Baa Atoll may have an interest in conserving marine biodiversity and hence may give a high WTP to the CV survey hoping to improve management at MPAs, while knowing they may not visit Baa Atoll again and hence may not actually have to pay for conservation. Carson et al. (2001) suggests that strategic behaviour varies depending on the elicitation format used in CV surveys and that while empirical studies show that such behaviour is present, it is not as prevalent as

economists might predict. There may not be well developed theories as to what exactly strategic respondents will do, because the questions in CV are supposed to be hypothetical. But economists have worried that if people do take it seriously, and as if non-hypothetical, then they will have incentives to be strategic. There are many such issues in the design and administering of CV surveys and these will be discussed in brief in Sections 3.5.1 and 3.5.2.

Another potential problem identified by critics is that many CV studies have shown much wider empirical differences between WTP and WTA (Bishop and Heberlein 1986; Hammack and Brown Jr. 1974; McDaniels 1992). Mitchell and Carson (1989) have proposed the following explanations for an excessive WTP/WTA discrepancy: (1) rejection of the WTA property right, (2) the cautious consumer hypothesis (where WTP is understated by reason of habit), (3) prospect theory – that individuals value losses more heavily than gains. On the other hand, Hanemann (1991) has shown that economic theory would predict that WTP and WTA should differ, at least to some degree. In particular, the lower the elasticity of substitution between the goods being valued and other private substitutes and the lower the amount of available substitutes, the greater the difference should be between WTP and WTA. Also WTP should differ from WTA because of income effects. That is, a consumer who will be given compensation has a higher income from which to make valuation decisions than a consumer from whom income will be taken away (Nayga Jr. and R.Woodward 2005).

Concerns over the validity of CV results have led to various panels making recommendations as to how they should be conducted. An example is procedures developed by the National Oceanic and Atmospheric Administration (NOAA) panel of 'blue ribbon economists'(Arrow et al. 2001). Initial controversies and criticism of the CV method have led to investigations of the method and its credibility and thus have improved CV methodology and studies as well as guidelines and best practices. Figure 3.3 gives a general overview of the steps normally required in a CV study (Boyle 2003).

Many of the issues and controversies are still ongoing debates. Despite these, many economists believe that a well designed CV study can provide valuable information to guide public policy (Boyle 2003; Hanemann 1994; Mitchell and Carson 1989). For applications like habitat preservation that involve significant non-use values, CV may be the only method available.

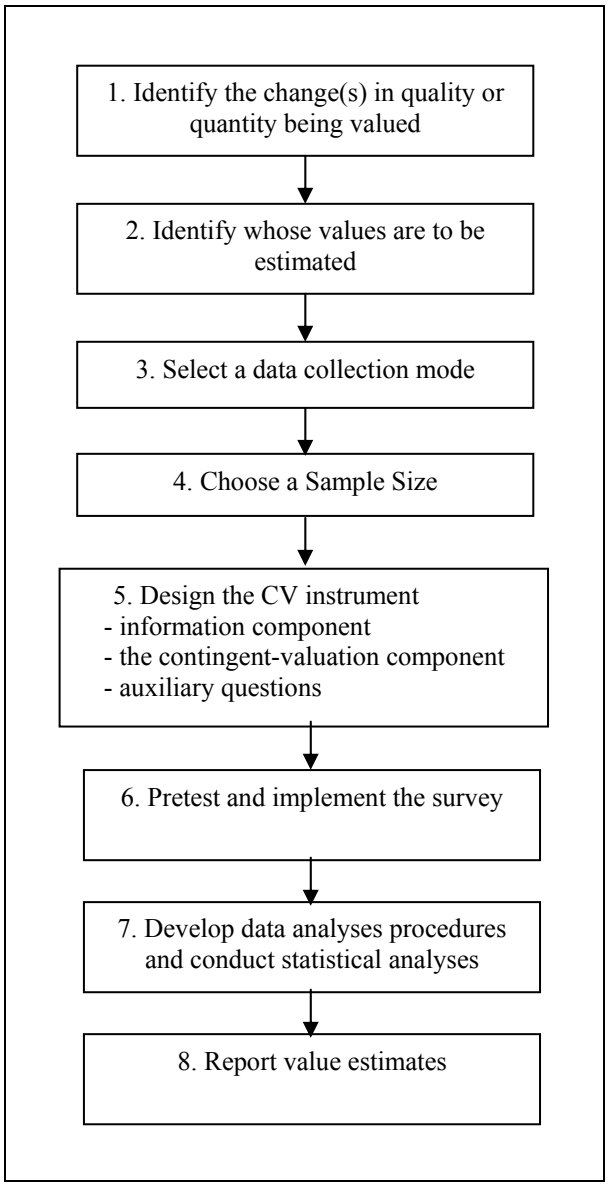


Figure 3.3. Steps in Conducting a Contingent Valuation Study
Adapted from Boyle (2003)

3.5.1. The Design of the CV Instrument

As identified by many CV literature surveys, the design of the CV survey instrument is crucial to obtaining reliable and accurate information from respondents. The "best practice" design of CV surveys has evolved with new findings and many practitioners propose that a good CV design should contain the following:

1. an introductory section that helps set the general context for the decision to be made,
2. a detailed description of the good to be offered to the respondent, the institutional setting in which the good will be provided and the manner in which the good will be paid for,
3. a method by which the survey elicits the respondent's WTP,

4. follow-up questions about why respondents answered certain questions the way that they did, and
5. a set of questions regarding respondent characteristics including attitudes and demographic information (Boyle 2003; Carson 2000; Food and Agriculture Organisation 2000).

A well-planned CV study should provide survey respondents with the intended objectives of the proposed policy change and its probability of success, all in a clear and understandable form. Descriptions of the changes in resource conditions resulting from the proposed policy change are often used to convey this information (Boyle 2003; Mitchell and Carson 1989). My research describes the present health of the reef at Dhigali Haa and the changes expected to the status quo with the proposed improved management.

It is important that the non-market good or the changes in the provision of the good are described in a non-technical form that the respondents can understand as the accuracy of CV studies is very much dependent on the respondents understanding the goods to be valued (Carson et al. 2001). This description of the scenario should include a range of available substitutes. It is equally important to provide adequate information on how the change will be provided and paid for as the payment and provision mechanism can substantially influence respondents' WTP (Mitchell and Carson 1989).

The target audience of the CV survey or whose value is to be determined should be identified clearly so that the CV questionnaire can be designed in a way that can be understood by them. Although Dhigali Haa is used by both locals and tourists visiting Baa Atoll, I have chosen to target this CV survey only for tourists visiting Baa Atoll. The main reason for this is that, compared with local people, tourists would be more familiar with the concept of paying for environmental goods for recreational purposes and also with taxes and user fees associated with enjoyment of natural resources. For example, other diving destinations such as the Caribbean and many countries of South-East Asia implement user fees for management of the MPAs (Depondt and Green 2006; Thur 2003). Tourist surveys conducted in the Maldives suggest that the tourists visiting the Maldives are highly educated, have a keen interest in the marine environment and have visited many similar destinations (Cesar et al. 2000; Salih 2000). In contrast, recent experiences of conducting a WTP survey in Baa Atoll to find households' WTP for waste collection and disposal indicated that, this kind of survey was very new to the local community and the legitimacy of paying for this service was widely rejected (Seamarc 2006). In light of this study, where the service to be valued was familiar to the local people, I believe the

results would have been worse for valuing a marine area, which is thought of locally as a pure public good (United Nations Development Programme 2004).

Several question formats can be used to elicit a person's willingness to pay. One is to ask open-ended questions on the maximum willingness to pay for a given change. Some of the other methods used are bidding games, referendum/dichotomous choice and payment cards. Bidding games involve presenting the respondents with a price they could pay for a particular change or program, and increasing (decreasing) the price until a negative (positive) response is given by the respondent. The dichotomous choice is similar but it asks the respondents a single price and requires a 'yes' or 'no' response to the particular price. The payment card method presents the respondent with a scenario and several WTP categories printed on a card and the respondent is asked to choose the category containing his or her preferred maximum amount. Table 3.3 gives a comparison of the three main types of elicitation format used.

Table 3.3 Comparison of CV Elicitation Formats

Characteristics	Open Ended	Dichotomous	Payment Card
Incentive compatible	no	has some desirable properties	low
Bid design	not required	required	required
Responses	continuous $[0,+\infty)$	interval (Above or below a bid threshold)	interval (within a $k+1$ interval; k is number of bid amount on card)
Potential Problems	zero bids, fair share responses	anchoring, yea saying, voting as good citizen	anchoring

Source: Boyle (2003), p 137

Perhaps the most commonly used elicitation format is the dichotomous choice. This method is popular in part because dichotomous choice questions are a hypothetical analogy to real world referendum questions, which provide incentives for people to answer honestly (Boyle 2003). That is, a respondent faced with a question about whether he or she would be willing to pay $X to see a project implemented, has nothing to gain by answering other than truthfully. The NOAA panel economists are of the opinion that referendum type questions tend to reduce the tendency to overstate (Arrow et al. 2001). On the other hand, comparisons of WTP responses from open-ended and dichotomous choice methods by Brown et al. (1996) shows that dichotomous choice responses tend to overestimate the WTP more compared to open-ended format. Critics of dichotomous choice elicitation also point out that this method can more readily lead to an upward bias in estimates of WTP, as uncertain respondents 'anchor' on the provided dollar

amount and the amount as a signal of a 'reasonable' amount to pay (Boyle 2003). The payment card method is also known to have similar anchoring problems (Yeo 1998).

According to Arrow et al. (2001), open-ended questions are unlikely to give accurate information as respondents tend to overstate their WTP both because of the hypothetical nature of the CV and also to strategically influence the outcome of the survey. Even so careful design of the CV survey should include questions to detect if the respondent has overstated or not. The open-ended format tends to deliver a significant number of zero responses. These responses may be either true zero values or protest bids where the zero value may be a protest against the payment vehicle, or some other premise of the CV survey (Boyle 2003). Carson (2000) suggested the use of follow-up question; a reason why they chose to answer the elicitation question in a particular manner; to help distinguish between true zero responses and protest bids. The open-ended format has the advantages of giving a continuous distribution of WTP responses, a bid design is not required and would avoid respondents 'anchoring' on the provided bid amounts (Boyle 2003).

After considering the different elicitation methods available and their methodological issues, I have chosen to use an open-ended format for this research. A difficulty in using this format would be that respondents might find it difficult to give a specific dollar value if they are not familiar with the policy being valued (Brown et al. 1996). Based on the likely experience of the tourists being targeted in my study, I decided that an open-ended question format was reasonable to use in this survey.

3.5.2. The Administration of the CV Instrument

The population to be sampled should be chosen carefully by identifying those who would be affected by the proposed policy change and so would have an interest in considering its cost or benefit. The CV survey in this research is targeted to tourists visiting Baa Atoll. Recall that Baa Atoll surrounds Dhigali Haa and that visitors to the site would be very likely to be living or visiting on the Atoll. While tourists who dive at Dhigali Haa would get direct use benefits, a tourist who may not visit Dhigali Haa may also be willing to pay to contribute to the protection of the reef in the knowledge that it would be preserved for future generations. Hence, those who do not visit Dhigali Haa may have a non-use value for the reef. As the CV method captures both use and non-use values the population to be sampled are all tourists visiting Baa Atoll.

Random sampling is most appropriate, as this would ensure that all members of the relevant population have a positive and equal probability of being included in the sample. According to Mitchell and Carson, (1989) CV studies require large sample sizes because of a large variance in

WTP responses. The sample size required will depend in part on the elicitation method used in the survey. While the open-ended ended format yields more information per person than dichotomous choice, for example, it also generates a large number of zero responses. Therefore, a sample size should be chosen taking into account the anticipated zero responses.

The three main methods of administering surveys in CV are by mail, telephone and in-person interviews. Although telephone and mail surveys are less costly, they tend to generate lower response rates compared to in-person interviews. Many CV practitioners recommend in-person interviews as they allow the surveyor to use visual aids, explain anything that is unclear and answer questions (Arrow et al. 2001; Boyle 2003). Hence, the data collection method initially chosen for this survey was in-person surveys. Pre-tests and pilot studies to test how well the survey works should be done prior to actual administration of the survey.

3.5.3. Handling and Analysis of CV Survey Data

Prior to analysis of the collected data, basic checks should be done for errors. This includes deciding how to treat protest bids (or zero values from individuals who support the project but reject the payment scenario) or unrealistically large WTP values from respondents reporting low incomes (Boyle 2003).

The endpoint of the CV survey is the development of a WTP function and the estimate of the net economic value to society of the policy proposal. Assuming the CV sample is representative of the population of interest, the response rate is high and an open-ended format is used this value can be calculated simply by measuring the mean WTP of the sample, and multiplying this by the size of the population represented by the sample[7]. More formally, responses to open-ended questions are typically analysed by computing the arithmetic mean:

$$\overline{WTP} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad (3.4)$$

Where n is the sample size and xi is the reported WTP amount of the i^{th} respondent.

Most CV studies estimate a WTP function to test whether the survey has obtained results that accord with economic theory, or at least intuition. WTP responses are regressed on respondent demographics, income, past recreational use, and various attitude and knowledge questions concerning the good (Carson 2000). A simple format of such a WTP equation is given below.

$$WTP_{ij} = f(V_{ij}, Q_j, I_i, S_i, X_i) \qquad (3.5)$$

Where:

[7] Data from dichotomous choice and payment card methods require more complex statistical analysis.

WTPij = individual i's willingness to pay for asset j
Vij = number of visits by individual i to site j
Qj = environmental characteristics of site j
Ii = income of individual i
Si = relevant socio-economic characteristics of individual i
Xi = other explanatory variables of individual i

3.6. The Application of the CV Method

Many revealed preference techniques such as the Production Function, Replacement Cost and Travel Cost methods have often been used to value reef resources (Dixon et al. 2000; Nam and Son 2001; Pendelton 1995; Riopelle 1995). While such methods can estimate use values only, the CV method has the advantage of being able to estimate both use and non-use values. Many recent studies have used the CV method to value conservation and or recreational use of MPAs. This section looks at some applications of CV in valuing MPAs.

One of the pioneer work in the application of the CV method in valuing MPAs was done by Dixon et al (1994) in 1991 to obtain a visitors' general perception and WTP user fees for the Bonaire Marine Park in the Caribbean. Using an open-ended format for elicitation, the mean WTP user fee for Bonaire Marine Park was found to be US$27.40 per diver per year. The study also estimated a consumer surplus of US$325,000 based on the set admission fee of US$10 and the number of divers willing to pay the amount. A more recent CV study of Bonaire Marine Park done in 2003 estimated the mean WTP user fee using dichotomous choice and payment card methods to be between US$62.50 and US$122.36 per diver per year (Thur 2003). Thur (2003) attributed the higher WTP estimates due to elicitation method used and also the fact that while respondents for his survey were familiar with the concept of paying an entrance fee, Dixon et al. (1994) had asked the WTP for a potential entrance fee which at the time was not in effect and therefore would be unfamiliar to the divers. These two studies clearly demonstrate the affect the choice of elicitation formats and the level of understanding of the survey scenario by respondents could have on their WTP responses. The higher value in the latter study could also reflect an increased awareness on the need for conservation of marine resources and, hence, divers placing a higher value on the use of the MPA.

In more recent years, the CV method has become a popularly used method to value MPA use or conservation. Table 3.4 gives a summary of some of the studies which use the CV method to value MPA use and or conservation. Most of the available CV studies estimate a WTP to access the MPAs through an entrance or user fee.

Table 3.4. Results of Some CV Applications Used to Value MPAs

Ecosystem and Original Study	Elicitation Format	Payment Vehicle	Valuation Results: Mean WTP
Hon Mun Islands MPA, Vietnam (Nam and Son 2001)	Payment card	A per visit user fee	Local Visitors: US$1.24 Foreign visitors: US$1.85
Phi Phi Islands, Thailand (Seenprachawong 2002)	Dichotomous choice	A per annum payment for 5 years to be paid into a trust fund	Local Visitors: US$7.17 Foreign visitors: US$7.15
Pulau Payar Marine Park, Malaysia (Yeo 1998)	Payment card	A per visit entrance fee	All Visitors: US$4.20
Curaçao and Jamaica (Spash 2000)	Open-ended	A per annum payment for 5 years to be paid into a trust fund	Curaçao : Local Visitors: US$25.28 Foreign visitors: US$25.12 Local Visitors: US$28.00 Foreign visitors: US$23.46

In my research, I would be applying the CV methodology to estimate WTP a user fee to access Dhigali Haa MPA in Baa Atoll as well as a WTP a conservation fee for improving management at Dhigali Haa whether or not the respondent intended to visit Dhigali Haa. The details of the methods used for this study are given in the following sections. Section 3.7 describes the development of the background information needed for the CV survey instrument and also the local consultations held to obtain the views of the local community on MPA establishment and management. Section 3.8 gives details of the CV survey design and its implementation.

3.7. Local Consultations and Development of the Proposed Improved Management Scenario (IMS)

As the CV survey does not include the local population of Baa Atoll, this research does not estimate economic values placed by local community on Dhigali Haa MPA. Although this was not possible, focus group sessions for local community groups were held to discuss their views on the concept of MPAs to protect biodiversity and the associated benefits and costs of stricter protection and to probe how they viewed involvement in conservation measures. These discussions also served the dual purpose of obtaining information to improve the proposed IMS for Dhigali Haa. This IMS was used in the information component of the CV questionnaire and details of the development of the IMS are given in Section 3.7.1

I used a focus group interview method for these consultations as local island communities in the Maldives are familiar with this type of research method (Live and Learn Environmental

Education 2006; Seamarc 2006). Focus groups are a qualitative survey method which brings together selected representatives of a community to discuss a chosen topic or concept to be tested (Edmunds 2000). A main idea behind the use of focus groups is that group discussions can help easily explore and clarify stakeholder views compared to individual interviews. They can also generate more critical discussions of a given policy issue (Kitzinger 1995). As focus groups encourage participants to explore the issues of importance to them and based on literature on the use of focus groups, I believe this would be an appropriate research method to use for consultations with local groups.

I selected four islands for the focus group interviews. The islands were selected based on importance of fishing and tourism as economic activities, population and proximity to Dhigali Haa and the resorts. Table 3.5 gives details of the islands where the focus group interviews were conducted. The islands visited comprise 60% of the population of Baa Atoll.

The stakeholder groups that I aimed to include in the focus groups are fishermen, community development groups and school children[8]. The fishermen as the local users of Dhigali Haa would have crucial knowledge of the use Dhigali Haa and related issues and hence compared to the other stakeholders would identify more strongly with the issue of management of the MPA. The discussions and thoughts of the rest of the stakeholders would be more in terms of impacts on the community rather thinking in terms of personal livelihood. For this reason, I anticipated that the discussions of the focus groups would have a better group dynamic if the fishermen were interviewed as one stakeholder group and the community development groups as another. As youth and school children would be the future generations involved in such issues, I included students as a third separate focus group.

Table 3.5. Characteristics of Island chosen for the Focus Group Interviews

Island	Population	Fishing Activities	Tourism Related Activities
Dharavandhoo	740	Reef Fishery Live Bait Fishing	Direct Employment
Eydhafushi	2409	Tuna Fishery Reef Fishery Live Bait Fishing Sea Cucumber Fishery	Direct Employment Island Visits
Maalhos	392	Reef Fishery Live Bait Fishing	Direct Employment Island Visits and Cultural Centre
Thulhaadhoo	1759	Tuna Fishery Shark fishery Live Bait Fishery Lobster Fishery Sea Cucumber Fishery	Direct employment at resorts Handicraft and lacquer work Island Visits

[8] The community development groups included members of Island Development Committees (IDC), Womens' Development Committees (WDC), Youth Groups, Non-Government Organisations (NGO) and school educators.

I designed a set of structured questions to guide the discussion. The questions for the interview were translated into Dhivehi, the local language in which the interviews were conducted. Appendix 2 provides the guiding questions in English. These guiding questions included discussion areas for both focus groups. The questions for the fishermen were primarily aimed at finding out about i) their use of Dhigali Haa before it was declared a protected site in 1999, ii) any changes in use since Dhigali Haa became an MPA, iii) any issues with other users, iv) their views on management, v) how things could be improved (discussion of IMS), and finally vi) their role in management of the MPA. This would help me understand the problems of establishing and managing Dhigali Haa from the view of local users. Discussion of the IMS would also help in development of a more participatory approach to management of Dhigali Haa.

The questions for the community development groups and students were aimed at obtaining their views on i) the establishment of MPAs for biodiversity conservation, ii) the present management of MPAs and iii) discussion of the IMS in relation to Dhigali Haa. These discussions would provide me with the present level of involvement of the stakeholders during the establishment and subsequent management of the MPA, the amount of information available to stakeholders on MPAs and their management and the level of dissemination and understanding of such information.

3.7.1. Development of the Improved Management Scenario

The CV study used in this research estimates the value put by tourists visiting Baa Atoll to improve management at Dhigali Haa MPA and, hence, improve the quality of the reef. I developed the IMS primarily for use in the CV survey to describe the intended objectives and expected impacts of the proposed policy change. To this end, I collected background information on the present management regime of Dhigali Haa and surveyed the literature on effective MPA management elsewhere.

In view of the existing literature on Dhigali Haa I established that there are few studies and texts specific to Dhigali Haa, but a recent biodiversity assessment of Baa Atoll done under the AEC Project discussed some of the issues relating to MPAs and their management in Baa Atoll. Lacking published information, I collected information from different groups to obtain specific information about conditions at Dhigali Haa.

In the absence of any existing management plans for Dhigali Haa or any MPA in the Maldives, my resources to develop the IMS were limited to experiences of other MPAs of the world and management guidelines produced by conservation groups such as the International Conservation

Union for Nature and Natural Resources (Guénette et al. 2000; Pomeroy et al. 2004; Lead Agency for Park and Wildlife Services 2000). In order to ensure the IMS would be consistent with management policies planned by the Maldives government, I consulted the MPA Division of the Ministry of Environment in developing the initial IMS. Discussions from consultations with local community, resort management, dive centres and related government agencies were also included in the development of the IMS.

Table 3.6 gives a summary of the types of information collected from the various groups I targeted. Information from the government agencies and the AEC Project were obtained from communicating with officials in the respective agencies and also from information (unpublished government reports) provided by them. Information collected from resorts and dive schools were obtained by sending out questionnaires asking about diving in Baa Atoll and specific questions on conditions at Dhigali Haa. Appendices 3a-c provide the detailed questions I posed to each group.

Table 3.6 Background Information Collected from Different Sources

Target Group	Information Collected
Resorts and Diving Schools	- Use of Dhigali Haa including frequency of trips and characteristics of visitors - Present health/quality of the reef at Dhigali Haa - Observed changes in the health of Dhigali Haa over the recent years - Opinion of present management at Dhigali Haa
Government Agencies (Environment, Fisheries and Tourism Ministries)	- Use of Dhigali Haa and resource use conflicts - Present management policies and measures and their effectiveness - Future management plans and policies
Atoll Ecosystem Conservation Project, Baa Atoll	- Conservation objectives in Baa Atoll - Planned activities and initiatives for effective MPA management in Baa Atoll - Present status, local use and management of Dhigali Haa

According to the Coral Reef Alliance (2003), an effective management plan requires a thorough assessment of the on-the-ground situation and the incorporation of the views of local stakeholders need to be incorporated. Therefore, I used the planned focus group sessions with local communities to obtain their views and input into the proposed IMS. The details of these consultations are given earlier in this section. In addition to local stakeholders, the IMS was further discussed with relevant Government Agencies, the AEC Project and the tourism industry. The people consulted were from:

1. the Ministry of Environment, Energy and Water (MEEW),

2. the Ministry of Atolls Development (MoAD),
3. the Ministry of Fisheries Agriculture and Marine Resources (MoFAMR),
4. the Ministry of Tourism and Civil Aviation (MTCA),
5. the AEC Project,
6. the Marine Research Centre (MRC),
7. the Maldives Association for Tourism Industry (MATI) and
8. Resort management and dive schools in Baa Atoll.

Due to a lack of research and information in the Maldives on effective MPA management and on the expected changes improved management could bring to reef health, I used findings from similar research conducted in other parts of the world to establish the expected changes to the status quo of Dhigali Haa from implementing the proposed IMS.

3.8. CV Design and Implementation

The proposed policy change to be valued in this study is the proposed improved management at Dhigali Haa. It is expected that the proposed policy change would bring about changes in the health of the MPA. The intended population of the survey was for all tourists visiting Baa Atoll. Table 3.7 gives all resorts operating at Baa Atoll during the survey period. A sixth resort, Four Seasons at Landaa Giraavaru just started operation at the end of 2006 and was, thus, not included in the survey. Most of the resorts in Baa Atoll are very exclusive and expensive to stay at, yet also offer differentiated products.

Table 3.7. Tourist Resorts Operating in Baa Atoll

Resort	**Started Operation**	**Present Bed Capacity**	**Resort Description**
Sonevafushi	1983	130	Described as a Robison Crusoe type holiday island, the resort is mainly marketed as very private and offering close proximity to nature
Coco Palm Resort	1998	200	An award-winning resort marketing mainly for honeymooners, weddings and anniversaries.
Reethi Beach Resort	1998	200	This resort offers more affordable board rates with a more adventure-based holiday offering many activities.
Kihaadhuffaru Resort	1998	200	Exclusively marketed to Italians
Royal Island Resort	2001	304	One of the most high end and exclusive resorts. Provides a relaxing and social atmosphere
	Total:	**1034**	

I chose in-person surveys (IPS) as the mode of administering the CV survey. Taking into account factors such as the budget and time allocated for this research, I aimed to interview between 25 and 50% of the estimated total sample population of 1034 guests staying in Baa Atoll in November 2006 (Table 3.7).

The main questionnaire was designed in English (Appendix 4). Based on tourist arrival information from Ministry of Tourism and Civil Aviation and background information collected from the resorts in Baa Atoll, the questionnaire was also translated into the three most common visitor languages: German, Italian and Japanese. I had the questionnaires translated by university students who were fluent in the above languages. In order to test the reliability of the translations, I used the available online Google language facility (www.google.com) for translating the German and Italian versions back into English. As I could not understand the Japanese characters, this was more difficult to do, but while preparing for the field surveys, I had a Japanese volunteer working at the Environment Research Centre of the Maldives, check the Japanese translation.

The CV questionnaire designed for this survey consisted of four main parts:

Part A – Questions about the respondents' visit to Baa Atoll and their diving experience.

Part B – Information on Dhigali Haa, its present management, proposed improved management and expected changes its health.

Part C – The elicitation of WTP

Part D – Questions on demographics and individual attributes.

In addition to obtaining information on the respondents' visit to Baa Atoll, Part A also provided "warm up" questions to make the respondent feel comfortable with participating in the survey and answering the questions. Part B is the main information component of the questionnaire and contained the description of the changes to be valued, the method of provision of the good, the payment vehicle and a time frame of payment. Details of the payment vehicle used in this study are given later in the discussion of Part C of the questionnaire.

This survey used two elicitation questions, where Questions C1 was aimed at all survey respondents, and asked each his or her WTP a one-off conservation fee for the improved management of Dhigali Haa. This fee would be paid by all tourists visiting Baa Atoll. The second elicitation question, C4 was asked of respondents who had gone, or who planned to go, diving during their visit. This group was identified as MPA "direct users only" and each was asked his or her WTP a user fee (entrance fee) each time they visit the Dhigali Haa MPA. I have chosen to use an open-ended elicitation format for both valuation questions in this survey. Part D included the

auxiliary questions and this information was used in the analyses of the WTP responses and to develop a WTP model.

The decision rule or information on whether the findings of this study would result in a definite decision to implement the proposed payment vehicles is an important component in the design of CV surveys and is still evolving with ongoing theoretical and empirical research (Boyle 2003). As provision of a specific decision rule may cause respondents interested seeing a particular change to influence the outcome of the study by purposely misstating their true WTP, I chose not to specify the decision rule for this survey.

Following the initial design phase of the CV questionnaire, the CV survey instrument was tested for clarity of language and duration. I approached University of Canterbury students and employees for this phase of pre-testing. This proved useful in reducing the time duration of the questionnaire and was good practice for the actual survey. As the target audience was a very different population, the survey was also pre-tested and reviewed in Baa Atoll. This pre-testing and actual survey administration was carried out between 8th November and 7th December 2006. This time period was chosen as this is the start of the peak tourist season in the Maldives and, therefore, there would be a larger target population of tourists available during this time.

Two days were spent in Royal Island Resort for pre-testing. Initially, 20 resort rooms were selected at random and were sent invitations inviting the occupants of the rooms to take part in the survey. Many of these tourists were not willing to participate in the survey[9]. The main reason given for this was that they were on holiday and did not want to spend time doing a survey. With no positive responses, I changed to approaching tourists randomly and asking them to participate in the survey. The survey was pre-tested and it was found that the timing was reasonable. I was able to conduct all surveys within a 20 minute time frame, except one where there was a very keen interest by the respondent. The respondents for the pre-test included both users and non-users and the information present was found to be clear and adequate.

While no major changes to the survey questionnaire were needed, the most helpful thing I found from the pre-test was the method of approaching respondents. Rather than sending invitations, I found a more effective way was to approach people in-person and interview them. I found it ideal to approach people in the lobby while they were coming from meals and in the afternoon and evenings when most of the outdoor activity had ceased. My actual method of approach varied depending on the resort type and willingness of resort management.

[9] The invitation letter did not state that this was a pre-test and included a response form to send back to the reception.

The response rate from all resorts was not as high as I had originally anticipated. The managers of all the resorts were extremely helpful and suggested that using mail surveys may improve response rates from tourists. As the tourists stayed on the resorts most of the time, apart from excursions or activities, the resort management indicated that it might be more convenient for the tourists to respond to a MS at their own convenience. To try this alternate method I sent out 200 questionnaires, in December 2006, to each of the 4 resorts participating in the survey. Table 3.8 gives the details of mail survey questionnaires sent out to the resorts. The mail survey questionnaire is given in Appendix 5.

As the in-person questionnaire was designed to be accompanied by an interviewer, the questionnaire had to be modified for a mail survey format, where an interviewer would not be present to give the information. The in-person questionnaire was designed such that the information is provided more verbally with the aid of show cards. Therefore, for the mail survey questionnaire, the main modification was to make the information provided in Part B more self-explanatory by incorporating the information in the show cards directly into the survey.

Table 3.8. Mail Survey Questionnaires sent and Responses Received

Resort	**# Questionnaires Sent in Given Language**[10]				**# Questionnaires Sent**
	English	**German**	**Italian**	**Japanese**	
Coco Palm Resort (CP)	100	50	-	50	200
Kihaadhuffaru Resort	-	-	200	-	200
Reethi Beach Resort	16	120	-	64	200
Royal Island Resort	150	50	-	-	200
				Total	800

*Completed responses lost in transit

The questionnaires were sent to the resorts with instructions to give a copy to each tourist upon arrival and for the completed questionnaire to be returned to reception before departure. The forms were distributed by resorts in December 2006 during a period of two weeks. Completed questionnaires were collected by the resort staff and sent to me via the AEC Project office. Although both Coco Palm and Kihaadhuffaru Resort had collected completed questionnaires from the tourists, their MS responses were not received as they were lost in transition from the resorts to Malé. Therefore, the total number of MS that were used in calculating the response rates was from the Reethi Beach Resort and Royal Island Resort pool of 400 questionnaires which was sent out.

[10] The amount of questionnaires in the given languages was provided by each resort based on their tourist arrival information.

3.9. Conclusion

Environmental goods such as reef resources have often been undervalued leading to overuse of these resources. Government policies often determine the allocation and use of these resources. Recognizing the economic values of these resources would help strengthen such policy and also make resource users are aware of the true value of these resources. Economic valuation is based on the premise that the value of such resources would be best determined by what they are worth to individuals in society. There are a variety of valuation techniques developed to determine the value of environmental resources. Material resource uses can often be valued by direct market prices but non-market goods such as environmental resources require non-market valuation techniques. The two main types of NMV methods used are revealed preference and stated preference. These are based on observing the actual behaviour of individuals and obtaining stated preference values from individuals, respectively.

This study uses one of the most commonly used stated preference techniques, the contingent valuation method. This method has the advantage of being able to value both use and non-use values. CV is a survey based method which presents people with proposed policies that would result in changes to environmental amenities. Survey respondents are then asked to state how much they value these changes in dollar terms. In particular, a CV survey measures a person's maximum WTP or minimum WTA compensation for proposed changes in an environmental amenity. The welfare estimation in this study is based on Hicksian compensating surplus (WTP).

There are many controversies concerning the use of this method but most of the issues are still ongoing debates. Despite these, many economists believe that a well designed CV study can provide valuable information to guide public policy (Boyle 2003; Hanemann 1994; Mitchell and Carson 1989).

This research focuses on valuing reef resources in the Maldives and uses the CV method to estimate the WTP of tourists visiting Baa Atoll to improve management of Dhigali Haa, the only MPA in Baa Atoll. The local population of Baa Atoll was not included in the CV survey as they would not be familiar with such valuation concepts. Instead, local consultations were held with fishermen, community and students to discuss their views on the concept of MPAs to protect biodiversity and the associated benefits and problems. These discussions also served the dual purpose of obtaining information to improve the proposed Improved Management Scenario (IMS) for Dhigali Haa. This IMS was used in the information component of the CV questionnaire.

The survey used an open ended elicitation format and two main elicitation questions were used. These were to estimate tourists' (i) WTP a conservation fee targeted at all visitors to Baa Atoll and

(ii) to estimate divers' WTP a user fee targeted at all divers who are expected to visit Dhigali Haa. Initially in-person surveys were used but due to the low response rate encountered, mail surveys were also used to see if a better response rate could be achieved.

The subsequent chapters provide the results of the field research. Chapter 4 gives details of the development of the IMS as well as results of the focus group and stakeholder consultations. Data analyses of the CV survey and WTP value estimates are given in Chapter 5. The WTP information obtained from the surveys will be used to estimate the value of improving MPA management at Dhigali Haa. The comparison of benefits and costs associated with implementing the proposed IMS and the resulting policy implications will be given in Chapter 6.

4. Improved Management Scenario for Dhigali Haa

4.1. Introduction

In order to value improved management of the MPA reef resources, this research used a CV method where the proposed policy change was an improvement to existing management conditions at Dhigali Haa. The present resource conditions and expected changes from implementing the proposed policy, in the form of an improved management scenario (IMS), were used to impart information to the CV respondents on the probability of the success of the proposed policy.

A prominent part of the discussion presented on the development of the IMS is from findings of focus group interviews held with the local community (Table 4.1). Although the main purpose of the focus group interviews was to obtain local view on MPAs and their management, they served the dual role of providing information and views on the proposed IMS. Therefore, discussion of the IMS, within the chapter gives more detail than the information used for the CV survey. This discussion is also intended to give sufficient detail so as to provide policy recommendation for improving management of Dhigali Haa.

Table 4.1. Details of Participation in Focus Group Interviews

Island	Population	Groups Interviewed	Number of participant
Dharavandhoo	740	Community Development Groups	7
		Fishermen	6
Eydhafushi	2409	Community Development Groups	12
		Fishermen	10
Maalhos	392	Community Development Groups	12
		Fishermen	1
		Students	17
Thulhaadhoo	1759	Community Development Groups	12
		Fishermen	10

First the chapter provides a description of findings on the present status of Dhigali Haa including the use of the reef and reef health. This is followed by a discussion of the proposed IMS. The expected effects of the proposed IMS are also presented. The chapter concludes with a discussion of the resources needed for implementing the IMS and an estimate of the likely implementation costs for Dhigali Haa.

4.2. Dhigali Haa as an MPA

Dhigali Haa in Baa Atoll (Figure 4.1) was given protected status in October 1999, but apart from a paper proclamation there have been no management efforts put into the MPA by the government (Marine Protected Areas System 2001; United Nations Development Programme 2004). The management practice applied to Dhigali Haa is similar to all established MPAs in the Maldives (Bers 2005). According to the description of MPA management practices in the Maldives given in Chapter 2, I would state that Dhigali Haa, like all MPAs in the Maldives, lacks the necessary elements for effective management and, without proper monitoring, it would not be possible to state the effectiveness of the MPA.

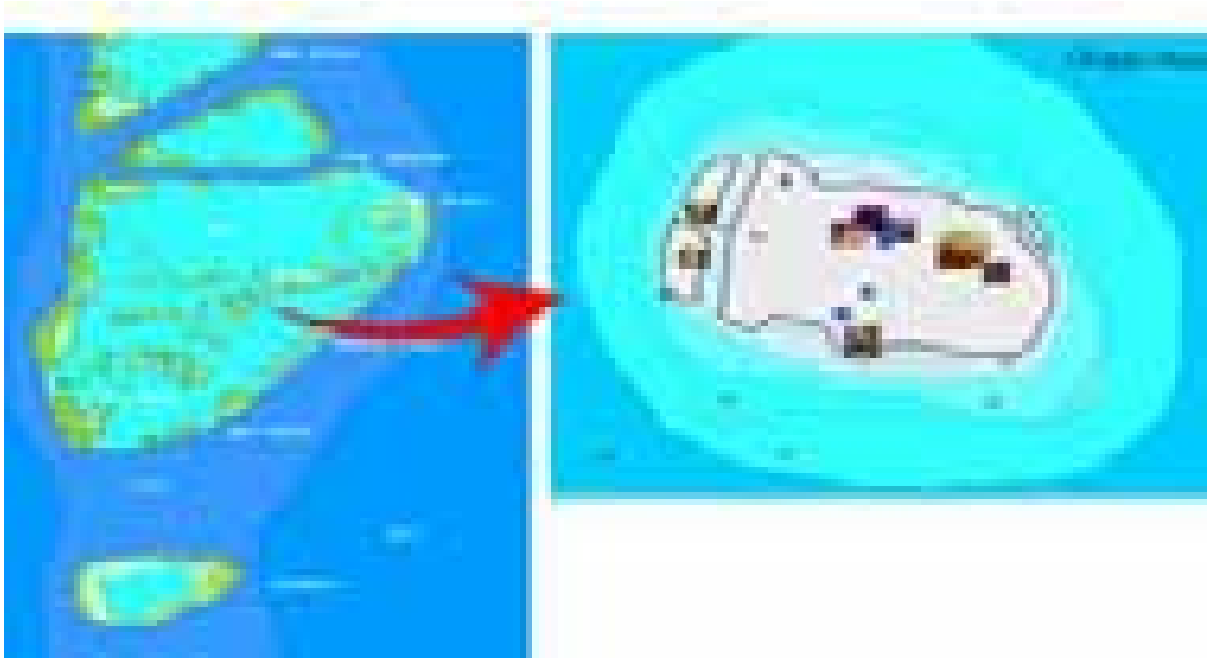


Figure 4.1. Map of Baa Atoll showing location of Dhigali Haa.
The green area on the map represents reef area and the shades of blue represent various ocean depths (100+, 200+). The red dots are the dive sites in Baa Atoll which is used by tourist resorts. The enlarged map shows Dhigali Haa. The shades of blue represent the various depths of the MPA. Source: Soleni Dive Centre, (www.soleni.com)

4.2.1. Present Status of Reef Conditions at Dhigali Haa

Without proper research and monitoring being carried out at Dhigali Haa, there is a significant gap in the information and documentation available on the present quality and health of the reef. The only monitoring work that I have come across is by a resident coral reef scientist, who monitored the growth of coral reefs after the El Niño event of 1998. With few scientific records, I have turned to local dive schools, who have been frequent and ongoing visitors to Dhigali

Haa[11]. Dive school operators would be able to provide qualitative and anecdotal evidence regarding the present status of Dhigali Haa and overall changes in the quality of its reef since its declaration as an MPA in 1999.

Although I attempted to obtain information from all 5 dive schools in Baa Atoll, I was only able to get information from dive schools at Coco Palm Resort, Royal Island Resort and Sonevafushi. The main reason not providing the information was due to commercial reasons, as some of the dive schools felt the questions required answering information that were confidential.

Talking with the available dive schools I found that except for Ocean-Pro Diving (the dive school at Coco Palm Resort) all of the local dive schools currently visit Dhigali Haa for diving[12]. Ocean-Pro Diving has not used the site is because its affiliated resort, Coco Palm, is a bit far from the site (Refer map of Baa Atoll in Chapter 2). Soleni Dive Centre (Sonevafushi Resort) and Delphis Diving Centre (Royal Island resort), are the closest to Dhigali Haa and the most frequent visitors.

The dive base leader at Soleni Diving Centre and a resident reef scientist were the only people I communicated with who worked in Baa Atoll (diving at Dhigali Haa) since before Dhigali Haa was declared a protected site. Therefore, communications with them have been used to get an idea of the changes in the quality of the MPA since its establishment. According to them, the quality of the reef at Dhigali Haa has degraded considerably, but due to a lack of monitoring it would not be possible to quantitatively estimate the changes. The human damage to the MPA has been attributed to anchor damage (from fishing by local fishermen and night fishing by resorts) and diver damage (personal communication, T. Waelchli, Base leader, Soleni Dive Centre, 29th July 2006; personal communication, W. Allison, Coral Reef Scientist at Coral Reef Research and Management, Maldives, 31st October 2006; Bers 2005)[13]. The El Niño event of 1998 has masked much of the human impacts at Dhigali Haa. Conditions at Dhigali Haa have now reached pre-El Niño conditions (personal communication, W. Allison, Coral Reef Scientist at Coral Reef Research and Management, Maldives, 31st October 2006).

According to the information sources, the number and varieties of marine animals, particularly the pelagic fish, have decreased over the past years. Most notably, the shark abundance has declined significantly (personal 29th , T. Waelchli, Base leader, Soleni Dive Centre, July 2006;

[11] Dive schools are usually run from the resorts. During the field work there were 5 dive schools operating at the five resorts of Baa Atoll.
[12] According to the base leader of Ocean-Pro Diving, the dive school would soon be starting diving trips to Dhigali Haa.
[13] As the main type of diving done at Dhigali Haa is drift diving, boats which take the divers to the site do not drop anchor, but drifts on the surface waiting to pick up divers when they finish (email comm. with Mr. M. Jameel, Diving Instructor, Delphis Diving Centre in August 2006)

personal communication, W. Allison, Coral Reef Scientist at Coral Reef Research and Management, Maldives, 31st October 2006; personal communication, M. Jameel, Diving Instructor, Delphis Diving Centre, 4th August 2006; Bers 2005). According to the sources, while about a dozen sharks (including grey reef and white-tip sharks) were observed on each dive in the year 2000, sharks of any kind are now seen on a couple of dives in a year. Also while November is a time when manta rays are frequently sighted, there were considerably fewer mantas observed in 2006 compared to previous years. (personal communication, T. Waelchli, Base leader, Soleni Dive Centre, 9th November 2006).

All sources attributed this decline in shark populations to the targeted shark fishery in Baa Atoll. Although the government has banned shark fishing in Baa Atoll since September 1998 (for a period of 10 years), without proper monitoring and enforcement illegal shark fishing is still carried out (Bers 2005; personal communication, Rasheed, Manger, Coco Palm Resort, 18th November 2006; focus group interviews with local fishermen carried out in November 2006)[14]. An annual award by a German based shark protection organisation, Shark Project, had awarded the Maldives, the "Enemy of the Shark" in 2004 (Shark Project, accessed on 10th June 2007, www.sharkproject.org)

4.2.2. Local Use of Dhigali Haa

The main local users of Dhigali Haa are fishermen who use the reef for seasonal bait fishing. Discussions from focus group interviews conducted at selected islands in Baa Atoll provided information on the local views on Dhigali Haa, its use and management. According to the fishermen in my groups, Dhigali Haa was used for bait fishing and fishing for reef fish before it was declared an MPA. Although, shark fishing was not directly mentioned as being carried out by interviewees during the discussions, there was mention of fishermen from other islands in Baa Atoll as well as other atolls carrying out shark fishing even now. Though, bait fishing is the only legally allowed fishery, fishermen reported, however, that illegal fishing is still being carried out, for the principal reason that there is no one to monitor such activities or impose penalties for these illegal activities. Clear penalties for these illegal activities do not exist on paper except for the Environment Protection and Preservation Act which provide the legal basis for imposing environmental penalties in the Maldives. Although an illegal activity, the prospect of earning about US$32 without the possibility of any penalties or legal action would be enough

[14] Rasheed reported that during a visit by tourists to a nearby inhabited island, they had observed large amounts of fished sharks on the beach.

reason to pursue this activity[15]. Shark fins are in great demand in souvenir shops in Malé, where they are allegedly sold for between US$2,000 and US$3,000 (Jordan 2007).

The fishermen in my focus groups reported that the crew of resort dive boats would often tell them to leave Dhigali Haa, leading to direct conflicts between the fishermen and divers. These same fishermen also reported that they have also been asked to leave from other reefs, used for diving, besides Dhigali Haa by dive crew. From the focus groups with the fishermen and interviews with staff of diving centres, it appears that the reason for this open conflict is that the fishermen and diving centres lack sufficient information on the MPA and its status to interact appropriately. While diving centres were aware of Dhigali Haa being an MPA, they were not fully aware of what was and was not allowed in Dhigali Haa under the protected status. A common misperception of diving centres was that all fishing activities including bait fishing were prohibited. At the same time, the local fishermen did not have adequate information on Dhigali Haa being an MPA or, they were not even sure how many MPAs were in Baa Atoll. In addition, I also found that amongst the fishermen there was a lack of understanding of the term "protected" and of the purpose of protection.

Despite the apparent conflicts, both fishermen and the local dive centres wanted to see more effective enforcement of the ban on shark fishing including such measures as a national ban on the export of shark products to discourage the illegal activity. The fishermen reported that, with the decline in shark populations, they have noticed a decline in bait and reef fishing at Dhigali Haa as well as the tuna fishery outside the reef. This observation has also been reported in other local and international studies (Bascompte et al. 2005; Bers 2005). Baitfish usually form schools as a protective measure against predatory sharks and hence are more accessible to fishermen (Bers 2005). According to the fishermen interviewed, the number of fishermen involved in the illegal shark fishery in Baa Atoll is small compared to those involved in the tuna and reef fisheries, hence, the majority of fishermen supported better enforcement of the ban on the shark fishery. It became apparent to me that the lack of communication and recurring conflicts between fishermen and diving centres prevented these two groups from realizing that they share a common goal and prevented any positive discourse about this.

4.3. Proposed policy change: improved management at Dhigali Haa

The situation described above, reveals that there are no management initiatives or enforcement activities at Dhigali Haa. Without proper management and enforcement, the conditions at

[15] The value US$32 is the value of a shark to a fishermen as reported in United Nations Development Programme (2004).

Dhigali Haa would likely continue to degrade as tourist numbers continue to rise. I thus developed and an improved management scenario (IMS) for Dhigali Haa for use in my CV survey. To keep the IMS as realistic as possible, I proposed a basic management prescription which could be implemented within the near future, given the existing governance capacity. The successes and failures of this IMS could be used to strengthen future management plans. Based on initial information collected I have identified the following areas as needing to be addressed in the proposed improved management:

1. increasing local awareness and education regarding Dhigali Haa, its purpose, rules, regulations and enforcement arrangements for the MPA,
2. setting up an enforcement mechanism for monitoring prohibited activities,
3. minimizing damage to the reef area,
4. monitoring and research for changes in the conditions and effectiveness of the MPA, and
5. improving consultation and participation of local stakeholders in the implementation of the management process.

Table 4.2 gives the initial management recommendations developed based on literature available on MPA management and discussions with the stakeholder groups identified in Chapter 3.

Table 4.2. Proposed Initial Management Recommendations

Management Area	Recommendations
Awareness and Education	- Develop awareness resources (websites, leaflets etc.), - Conduct awareness campaigns to develop community awareness and - Long-term education targeted for schools.
Management and Enforcement Mechanism	- Set up a management arrangement i. Identify main actors and define their responsibilities, ii. Identify institutional arrangements, and infrastructure for management, iii. Determine resources required (funds, personnel, and equipment), iv. Determine level and training requirements, v. Clearly define roles and responsibilities of management personnel, - Define policy measures, penalties and incentives for directing user behaviour and - Establish reporting and response mechanism - Establish mechanisms to monitor enforcement and management effectiveness
Minimise Damage to MPA	- Set up appropriate signs, lights and marker buoys to identify site, - Set up mooring buoys to discourage anchoring at Dhigali Haa, - Limit number of users on site and - Zoning (bait fishery vs. diving)
Monitoring and Research	- Conduct and report on a baseline monitoring of Dhigali Haa, - Periodically monitor and report on the health of the MPA - Develop updates on changes in the health of the reef, for dissemination to schools, local community, and resorts.
Stakeholder Involvement	- Consult during development and review of management plans and - Involvement in implementation of management plans

4.3.1. Increasing Awareness and Education.

Although MPAs are a resource governance tool, the success of MPAs can only be achieved by acceptance and support of local stakeholder groups. In order to do this it is vital that local communities should understand the purpose and benefits of establishment of MPAs. Also local community should be aware of the rules and regulations applied to the MPA.

From consultations with local fishermen, I found that although many were aware that Dhigali Haa was an MPA, they were unsure of the status of many other local reefs in regards to protected status. Based on the discussions, I perceived the reason for this to be that the source of such information for fishermen is from the diving boats of resorts that often purposely or otherwise misinform the fishermen. None of the fishermen consulted remember hearing or seeing the original announcement establishing Dhigali Haa as an MPA. Declaration of MPA status is made by the Ministry of Environment in the form of a public announcement over the television, radio and newspapers (distributed mainly in the capital) for a period of 3-5 days. With limited access to the television and newspapers by local islands (especially at the time Dhigali Haa was declared an MPA in 1999), radio was the main mode of receiving such information by rural communities. Representatives of all Island Offices and the Baa Atoll Office also informed me that they had not received any information about the MPA from the Ministry of Environment for dissemination to the public.

Based on my focus group interviews, the local community development groups were less aware of Dhigali Haa as an MPA or of there being any other MPAs in Baa Atoll. While the students were not aware of there being any MPAs in Baa Atoll, the educators expressed a lack of available information resources for use in the school. The community groups expressed the view that the Atoll and Island Offices should play a key role in disseminating such information to the community. At present, the local governance is centrally controlled by the government, in the capital Malé, and local Offices only function as administrative units of the main government, Ministry of Atolls Development. Therefore, the Atoll and Island Offices are not empowered or trained to conduct such activities.

Representatives of the community development groups expressed a desire to be informed of the purpose of the MPA, its overall benefits, and direct benefits to the community. If the community was aware of such benefits they indicated that they would keenly support such activities. This view supports that of Guénette et al (2000), who write that MPAs should be perceived as bringing tangible benefits to the locals in order for the locals to accept them. Both the local fishermen and community development groups were under the impression that the MPA was

established only or the benefit of the tourism industry. They are unaware of potential benefits to local fishermen such as protection of spawning stocks, provision of recruits to replenish fishing grounds and enhancement of catches in adjacent (unprotected) reef through emigration (McClanahan and Mangi 2000; Roberts and Polunin 1993). I found that information on such benefits has not been communicated to the public.

All the stakeholders consulted during this research identified raising awareness and disseminating information as the main areas on which to focus management efforts. All the resorts and diving centres consulted in this research were very involved in environmental protection and awareness activities. In addition to raising awareness among tourists and resort staff, many of the resorts were involved in awareness programmes for the local community and schools (field observations and personal communication, management of resorts in Baa Atoll, November 2006). For example, both Coco Palm Resort and Sonevafushi have received the national Green Resort Award (Ministry of Tourism and Civil Aviation 2006).

4.3.2. Management and Enforcement Mechanism

Both fishermen and local community groups identified a lack of management or enforcement of conservation guidelines as a reason for the failure of the MPA. As reported in the focus group discussions, illegal fishing was due to a lack of in the government enforcement measures. They commented that just declaring a reef as protected is not enough when economic incentives to ignore it exist. As an example fishermen from the focus groups reported that although shark fishery has been banned throughout the Atoll (for a 10 year period) it is still carried out, local people know about this and yet do not report it to the authorities. One reason for this may be the lack of a reporting mechanism that the local people are aware of. Representatives of the Island and Atoll Offices also reported that they are not aware on the procedures to follow if such reports were made to them. This issue was also raised by resorts and dive centres, who informed me that although they have documented proof (videos and photographs) of illegal fishing activities at MPAs, they do not know who to report this to. According to the Ministry of Environment, such a reporting mechanism has not been developed for MPA (personal communication, M. Zuhair, Ministry of Environment, 8th November 2006).

The only form of management or enforcement existing at Dhigali Haa is being carried out by the management of Royal Island Resort in the form of (unofficial) monitoring of fishing activity. As the resort frequently visits Dhigali Haa for diving, this action is in part for their own benefit. Being the closest island to Dhigali Haa any boats at the MPA can be viewed from the resort and the resort management has been sending their staff to inquire and if necessary send away these

boats (personal communication, management of Royal Island Resort, 15th November 2006). I believe this is an indication of the willingness of some of the local stakeholders to participate in proper management of the MPA. According to the management of Royal Island Resort, without actual authority, the resort is not always successful in such attempts and without any reporting mechanisms to the government authorities, there is no credible threat of penalties being imposed, so that the offenders could return.

All stakeholder groups supported the idea of improved management at Dhigali Haa in principle. While the resorts and dive centres were more willing to actively participate, the local communities were more skeptical of such management actually being implemented. The fact that locals have not seen any management plan over eight years since establishment of the MPA, provide reason for the mistrust.

All stakeholders agreed that ideally there should be an MPA management office, Dhigali Haa Management Office, working on the ground in Baa Atoll for successful implementation. The local community groups highlighted the need for the Dhigali Haa Management Office to be a separate body from the Atoll and Island Offices that would report to the Ministry of Environment. This separation would address local mistrust of the local authorities using resources appropriately.

Ideally, such a management office should be an autonomous agency which would look at the aspects of MPA management such as monitoring the MPA activities, issuing fines and penalties, monitoring and reporting on the health of the MPA and creating awareness on the MPA status and effectiveness of the MPA. In view of the limited capacity in the Maldives, such as trained staff, management and legislative frameworks and available funds, to establish an ideal agency my IMS proposes to set up an initial management body within the administrative set up of the Atoll office, and working in close collaboration with the Ministry of Environment, who is responsible for establishment and management of MPAs in the Maldives. Figure 4.2 presents the implementation structure and the proposed function of the Dhigali Haa Management Office. The established management arrangement could be used for any future MPAs established in Baa Atoll.

The establishment of Dhigali Haa Management Office in Baa Atoll would facilitate opportunities for collaborative management with the local stakeholders and this would help minimise issues raised on not being able to report illegal activities at the MPA. The monitoring MPA activities would involve patrolling the site and or responding to reports, monitoring bait fishing and diving (taking daily visitor census), monitoring any illegal activities and issuing fines if required.

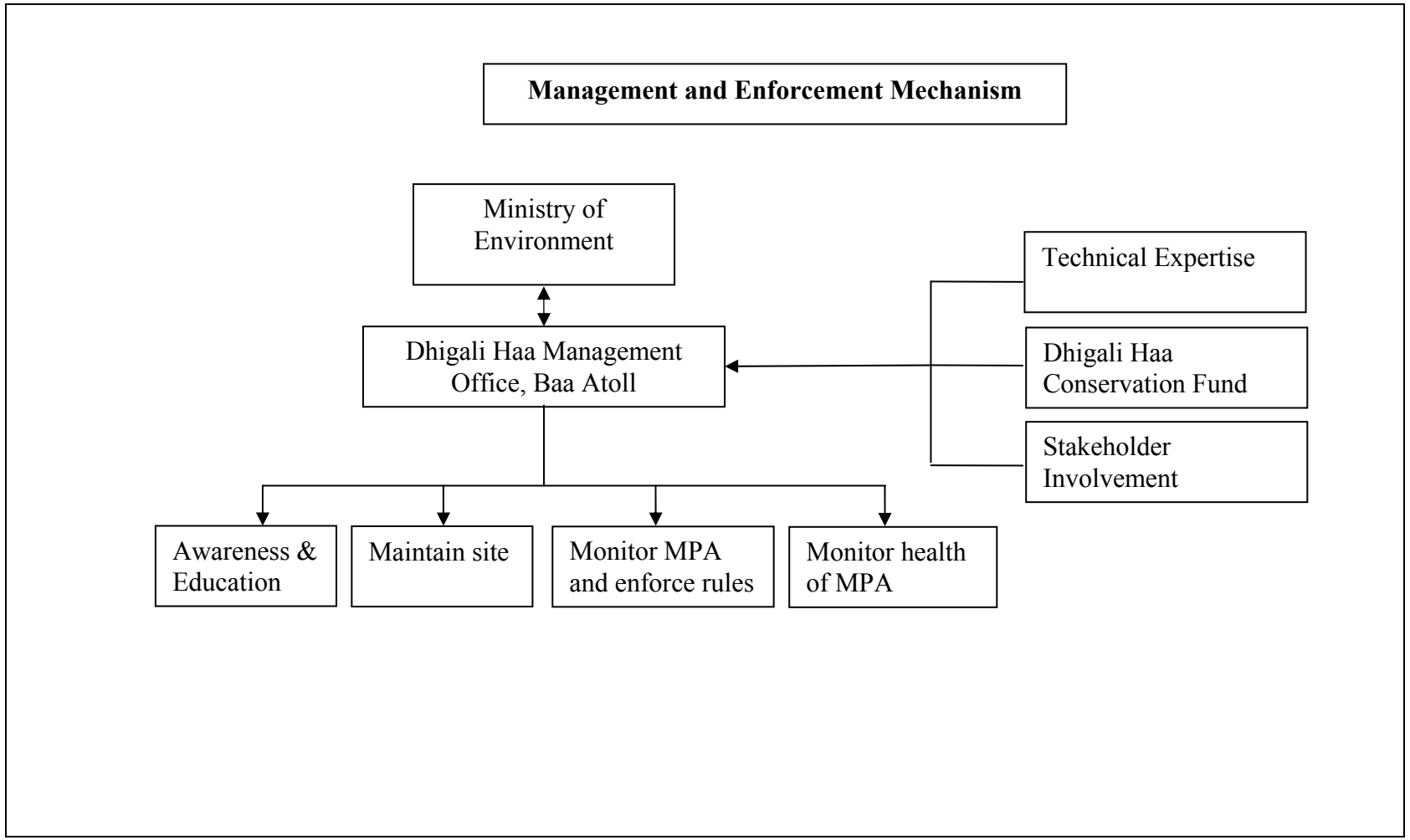


Figure 4.2. Implementation Structure for the Proposed Dhigali Haa Management Office

One important issue raised at the focus group interviews was the logistics of monitoring illegal activities. The discussion groups suggested it would be too costly and unrealistic for staff to continuously patrol the MPA. Ministry of Environment also agreed in this that there would not be enough resources for such an ambitious coverage (personal communication, M. Zuhair, Ministry of Environment, in 21st October 2006). In IMS, I am proposing that recruiting four full-time enforcement officers working in shifts between 0700 hrs and 1800 hrs would be a more achievable, initial scenario. This is based on there being more diving and fishing activity during the day. The local community development groups from the consultations suggested an alternative of having a land-based monitoring post near Dhigali Haa and have them report to the management office if any suspicious activities are going on. This was proposed a more efficient system in case future MPAs were established. Representatives from the community development groups suggested being close to Dhigali Haa, Royal Island Resort would be a good choice for a monitoring station for the MPA. This is an opportunity to utilise the present unofficial monitoring role of Royal Island Resort but to the fishermen this may seem to be a bias towards the tourism industry. I believe that a combination of a 24 hour monitoring station and periodic patrols would provide a sufficient level of initial monitoring. The decision of establishing a monitoring station in a resort should be made after having further consultations with local community, especially the fishermen.

The Ministry of Environment should have appropriate fines for violations of the protection guidelines determined prior to the Dhigali Haa Management Office coming into effect and the public should also be made aware of these fines and penalties before they become effective. On discussion of fines and penalties for violations with the local fishermen and community groups, they were in agreement that these should be implemented. All were of the view that in order for this to be a success the fines should be sufficiently high in relation to the economic benefits of the illegal activity.

To make this management and enforcement mechanism a reality, personnel, equipment and technical inputs would be required. These are discussed further in Section 4.5. The section also cost estimates for the establishment and operation of Dhigali Haa management Office.

4.3.3. Minimise Damage

The findings from the stakeholder consultations identify that the main damage to Dhigali Haa has been from fishing, anchoring (fishermen and night fishing from resorts) and diving. The management office at Dhigali Haa would need to create awareness of preservation benefits and restrictions to promote positive behaviour from users. First, appropriate signs and marker buoys

should be established at the MPA. Both the local community groups and diving centres had raised concerns that Dhigali Haa is not known on the ground nor visible as an MPA. Suggestions on putting up mooring buoys to discourage anchoring were not supported by the discussion groups or the dive centres, as they thought this might encourage rather than discourage boats to drop anchor.

Internationally, many large size, multiple use MPAs employ zoning schemes to prevent resource use conflicts between users (Ticco 1993; Guénette et al. 2000). While zoning may help reduce user conflicts, Dhigali Haa is very small in size, which makes zoning difficult. According to the MEEW, zoning could be possible but before zoning plans are developed they suggested that the resource use levels should be identified to determine the most common uses to allocate zones according to the level of use (personal communication, M. Zuhair, Ministry of Environment, 21st October 2006). As this data is not available and outside the scope of the study, zoning does not seem an immediate concern for an initial IMS.

Recreational diving is a use allowed in many MPAs and in some cases generates revenues for MPA management (Davis and Tisdell 1996; Depondt and Green 2006; Dixon et al. 1993). Recent studies also show that reefs become degraded due to poorly planned and unregulated tourist use (Dixon et al. 1993; Jameson et al. 1999; Zakaia and Chadwick-Furmanb 2002). According to Davis and Tisdell (1996), there are many options that can be implemented by MPA management to regulate diving. Some of these include diver training, awareness and limiting use directly via limits on the number of users per year, or licensing systems for divers, or indirectly via user fees. Implementing options such as limits on number of users would not be possible for Dhigali Haa as data on the number of users of Dhigali Haa is not available at present.

The proposed IMS should concentrate on achievable activities such as diver training and awareness. Local dive centres in Baa Atoll informed me that during diving sessions divers are given instructions to look after the reef environment and that most divers who visit Dhigali Haa are experienced divers. Analysis of CV information collected in my research confirms that divers coming to the Maldives are highly experienced (Chapter 6). The level of instructions currently given varies for each individual resort. Under the proposed IMS, the Dhigali Haa Management Office should work with dive centres to ensure a consistent level of diver awareness and ensure only experienced divers visit Dhigali Haa.

4.3.4. Research and Monitoring

Despite the many social and economic benefits and aims of MPAs, this mechanism of protection is ultimately a tool for conserving biodiversity. Hence, to know the effectiveness of an MPA,

monitoring of the physical and biological condition of the MPA is required. Dhigali Haa, like all MPAs throughout the Maldives lacks, consistent monitoring (Bers 2005). A quantitative baseline assessment of the health of Dhigali Haa was not done prior to it being declared an MPA. Hence the initial step of the IMS would be to establish the present status of Dhigali Haa. MPAs in other parts of the world carry out periodic monitoring twice, three or four times a year based on the level of information needed and the funding available (Wilkinson et al. 2004). Considering the slow rate of coral growth, the limited funding and resources available, and the small size of Dhigali Haa, I propose that further assessments should be done twice a year to measure changes in the health of the MPA. As given in Wilkinson et al. (2004), the main monitoring parameters usually include assessing corals and other benthic organisms for changes in bottom cover and changes in major species or life forms.

All diving centres I communicated with expressed concern over the lack of monitoring at Dhigali Haa and that they would be keen to participate in such activities. This would increase stakeholder involvement as well as reduce the cost of continuous monitoring. From discussions with the local community groups it is evident that they understand Dhigali Haa to be established for the benefit of tourism and, hence, there is no ownership or involvement by the local community. Therefore, this opportunity to involve stakeholders should look at including the local community as well. For the IMS I am proposing to involve students from local schools in the monitoring of Dhigali Haa, as this would be an educational experience for them as well as creating future interest in such programmes. In addition, local residents trained under the nationwide Coastal Zone Management (CZM) training programme being conducted by the Ministry of Environment could be involved in these monitoring (Ministry of Environment and Construction 2005).

4.3.5. Stakeholder Involvement

The success of MPAs have been shown to be greatest when communities collaboratively support the MPA process (Jameson et al. 2002). According to Zuhair (2003), the involvement of stakeholders is an important element lacking in the establishment and management of MPAs in the Maldives. During the focus group discussions, fishermen complained of not being involved in the initial establishment process of Dhigali Haa. As an important user of the MPA, their concerns should have been discussed but, in addition to this, the fishing community would through experience possess valuable knowledge of the local area and the MPA.

As the main purpose of this thesis is not to diverge into the establishment process of MPAs, but to value improved management of existing MPAs, I will concentrate on how the level of

stakeholder participation can be improved in the management process. But I would also recommend that future processes of establishing MPAs include stakeholder participation. The management actions discussed earlier had mentioned several opportunities for stakeholder involvement in the IMS. Table 4.3, outlines the main local actors and proposals for their involvement in the management process.

Table 4.3. Main Local Stakeholders and Proposed Involvement in Management Process

Stakeholder	**Involvement**
Atoll and Island Offices	- promote local awareness and education programmes - disseminate information
Community Development Groups	- promote local awareness and education programmes
Fishermen	- assist in monitoring of MPA activities - report unusual activities
Educators and Students	- promote local awareness and education programmes - assist in monitoring of the health of the MPA
Resort Management	- promote local awareness and education programmes - provide awareness and education programmes for tourists
Dive Centres	- provide awareness and education programmes for tourists - assist in monitoring of the health of the MPA - assist in monitoring of MPA activities - report unusual activities

4.4. Effects of implementing the proposed policy change

As there is no literature on local MPAs and their effectiveness in conserving marine biodiversity, I have sought similar studies from other MPAs in the world to estimate the likely changes in Dhigali Haa from implementing the proposed IMS. Some of the literature on the impacts of MPAs and their major findings are provided in Table 4.4. These studies measure impact using indicators such as fish abundance, size, biomass fish density and species diversity. Although some studies state that the amount of benefits provided is not clear cut, most studies agree that properly resourced MPAs are effective measures for conserving marine populations.

Two remaining questions that need to be answered are (1) how long would it take for effective MPA management to produce conservation results and (2) does the relatively small size of Dhigali Haa affect this estimate? As seen in Table 4.4, the number of years of effective protection of MPAs varied from 1 to 26. This indicates that effective protection can produce results over a short timescale. On the question of reserve size, a meta-analysis of 89 studies done on the impacts of MPAs by Halpern (Halpern 2003) showed that irrespective of the size of the MPA, properly managed MPAs lead to increases in density, biomass, individual size and diversity in all functional groups of fish studied. On the other hand, Halpern (2003) also states that proportional increases occur at all reserve sizes so that we should not depend solely on small reserves for effective conservation.

Table 4.4. Some Studies done on Impacts of MPA and their Major Findings

Study	Number of Years of protection* in MPAs studied	Reported Major Findings**
Halpern (2003)	112 MPAs (years of protection not reported)	20 – 30 % increase in diversity of communities and the mean size of organisms 2 times increase in density of organisms 3 times increase in biomass of organisms
(Côté et al. 2001)	19 MPAs (3 – 26 years)	25% increase in fish numbers 11% increase in species diversity
(Mosqueira et al. 2000)	12 MPAs (1 – 26 years)	3.7-fold increase in fish abundance
(Roberts and Polunin 1993)	Philippines (8 years)	Two-fold increase in target fish abundance Doubling of fish biomass
	USA (2 years)	93 and 439% increase in abundance of snappers and grunts
(Polunin and Roberts 1993)	2 MPAs in the Caribbean (4 years	1.9 – 2.0 times greater biomass of target fish 45 – 59% of target fish in both MPAs showed greater increase in abundance, size and biomass

* the studies take into account number of years where effective management has been in place.
** main findings in all cases are compared with unprotected and or fished areas.

4.5. Resources for Implementing the Proposed IMS

Figure 4.3 shows the proposed IMS and its implementation structure. The implementation of such an IMS requires resources such as human and physical capital and technical expertise. According to Wilkinson et al. (Wilkinson et al. 2006), the most important and mainly lacking resource is appropriate funding for such measures. In particular, funds would be required for initial capital costs such as establishment of infrastructure, procurement of required equipment, recruiting and training staff as well as recurring costs for continued operation of the IMS. It was suggested by McClanahan (1999) that MPAs in poor countries fail because of an inability to sustain running costs and that MPAs could only be successful if they reach a self-financing status. Therefore in order to successfully implement the proposed IMS, there should a sufficient funding mechanism.

For the IMS I propose that a trust fund--Dhigali Haa Conservation Fund--be established for implementing the IMS. The trust could be managed by a board of trustees which represent the local community, fishermen, resort owners and the government as this would create more

credibility for the donors, tourists and locals in the use of funds from the trust. Some proposed funding mechanisms are:

1. a conservation fee collected from all tourists visiting Baa Atoll,
2. a conservation fee charged to resorts or diving schools,
3. establishment of an entrance fee for divers using Dhigali Haa,
4. government contribution and
5. other donor assistance.

The Maldives does not have experience in creating such funds and also does not have a legal framework for their establishment (personal communication, H. M. Shareef, Lawyer, Ministry of Fisheries, Agriculture and Marine Resources, Maldives, 11th October 2006). To be feasible, this component of the IMS would need sufficient detail in design and implementation, which could be explored within the activities of the present conservation project being implemented in Baa Atoll, the AEC Project

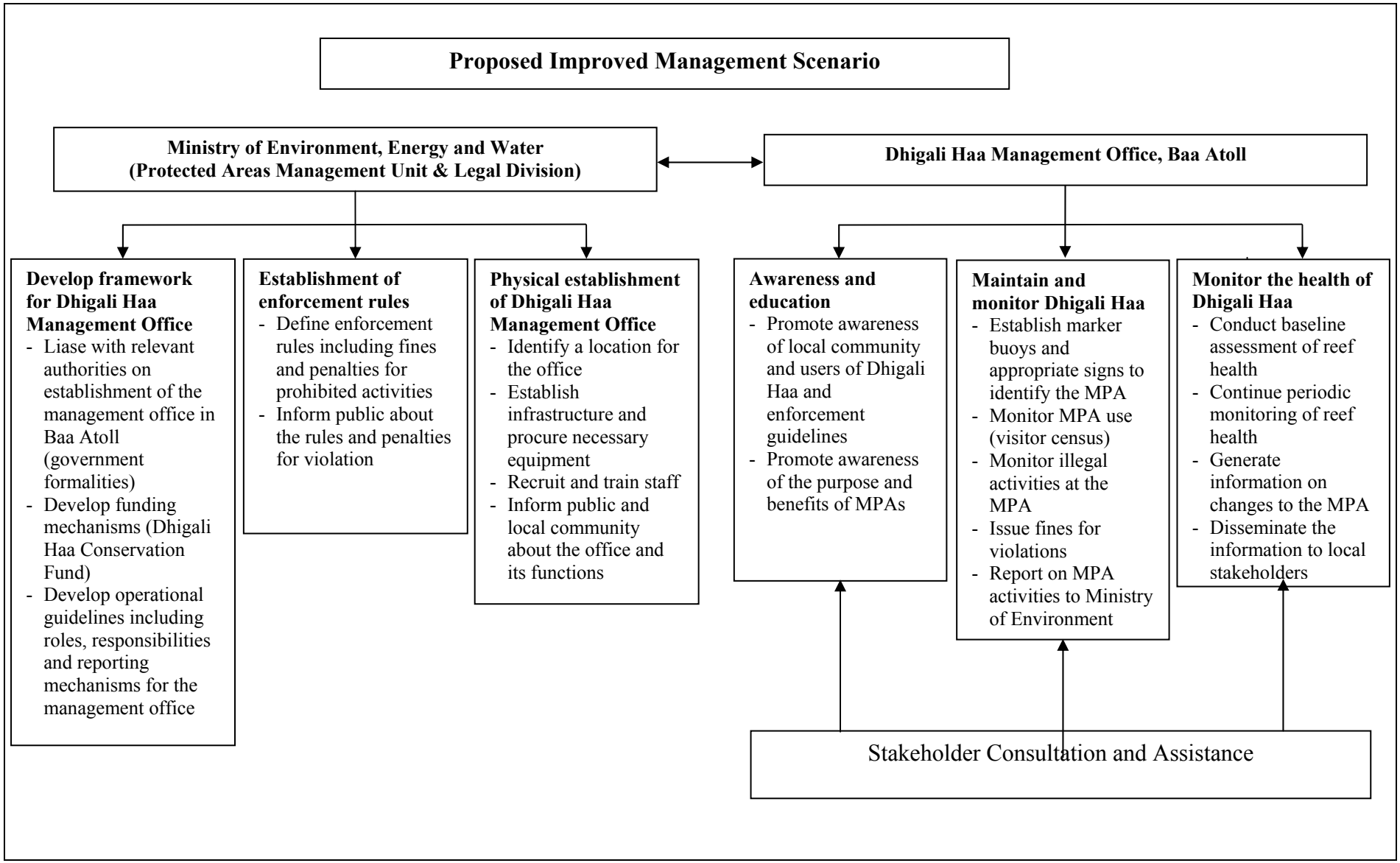


Figure 4.3. Proposed Improved Management Scenario

4.6. Estimated Costs for Implementing the Proposed Improved Management

Lack of financial resources has been identified as a main reason for poor management and enforcement of many MPAs in the world (Cho 2005; Depondt and Green 2006; Souter and Lindén 2000). This has also been identified as a barrier in the Maldives. This section provides an estimation of the cost of implementing and operating of the proposed IMS for Dhigali Haa. The WTP estimates of the CV survey, given in Chapter 5, would be used to compare the costs of the IMS with benefits from imposing conservation for tourists visiting Baa Atoll and user fees for those diving at Dhigali Haa. These will be discussed later in Chapter 6.

Table 4.5 gives a summary of the estimated costs for implementing the proposed IMS. The estimated costs are expressed in nominal dollar values. The initial establishment capital cost for the project would be about US$77,027 and would incur an estimated annual operational cost of US$101,634. This gives an initial total estimate of US$173,661 for Year 0 of implementing the improved management.

Table 4.5. Summary of Estimated Costs for the Proposed Improved Management at Dhigali Haa

Area	Activity	One-off Capital Cost ($US)	Ongoing Annual Recurrent Cost ($US)
Monitoring and Enforcement Unit - establishment	Development of operational guidelines for MEU, Baa Atoll	1,000	
	Awareness of MPA rules/regulation	3,258	
	Infrastructure	11,300	
	MPA maintenance and monitoring equipment	53,279	
	Staff Training	3,190	
Monitoring and Enforcement Unit - operation	Staff wages		24,260
	Office Operation		4,202
	Awareness and Education		1,000
	MPA monitoring		72,171
		77,027	**101,634**

The main capital costs include development of infrastructure and MPA monitoring equipment. The infrastructure cost is based on the MPA management office being a part of the existing infrastructure of the Baa Atoll Office. The bigger contribution to the cost of MPA monitoring equipment comes from the cost of purchasing the patrol boat, diving and snorkelling equipment and mooring buoys. The bulk of the recurrent cost is for MPA monitoring and a large portion of this cost is from the maintenance and running of the patrol boat. Detailed calculation of the estimated costs is given in Appendix 7.

As given in White et al (2000), conservation of a small area, 1.5 km^2, of reef at Apo Island, Philippines cost an initial amount of US$75,000 and the continued maintenance costs were US$5,000 a year. As Apo Island MPA is managed by the island community, mostly volunteers, this annual maintenance cost for Apo Island does not include staff wages, which on the other hand, forms a large part of the annual recurrent cost in my estimate. Comparably larger than Dhigali Haa, the protected reef area of Apo Island MPA surrounds Apo Island, but, Dhigali Haa is situated in the middle of Baa Atoll, away from land. Because of the greater open water between Dhigali Haa and the management office, more costs would be incurred on patrolling the MPA. For example, the MPA monitoring cost given in Table 4.5 is mainly from the cost of running and maintaining the patrol boat. Therefore, it is reasonable that this estimate for Dhigali Haa is higher compared with Apo Island MPA.

The annual operational cost of the Bonaire Marine Park in the Caribbean was reported by Thur (2003) to be US$270,000. Bonaire Marine Park, which surrounds the island of Bonaire is approximately 2,700 hectares (Thur 2003). As this MPA is very large compared to Dhigali Haa, which amounts to only a few hectare, the operational cost of the proposed IMS should in principle be considerably lower. Although my estimate is lower compared to that of Bonaire Marine Park, the difference not being in proportion to the difference in size may be due to the fact that, as with Apo Island MPA, Bonaire Marine Park is surrounding land. In contrast, Dhigali Haa being isolated from land, and the required patrol and access by boat, substantially increases the estimated operational cost of the MPA.

4.7. Conclusion

Dhigali Haa, like all MPAs, in the Maldives lacks proper management and enforcement of its protected status. Due to this lack there is continued fishing of sharks and reef fish from the MPA and the use and effects of recreational diving is also not monitored. Hence, there is continued degradation of the MPA. At present, there are continued conflicts between fishermen and the resorts (mainly diving centres) over use of Dhigali Haa. From detailed discussions with these two groups I found that, despite the continued conflicts, both stakeholder groups have an interest to protect shark populations as sharks are beneficial to both the fishermen and divers who use the MPA.

Further discussions with stakeholders showed that the main focus of the management should be to raise awareness of the MPA; its purpose and benefits, the protection rules and penalties for violations.

The proposed improved management has been developed with stakeholder consultations and based on the existing implementation capacity of the Government of the Maldives. The proposed IMS focuses on increasing awareness and education, maintaining and monitoring the MPA and its activities, monitoring the health of the reef and reporting on the effects of MPA management and enforcement. I propose that the IMS be implemented in a collaborative manner between the government and local stakeholders. Financial resources would be one of the main barriers to actual implementation of the IMS. An initial costing of the implementation estimates about US$173,661 including capital and annual operational costs. The WTP estimates obtained from the CV survey would be used later in Chapter 6 to compare the benefits of improving management at Dhigali Haa with this estimated cost of implementing the proposed IMS.

CHAPTER 5

5. CV Survey Analysis and Results

5.1. Introduction

This chapter gives the results of the contingent valuation (CV) survey conducted to obtain estimates of the willingness to pay (WTP) of visitors to Baa Atoll for better conserving Dhigali Haa. The chapter starts with a brief description of the response to the CV survey and the data analysis methods used. A description of the demographic characteristics of the survey sample is given to provide a background on the respondents. In order to determine if my survey sample is representative of the tourist population visiting Baa Atoll, a comparison of demographics from the two groups is included. This is followed by simple results of the WTP of the sample and regression results for a model estimating the determinants of WTP. The results of the regression analysis are used to adjust the simple estimate of WTP, based on discrepancies between the sample surveyed and the population of tourists visiting Baa Atoll.

5.1. Response to the CV Survey

There were a total of 86 respondents to the in-person survey and 113 respondents to the mail survey. Table 5.1 details the responses to the research from the different resort management and also the responses from the survey respondents. Although all the resorts which participated in the survey were very supportive of using mail surveys, the level of support to in-person surveys varied depending on resort type.

Response rates received for the survey were low, 21.8% and 28.3% respectively for in-person and mail surveys. The general reason that people on holiday would not want to spend time answering surveys was one factor in the low response rate. I also believe the level of access granted to tourists and the type of resort was a dominant factor affecting the response rate. For example, of the resorts participating in the survey, Coco Palm Resort, which offers the most privacy, had the lowest response rate for in-person surveys. Taking into account the response rate for the mail survey, just barely made the targeted lower sample size of 25%.

Table 5.1 Summary of Responses Received for the CV Survey

Resort	**Resort Response to Survey**	**In-person survey**			**Mail Survey***	
		# Occupied Rooms	**# Responses**	**Response Rate**	**# Responses**	**Response Rate**
Coco Palm Resort	Was supportive of the research, but I was cautioned on approaching tourists as this resort also provided privacy to the tourists. Instead, the management sent out invitations to all rooms and the tourists were informed of the survey and were asked to approach the survey desk provided at the lobby.	82	4	4.9%	0**	0%
Kihaadhuffaru Resort	Was very supportive of the research. Invitations were sent out to all the rooms, as well as announcements being made about the ongoing survey. As all the tourists here were Italians, the resort provided staff to assist in translations. I was allowed to approach tourists and communicate through the staff member.	75	33	44.0%	0**	0%
Reethi Beach Resort	Was supportive of the research and helped inform tourists about the research being carried out. I was not allowed to approach tourists directly but the management was very helpful in informing the tourists.	124	20	16.1%	21	10.5%
Royal Island Resort	Was very supportive and helpful towards the research. Invitations were sent out to all rooms. I was allowed to approach tourists and interview them.	113	29	25.7%	92	46%
Sonevafushi	Was not allowed to conduct survey as the resort gives high priority to providing privacy to tourists	-	-	-	-	-
	Total	394	86	21.8%	113	28.3%

* Each resort was sent 200 questionnaires

** Completed responses lost in transit. This reduced the total number of potential questionnaires to 400.

5.2. Data Analysis Methods

Data collected from the surveys were analysed using the software Statistical Package for the Social Science, SPSS version 15.0. Table 5.2 gives a description of the data variables collected from the CV survey. The variables under "Demographics" help describe the characteristics of the sample population. The variables listed as "Attitude/Behaviour" describe respondents' attributes such as use, awareness and concern for the environment, particularly the marine environment. The two variables listed under "WTP" refer to the responses given by respondents to the elicitation questions. Responses to the two WTP questions were in different currencies mainly depending on the nationality of respondents[16]. "WTP conservation fee" and "WTP user fee" give the WTP amounts of respondents converted to US$. While "WTP conservation fee" was targeted for all respondents "WTP user fee" was for divers only. Divers are identified as the respondents who give a "YES" response to the variable "User".

The raw survey data was first checked to identify missing or non-usable data and these respondents were not included in the analyses. Secondly, some variables were recoded as dummy variables to help in the analyses. A number of respondents to the survey did not answer the WTP questions. Of the 86 in-person survey respondents only 79 had provided "WTP conservation fee", and of 38 self-identified divers only 30 answered "WTP user fee". Similarly, for the mail survey the number of respondents was 100 of the 113 respondents and 51 of 54 divers for "WTP conservation fee" and "WTP user fee" respectively. For analyses of WTP, respondents with "WTP conservation fee" and "WTP user fee" missing were excluded.

Among the "Attitude/Behaviour" questions, "Reef Health" and "Reef Threats" had poor responses. From the in-person survey, I perceive that these low responses reflect either a lack of understanding of coral reefs in general or understanding of the question. The responses for the demographic variables were much better with usable responses of 85 of 86 for the in-person survey and 108 of 113 for the mail survey, except for "Employment" which had 107 responses. Although the number of respondents providing the WTP variables was lower than the number providing descriptive statistics, I used as many responses as available in each category for analyses. Therefore, the number of responses (N) used for in the descriptive statistics will vary for the different variables.

[16] The US$ was the most frequently used currency (72% of responses). 27% of responses used Euro while about 1% used British Pound and Japanese Yen. The US$ is the main currency used by resorts in the Maldives.

Table 5.2. Description of Variables Used in CV Survey

VARIABLE GROUP	VARIABLE	DESCRIPTION
Demographics	Gender	Gender
	Nationality	Nationality
	Age	Age at the time of survey
	Education	Highest level of education obtained
	Employment	Employment status at time of survey
	Household Income	Total household income in 2005 before taxes (in US$)
Attitude or Behaviour	Visit to Maldives	Number of times visited to the Maldives
	Visit to Baa	Number of times visited to Baa Atoll
	User	Planned to dive during current visit
	Diving Year	Number of years been diving
	Dive Certification	Level of diving certification
	Purpose	Main purpose of current visit
	Environmental Groups	Involved in Environmental Groups
	Conservation Activities	Involved in conservation projects
	Donate	Donates to environmental causes
	Reef Health	Awareness of present health of worlds coral reefs
	Reef Threats	Awareness of threats to coral reefs
WTP	WTP conservation fee	Amount willing to pay as a conservation fee for each visit to Baa Atoll
	WTP user fee	Amount willing to pay for as an entrance fee per visit to *Dhigali Haa*

5.3. Demographics and Attitude/Behaviour of the Sample

This section analyses the demographic and attitude/behaviour of the sample interviewed. Table 5.3 gives the percentages and standard deviations (Std. Dev.) of the main demographic variables for the in-person survey, mail survey and combined (ALL) samples. The table also gives comparisons with the population of visitors to Baa Atoll for the year 2006. Some of the detailed demographic and attitude/behaviour distributions are shown graphically in Appendix 7.

Table 5.3. Main Demographic Variables of Respondents

Variable	Description	In-person survey (%)	Mail survey (%)	ALL* (%)	BAA** (%)
Gender***	0 = female 1 = male (std. deviation)	49 51 (0.50)	36 64 (0.48)	42 58 (0.50)	51 49 (0.50)
Nationality***	0 = Other 1 = British 2 = German 3 = Italian (std. deviation)	14 18 25 44 (1.09)	23 33 42 2 (0.82)	19 26 34 20 (1.02)	49 18 19 14 (1.12)
Age	0 = Under 20 1 = 20-29 2 = 30-39 3 = 40-49 4 = 50-59 5 = Over 60 (std. deviation)	0 17 34 28 14 7 (1.14)	0 10 31 33 16 8 (1.12)	0 13 33 31 15 8 (1.13)	10 18 32 23 12 6 (1.32)
Education	0 = some high school 1 = high school diploma 2 = trade certificate 3 = some university 4 = university degree 5 = postgraduate degree 6 = other (std. deviation)	7 22 6 11 36 18 0 (1.64)	9 7 11 9 39 24 0 (1.58)	8 14 9 10 38 21 0 (1.61)	-
Employment	0 = unemployed 1 = employed (std. deviation)	20 80 (0.39)	15 85 (0.35)	16 84 (0.37)	-
Household Income***	0 = Under 20,000 1 = 20,001-40,000 2 = 40,001-70,000 3 = 70,001-100,000 4 = Over 100,000 5 = Not Stated (std. deviation)	9 12 29 16 21 12 (1.48)	3 5 19 14 44 16 (1.25)	6 8 24 15 34 14 (1.40)	-

Figures are expressed in percentages of the survey sample and Baa Atoll population. The standard deviations of the data are given in parenthesis.
*ALL include both in-person survey and mail survey.
** Tourist Arrival Statistics for 2006 from the Department of Immigration and Emigration, Maldives were used. Data was available only for variables "Gender", "Nationality" and "Age". The population size was 21954.
Note: N = 85 for all in-person survey variables and N=108 for all mail survey variables except WORK, which is 107
*** Independent Samples t-test showed that the means of these variables were significantly different for the two survey types at both 5% and 10% confidence levels.

While the in-person survey sample had a more balanced gender distribution in relation to the population of tourists visiting Baa Atoll, the mail survey had a slightly higher number of male respondents. Both survey methods showed that respondents are mainly from European countries and the main nationalities represented in the survey were British, German and Italian. All other nationalities have been categorised into "Other". This includes mainly Swiss, Austrian, Russian, American, Japanese, Korean and Polish tourists. Comparison with the population of tourists visiting Baa Atoll, "Other" nationalities seem to be very much under-represented in the survey sample. About 50% of actual visitors to Baa Atoll were of nationalities other than British, German or Italian, and hence, my survey sample appears to have over-represented these

nationalities. But a deeper look into the nationality distribution of tourists who visited Baa Atoll in 2006 (Table 5.4) showed that, similar to my survey results, German, British and Italian tourists were the most frequent single nationalities. Consistent with my survey sample, the "Other" nationalities included mostly tourists from European countries.

Table 5.4. Nationality Distribution for Tourists, Baa Atoll in 2006

Nationality	**Percent**
Austrian	4.3
British	18.0
French	8.2
German	18.7
Italian	14.3
Swiss	8.5
Other European	8.9
Japanese	5.5
Other Asian	3.9
Russian	5.8
Others	3.9
Total	100.0

For both in-person survey and mail survey the majority of respondents are in the age groups 30-39 and 40-49 respectively and the overall sample contained mostly respondents aged 30-39. The age distribution of tourists who visited Baa Atoll in 2006 also has the highest percentages in these two categories. The education qualification of respondents showed that 54% and 63% of respondents had a university degree or higher for in-person survey and mail survey respectively. Responses from both surveys also show that 22% of respondents have completed some high school or less and 9% have a trade certificate. Information was not available on the educational qualification of tourists visiting Baa Atoll. Studies targeted for tourists visiting the Maldives suggest that most visitors who come to the Maldives are highly educated (Cesar et al. 2000; Salih 2000).

The responses to the survey show that over 80% of the sample visitors to Baa Atoll are employed. The rest included those who were retired, unemployed had home duties or were students. While data for the population of visitors to Baa Atoll was not available for comparison, similar percentages for employment have been obtained in studies which included tourists visiting the whole of the Maldives (Cesar et al. 2000; Salih 2000). The variety of areas of employment of the survey sample indicates that they are employed in stable, high income jobs (Figure A7.1 in Appendix 7). This is consistent with the findings of a tourist opinion survey targeted for all the tourists visiting the Maldives (Ministry of Tourism 2005).

All respondents were asked their total household income in 2005 before taxes (henceforth will be referred to as household income). Overall, 14% of respondents declined to state their household income (12% and 16% for in-person survey and mail survey respectively). Most in-

person survey respondents earned a household income between US$40,000 and US$70,000 while most mail survey respondents had a household income greater than US$100,000. Data was not available to compare these household incomes with that of all visitors to Baa Atoll or for general tourists visiting the Maldives. A study conducted by the Ministry of Tourism (2005) and Cesar et al. (2000) had data on individual income, rather than household income of tourist and hence it was not possible to compare my results. Based on individual incomes, these studies do show that the general tourists visiting the Maldives are wealthy.

In summary, from the information collected in the surveys, the sampled visitors have a balanced gender distribution, are mainly between ages 30 to 49, highly educated, employed in stable, high income jobs and have a high household income. Comparing with available demographics of the population who visited Baa Atoll in 2006, I can conclude that apart from the nationality, my survey sample is well representative of the visitors to Baa Atoll. Although the variables "Employment", "Education" and "Household Income" could not be directly compared to the visitors to Baa Atoll, based on studies for general visitors to the Maldives, I could proxy that my survey sample is representative in terms of these variables.

5.3.1. Individual Attributes and Behaviour of the Sample

The results of responses to some of the individual attributes and behaviour questions are given in Table 5.5. More than 80% of the survey respondents were first time visitors to Baa Atoll and this was the first visit to the Maldives for more than 50% of the respondents (Figures A7.2 in Appendix 7).

Respondents were also asked about the purpose of their visit, where the categories of relaxing, diving or water related sport, honeymoon, work and other were given. The respondents were allowed to give multiple responses. The main reasons for the visit across both survey methods were relaxation and diving or water related activities (Figure A7.3 in Appendix 7). There were more respondents who came for diving or other water related activities in the mail survey compared to the in-person survey. This difference is also captured in the variable "User" which looks at visitors who plan to go diving during their visit. As seen in Table 5.5, non-users outnumber the users in the in-person survey sample while, the number of users and non- users are the same in the mail survey sample. The level of experience of divers is also significantly different got the two survey types. The users from the mail survey were more experienced with more than 60% of the users being involved in diving for more than 5 years and 88% having an Open Water diving qualification and above. In contrast, most of the users (52%) from the in-person survey had been diving for less than a year and 64% had a qualification of Open Water and above. Overall, the divers from the survey can be termed as experienced. A study targeted

for divers visiting the Maldives also indicate that divers visiting the Maldives are highly experienced (Salih 2000).

Table 5.5. Results of Individual Attributes of Survey Respondents

Variable	Description	In-person survey	Mail survey	ALL*
Visit to Baa	Once Twice More than Twice (Std. dev)	89 8 2 (2.27)	81 13 6 (3.10)	85 11 5 (2.78)
Environment Concern	0 = Not Concerned 1 = Concerned (Std. dev)	55 45 (0.50)	54 46 (0.50)	55 45 (0.50)
User	0 = Non User 1 = User (Std. dev)	61 39 (0.49)	50 50 (0.50)	55 45 (0.50)
Diving Year**	Less than 1 year 1-5 years More than 5 years (Std. dev)	52 27 17 (9.08)	15 24 61 (7.33)	29 25 46 (8.24)
Dive Certification**	0 = Beginner 1 = Open Water 2 = Advanced 3 = Master/Rescue (Std. dev)	36 27 30 6 (1.00)	2 44 46 8 (1.04)	16 37 40 7 (1.02)

Figures are expressed in percentages of the survey sample. The standard deviations of the data are given in parenthesis.
*ALL include both in-person survey and mail survey.
** Independent Samples t-test showed that the means of these variables were significantly different for the two survey types at both 5% and 10% confidence levels.
Note: N = 85 for all in-person survey variables except "Diving Year" and "Dive Certificate", where N = 33. For mail survey, N= 54 for "Diving Year" and "Dive Certificate". For other mail survey variables, N = 102, 108 and 105 for "Visit to Baa", "User" and "Environment Concern" respectively.

The variable "Environment Concern" is a dummy variable used to infer how concerned the visitors are about the environment. This uses the variables "Environmental Groups", "Conservation Activities" "Donate". Respondents with a "YES" response to, at least one of the three variables given above are identified as concerned about the environment. Table 5.5 shows that in both survey types, the greater population of the survey respondents were inclined to be not very concerned about the environment.

The survey also attempted to obtain information on the awareness of respondents about reefs and reef health in general. The variable "Reef Health" asked respondents to judge whether the health of reefs worldwide was improving, deteriorating or holding steady, while the variable "Reef Threats" probed respondents' knowledge as to specific threats to reefs. The results are presented in Figure A7.4 in Appendix 7. For the in-person survey, 27% of these respondents answered that they were not sure as to what the present status of reefs were and 10% of respondents from the mail survey gave a similar response. This is reflective of the fact that the mail surveys contained a higher percentage of divers, and, thus they would be more aware of coral reefs and its health.

In both surveys, the majority of respondents thought the health of reefs were generally deteriorating.

"Reef Threats" allowed respondents to give multiple answers to an open question. The responses were classified into the following general categories:

1. Human – includes use of reefs for activities such as fishing, recreation, mining and anchoring of boats.
2. Climate – includes climate change, El Nino and elevated temperatures
3. Pollution – includes dumping of waste, oil spills, and sewerage pipes. This has been used as a category separate from 'Human' because of the profound mention of this by respondents.
4. Nature – includes natural events such as tsunamis, storms and also biological invasions such as crown of thorns starfish.

Details of the results of this question are given in Figure A7.5 of Appendix 7. Rankings of the different threats were very similar for both in-person survey and mail survey. Therefore, the overall rankings are human activities (69%) climate related events (53%), pollution (32%) and Nature (6%). Literature on threats to coral reefs also identify impacts from human activity and climate related influences as the major threats (Kleypas and Eakin 2007). Overall the sampled visitors were aware of issues facing coral reef environments, at least in general terms.

5.3.2. Comparison of Users Vs Non-Users

This study has identified divers as one of the main users of Dhigali Haa and they were represented under the variable "User". This section compares characteristics of users and non-users and Table 5.6 gives a summary of the findings. Detailed comparison of the two groups among the survey types is presented in Table A7.1 in Appendix 7.

Compared with non-divers, the users were more likely to be male, in both survey types. In contrast, attributes such as number of visits to Baa Atoll and environmental concern were similar for the two groups. Although the number of visits made to Baa Atoll were similar for both groups, the variable "Visit to Maldives" shows that the percentage of users who have visited the country more than once is greater than non-users.

Table 5.6. Comparison of Reef Users and Non-Users

Variable	Description	User	Non-User
Gender	0 = female 1 = male (std. dev)	37 63 (0.49)	46 54 (0.50)
Nationality	0 = Other 1 = British 2 = German 3 = Italian (std. dev)	15 16 45 23 (0.24)	23 34 25 18 (1.03)
Age	0 = Under 20 1 = 20-29 2 = 30-39 3 = 40-49 4 = 50-59 5 = Over 60 (std. dev)	0 14 40 30 14 2 (0.98)	0 13 27 31 16 13 (1.24)
Education	0 = some high school 1 = high school diploma 2 = trade certificate 3 = some university 4 = university degree 5 = postgraduate degree (std. dev)	7 13 11 7 45 17 (1.54)	9 15 8 11 32 5 (1.60)
Employment	0 = unemployed 1 = employed (std. dev)	6 94 (0.24)	25 75 (0.43)
Household Income	0 = Under 20,000 1 = 20,001-40,000 2 = 40,001-70,000 3 = 70,001-100,000 4 = Over 100,000 5 = Not Stated (std. dev)	7 9 24 11 31 17 (1.51)	5 7 23 19 36 10 (1.31)
Visit to Baa	Once Twice More than Twice (std. dev)	86 11 4 (1.11)	85 11 50 (0.60)
Visit to Maldives	Once Twice More than Twice (std. dev)	47 20 33 (3.30)	64 14 22 (2.16)
Environment Concern	0 = Not Concerned 1 = Concerned (std. dev)	54 46 (0.50)	54 46 (0.50)

Figures are expressed in percentages of the survey sample. The standard deviations of the data are given in parenthesis.

Comparison of the age categories show that non-users are older compared to users. Although both categories have a high percentage of respondents with a university degree or more, the percentage is higher for users compared to non-users. Both users and non-users are employed, but the percentage of respondents who are unemployed is comparatively higher for non-users. The results show that the percentage of non-users having a household income greater than US$70,000 is more compared to users indicating non-users are wealthier than the users. The

more contrasting difference was found in the variable "Nationality". Users were more likely to be German compared with more British respondents who were non-users.

In summary, users are more likely to be German, between 30 to 39 years, highly educated, more likely to be employed and to have visited the Maldives more times than non-users. Non-users are most likely to be British, older, employed, highly educated and likely to have a higher income compared with users.

5.4. Willingness-to-pay (WTP) of the Sample

All respondents were asked their maximum WTP a one-off conservation fee (WTP conservation fee) per visit to Baa Atoll. Depending on whether the respondents planned to dive during the visit (User), they were then asked their maximum WTP an entrance fee (WTP user fee) each time they visited Dhigali Haa. This section presents how the WTP conservation fee and WTP user fee varied depending on the survey type and the different demographic and attitude/behaviour variables. Later, the WTP variables are analysed using linear regression, while controlling for the effects of individual variables.

5.4.1. The WTP Distributions

Figures 5.1 and 5.2 give the distribution of the WTP conservation fee for in-person and mail surveys respectively. The WTP user fee distribution is presented in Figure 5.3.

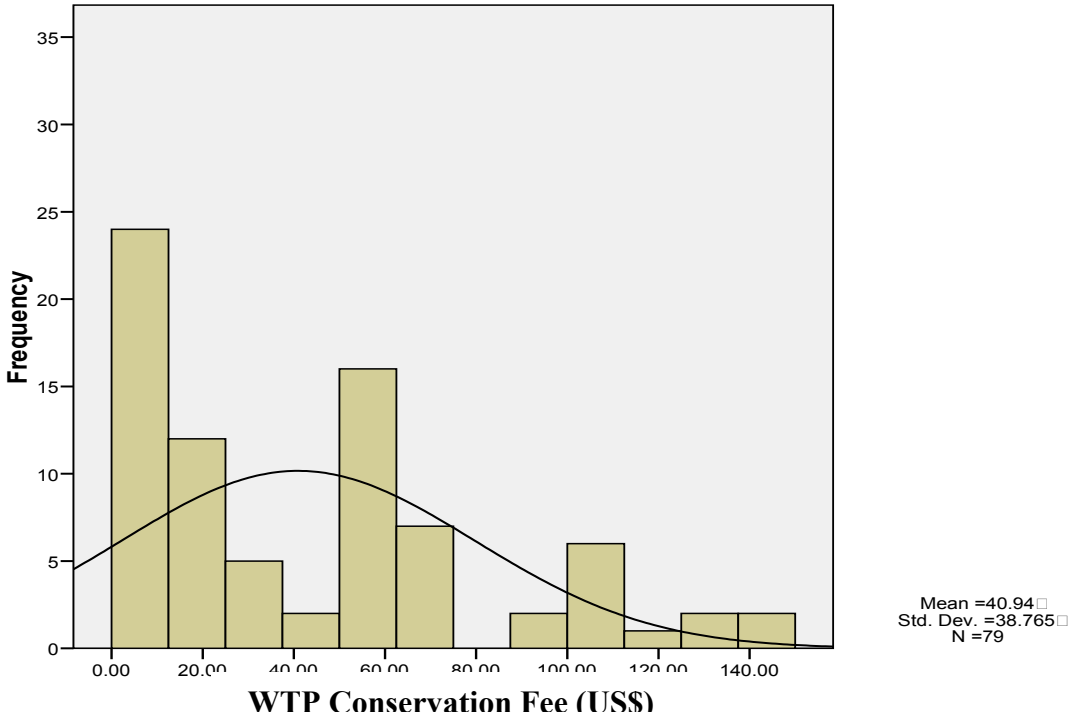


Figure 5.1. Frequency Distribution of WTP Conservation Fee (In-person survey)

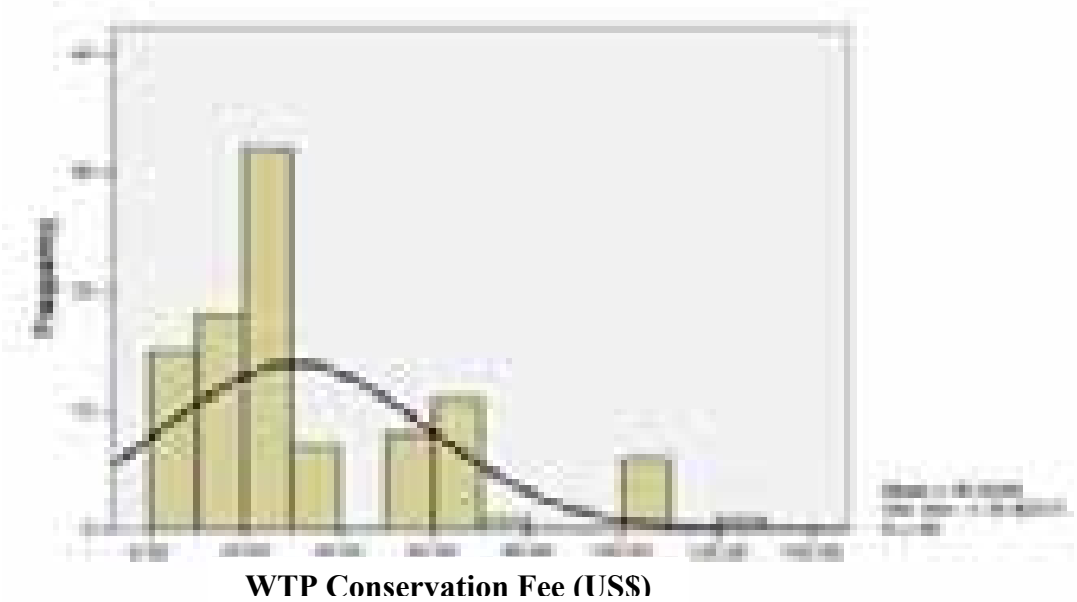


Figure 5.2. Frequency Distribution of WTP Conservation Fee (Mail survey)

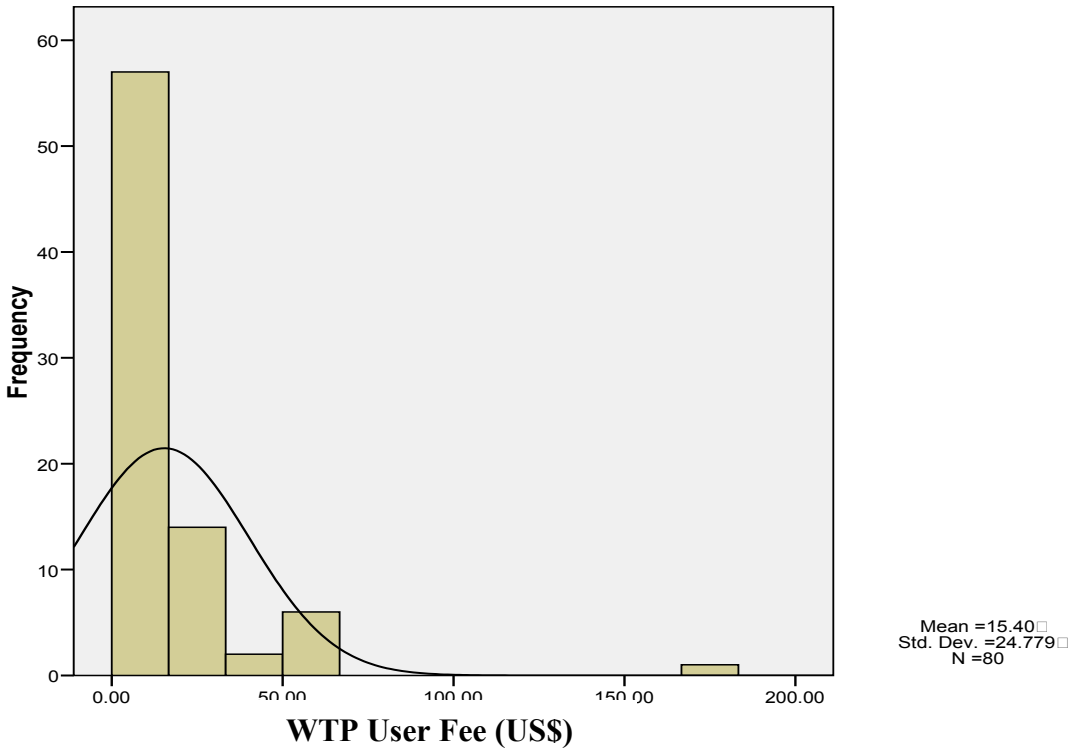


Figure 5.3. Frequency Distribution of WTP User Fee

Figure 5.1 and 5.3 show a big spike at zero for the WTP distributions, which is not surprising for many CV studies. Boyle (2003) states that many CV studies generate a high percentage of zero responses, which may mean to be "true zero" responses or they may be a "protest bid" due to the respondent not agreeing with one or more components of the survey. A follow up question was used to obtain reasons for respondents' willingness to pay or not to pay. This would help identify

if the zero bids were "true zero" bids or rather "protest bids" to some element of the CV survey. As seen in Table 5.7, the majority of the responses were "protest bids" rather than "true zero" bids. The main reason reported for these "protest bids" by respondents to the WTP conservation questions was that respondents felt, other groups, such as the government, resort operators, users of Dhigali Haa including divers and local fishermen, should pay. Similarly some of the reasons for the "protest bids" by users was that users felt it was not only divers who contributed to destruction of the reef environment, and hence, other visitors including the resort should also contribute to paying a conservation fee targeted for everybody. Other reasons included the view that MPAs should be protected from all users, the already high cost of diving in the Maldives and also the availability of good substitute sites which could be accessed without paying an entrance fee.

Table 5.7 Distribution of Zero Bids by Bid Type

Bid Type	**% of Zero Bids to WTP Conservation fee**			**Percentage of Zero Bids to WTP user fee (N=20)**
	In-person survey (N=12)	**Mail survey (N=13)**	**All (N=25)**	
true zero	17	8	12	15
protest bid	83	92	88	85

Table 5.8 presents the mean WTP conservation fee and mean WTP user fee, both including and excluding the protest bids. From the table it can be seen that the mean WTP conservation fee is higher for the in-person survey when compared with the mail survey. Despite the presence of a prominent zero model in the in-person distribution, compared with the mail survey distribution, the mean WTP by the in-person respondents was higher than for the mail survey. A common belief by CV critics is that in person survey generally give higher WTP values as respondents may feel an implicit pressure to come across as good people or impress the interviewer when in person, in contrast to when answering questions anonymously (Ethier et al. 2000). This is referred to as the "social desirability bias", where the respondent would want to appear morally good in the eyes of the interviewer.

Table 5.8. Mean WTP (US$) With and Without Protest Bids

WTP_Type	Survey Type	With Protest Bids			Without Protest Bids		
		N	Mean	Std. Deviation	N	Mean	Std. Deviation
"WTP conservation fee"	in-person survey	79	40.94	38.76	69	46.88	37.97
	mail survey	99	30.84	28.4	86	35.5	27.62
"WTP user fee"	in-person survey	78	14.85	24.73	64	20.69	26.79

The mean WTP user fee was US$15.40 in Table 5.8 is lower compared to the WTP conservation fee estimates for both survey types. The difference may be due to the users having objection to the payment vehicle for the WTP user fee, on the grounds of fairness. One of the main reasons stated by the users for the protest bids was the fact that the establishment of tourist resorts itself causes harm to the reef environment, and hence, the resorts are built for the benefit of all tourists who visit the area, it was not perceived as fair that only users of Dhigali Haa should pay to improve the MPA. A CV study to estimate benefits from recreational water based activities by Greenley et al. (1981), observed similar perceived inequities by local residents when the payment vehicle for improved stream quality was a residential tax compared with a general tax which included visitors to the area.

Another reason for the lower WTP user fee in my survey may be due to respondents perceiving the WTP user fee as being "in addition to" the WTP conservation fee. Although it was explicitly stated during the surveys that the WTP user fee was "instead of" a WTP conservation fee, the order of presentation of the two payment vehicles may lead to the users focusing that the user fee payment vehicle was an "in addition to". As I had purposely not stated the decision rule of the survey, the respondents may also be answering cautiously in case a user fee targeted only for users was imposed. Considering all the possible reasons for the difference, I would infer that the lower WTP user fee is based on an objection to the proposed payment vehicle.

As seen from Table 5.8, all the mean WTP estimates are lower when the "protest bids" are included as opposed to when they are not. Despite the fact that the mean WTP is higher, by approximately US$5, when the "protest bids" are excluded, in order to keep a conservative approach to this study, I would use the mean WTP estimates which include "protest bids" for future analyses.

5.4.2. Analysis of the mean WTP

For both WTP conservation fee and WTP user fee, the means from the two survey types were tested for equality using Independent Sample t-Tests from SPSS. Table 5.9 gives the results of the test. The means for WTP conservation fee were significant at 10%. For the WTP user fee, the

test was not statistically significant and hence the responses for the in-person survey were not statistically different from mail survey responses. Based on this, in the following WTP user fee analyses, the mail survey and in-person survey samples were grouped together, but for WTP conservation fee analyses, the two groups were analysed separately.

The mail survey sample contained a significantly higher number of users compared with the in-person survey. The results in Table 5.4 also show that users from the mail survey were more experienced divers compared with those from the in-person survey. I expect that being direct users of the MPA, divers would have a more obvious interest in seeing improvements at Dhigali Haa. Therefore, I would expect that this marked difference in the variable "User" would affect the responses to the WTP conservation fee. Therefore, this may be the reason for the mean WTP conservation fee to be significantly different for the two survey types. In contrast, the fact that non-users are not asked the WTP user fee may explain why there is no significant difference in the two survey types.

Table 5.9. Independent Sample t-Test for the Equality of the Means of the WTP Variables

WTP_Type	Survey Type	N	Mean	Std. Deviation	Sig. (2-tailed)
"WTP conservation fee"	in-person survey	79	40.94	38.76	0.055*
	mail survey	99	30.84	28.40	
"WTP user fee"	in-person survey	30	14.39	19.19	0.898
	mail survey	48	15.14	27.84	

* Significant at 10%

5.5. Regression Analysis of Willingness to Pay

The WTP would be influence by factors such as the respondent's income, whether or not a user of the MPA, educational level, concern for the environment or even whether the survey was done in-person or through mail. Based on the literature reviewed on similar studies and my own intuition, I believe that the demographic and attitude/behaviour variables described earlier are the main factors which would affect the WTP responses. Tables A8.1 and A8.2 in Appendix 8 present the mean WTP conservation fee and WTP user fee, respectively for changes in these variables. For example as users would get direct benefit from improving management at Dhigali Haa, they may be expected to have a higher WTP than non-users. A user, who has a desire to pay for improvements at Dhigali Haa, may actually be WTP less if his income is low and thus his ability to pay is low. Similarly, an employed person would be expected to have a higher ability to pay compared with an unemployed person, demonstrating a possible dependency on the variables "Employment" and "Household Income". These examples show that the affects of the demographic and attitude/behaviour variables are not independent and they have a combined effect on the WTP. Analysis of WTP using regression will control for the effects of individual

variables. Therefore, regression analysis would show if a variable has significant influence in determining the WTP.

Tobit regressions are typically used to model WTP if there is a concentration of zero responses (Boyle 2003). In this method the regression assumes that all values of zero and lower are censored. Tobit regressions were run using the statistical analysis software STATA 9.1. In order to obtain an idea of the effects of the demographic and attitude/behaviour variables, an initial regression was run using all the variables. Depending on the significance and strength of the coefficients and my own judgement on the importance of the variables, some of them were subsequently dropped from the regression. Table 5.10 gives a list of variables considered in the regressions. As the number of responses to the CV study is small, the original categories of the independent variables had to be coarsened to reduce the number of independent variables used in the regressions. Table 5.10 also includes the new dummy variables created and their descriptions.

Table 5.10. Variables Used in Regression Models of mean WTP

Independent Variable	**Dummy Variable**	**Description**
Gender	Gender	=1 if male
Nationality*	German	=1 if German
	British	=1 if British
	Italian	=1 if Italian
	Other	=1 if any Other Nationality
Age	Age1	=1 if age less than 30
	Age2	=1 if age between 30-49
	Age3	=1 if age over 50
Education	Education	=1 if has a university qualification or more
Employment	Employment	=1 if employed
Household Income	Low Income	=1 if HINCOME is less than US$40,000
	Medium Income	=1 if HINCOME is US$40,000 – US$70,000
	High Income	=1 if HINCOIME is more than US$70,000
	Income Not Stated	=1 if income not stated
Visit to Maldives	Visit	Number of times visited the Maldives
User**	User	=1 if diving
Environment Concern	Environment Concern	=1 if environmentally concerned
Survey Type	Survey Type	=1 if survey type is mail (is 0 for personal interviews)

* "Nationality3" and "Nationality1" had the lowest mean "WTP conservation fee" and "WTP user fee" respectively. Therefore these nationalities were used for the baseline in the regression analysis.
** The variable "User" is not included in estimating "WTP user fee"

Based on the variables chosen for the analysis the empirical models of WTP conservation fee and WTP user fee to be determined by the regression analysis are given by Equations (5.1) and (5.2) respectively. The regression analysis would give estimates of the coefficient, β in the

equations. The results of the coefficient estimates for the WTP conservation fee and WTP user fee equations are given in Tables 5.11 and 5.12 respectively. Appendix 9 provides a description of the Regression Models (1) – (13).

$$\begin{aligned} WTP\ conservation\ fee = {} & \beta_0 + \beta_1 Gender + \beta_2 Nationality1 + \beta_3 Nationality2 \\ & + \beta_4 Nationality4 + \beta_5 Age1 + \beta_6 Age2 + \beta_7 Education + \beta_8 Employment \\ & + \beta_9 Medium\ Income + \beta_{10} High\ \text{Income} + \beta_{11} Visit + \beta_{12} Environment\ Concern \\ & + \beta_{13} User + \beta_{14} Survey\ Type \end{aligned} \tag{5.1}$$

$$\begin{aligned} WTP\ \text{user}\ fee = {} & \beta_0 + \beta_1 Gender + \beta_2 Nationality2 + \beta_3 Nationality3 \\ & + \beta_4 Nationality4 + \beta_5 Age1 + \beta_6 Age2 + \beta_7 Education + \beta_8 Employment \\ & + \beta_9 Medium\ Income + \beta_{10} High\ \text{Income} + \beta_{11} Visit + \beta_{12} Environment\ Concern \end{aligned} \tag{5.2}$$

Initial regressions were done using the variable "Survey Type" for both WTP conservation fee and WTP user fee. These regressions showed that the survey type was significant at 5% to determine the responses to the WTP conservation fee, but the survey type was nit significant for responses to WTP user fee. Based on these results, variable "Survey Type" was not included in modelling WTP user fee. Based on the significance and strength of coefficients as well as my intuition, I have chosen the Regression models (4) and (13) respectively, to estimate Equations (5.1) and (5.2). For sensitivity analysis Regression Models (4) and (13) were run without the "protest bids" reported in Section 5.4.1. Results of these regressions are presented in Table A9.2 of Appendix 9.

Table 5.11 Regression Estimates for Willingness to Pay a Conservation fee for Dhigali Haa

Regress Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
N	172	176	175	177	56	34	172	176	177
df	14	13	12	10	11	11	14	11	10
log likelihood	-749.67	-760.40	-760.69	-766.97	-242.34	-134.92	-751.38	-766.75	-768.38
Constant	8.78 (12.87)	9.64 (12.84)	8.43 (12.77)	3.87 (11.68)	47.16* (27.50)	77.75* 45.89)	7.64 (13.66)	9.09 (12.81)	3.69 (12.48)
Gender	8.71 (6.08)	9.17 (6.04)	9.86* (5.98)	10.59* (5.92)	21.15 (13.09)	15.16 (4.89)	8.19 (6.22)	9.98* (6.01)	10.36* (6.02)
German	30.80** (9.72)	30.81** (9.62)	30.04** (9.57)	26.34** (9.15)	-	-	29.29** (9.79)	28.87** (9.61)	25.27** (9.24)
British	37.84** (10.25)	37.91** (10.03	37.32** (10.01)	35.08** (9.74)	-	-	36.58** (10.42)	36.05** (10.09)	34.05** (9.91)
Other	19.98* (10.48)	19.90* (10.34)	19.07* (10.30)	16.95* (10.07)	-	-	18.44* (10.67)	17.91* (10.43)	15.71 (10.27)
Age1	14.78 (10.95)	15.00 (10.48)	15.05 (10.51)	16.62 (10.44)	25.28 (33.17)	15.95 (34.73)	13.83 (11.13)	13.93 (10.63)	15.81 (10.63)
Age2	11.80 (7.60)	11.23 (7.31)	11.04 (7.32)	11.23 (7.29)	12.67 (15.66)	5.66 (30.92)	10.96 (7.68)	10.06 (7.35)	10.47 (7.36)
Education	-4.05 (5.95)	-4.45 (5.88)	-	-	-5.17 (12.51)	13.78 (16.84)	-4.85 (6.14)	-	-
Employment	13.92 (9.09)	12.36 (8.75)	12.22 (8.76)	13.97 (8.60)	-21.00 (21.58)	-41.25 (55.73)	13.32 (9.28)	12.12 (8.81)	13.80 (8.81)
Medium Income	-19.64** (8.03)	-17.76* (9.95)	-18.60* (9.91)	-16.88** (7.83)	-31.39* (16.34)*	- 39.32** 17.91)	-13.19 (9.79)	-14.56 (9.57)	-12.11 (9.51)
High Income	-10.67 (7.67)	-8.94 (10.01)	-10.38 (11.83)	-9.93 (7.37)	-8.41 (15.02)	-33.33 (20.37)	-4.78 (9.96)	-7.87 (9.48)	-6.64 (9.48)
Income Not Stated	-	1.92 (11.92)	0.68 (11.83)	-	-	-	-	-	-
Visit	0.26 (1.06)	-	-	-	1.58 (1.49)	-.49 (8.90)		-	-
Environment Concern	-6.68 (5.98)	-6.89 (5.89)	-7.16 (5.89)	-	-5.90 (11.61)	-30.55 (19.28)	-6.77 (6.05)	-7.21 (5.91)	-
User	0.02 (6.24)	-	-	-	11.32 (12.80)	-5.09 (15.77)	0.97 (6.26)	-	-
Survey Type	-23.13** (6.76)	-23.22** (6.58)	-23.02** (6.59)	-22.39** (6.43)	-14.57 (12.50)	-236.20 (-)[17]	-24.09** (6.87)	-23.40** (6.62)	-22.67** (6.53)

NOTES: Coefficients are estimated using Tobit regressions. N is the number of observation in the regression and df is the degrees of freedom; The regression coefficients are in the top line of the cells followed by the standard deviation in the parentheses; log likelihood gives a measure of how good the regression fit is.
** indicates significant at 5% level or better; * indicates significance at 10%.

[17] The WTPCONSV for Italians were zero for the MS samples and has been excluded from the regression.

Table 5.12. Regression Coefficients for Willingness to Pay a User Fee for Dhigali Haa

Regress Model	**(10)**	**(11)**	**(12)**	**(13)**
N	77	81	81	83
df	13	10	9	8
log likelihood	-284.49	-299.92	-300.03	-308.83
Constant	-43.02* (23.12)	-21.86 (17.16)	-19.95 (16.67)	-26.11** (12.57)
Gender	14.06* (8.54)	12.70 (8.11)	11.63 (7.78)	11.69 (7.65)
Other	17.62* (10.75)	12.88 (10.20)	13.04 (10.20)	13.28 (9.95)
British	20.26* (11.94)	17.68 (10.70)	17.39* (10.68)	16.75 (10.46)
Italian	16.95 (12.59)	11.51 (9.25)	11.15 (9.22)	10.09 (8.91)
Age1	26.12* (15.06)	25.85* (13.46)	24.96* (13.33)	25.49* (13.07)
Age2	21.58* (11.11)	17.09* (9.74)	16.78* (9.72)	16.11* (9.44)
Education	5.10 (8.07)	3.55 (7.61)	-	-
Employment	3.06 (17.29)	-8.78 (13.54)	-7.86 (13.39)	-
Medium Income	5.92 (9.54)	7.15 (9.10)	7.46 (9.08)	7.02 (8.91)
High Income	12.22 (9.22)	13.99 (8.93)	15.07* (8.64)	14.74* (8.41)
Visit	**-0.17** (1.14)	-	-	-
Environment Concern	**-0.35** (8.31)	-	-	-
Survey Type	5.2 0(9.94)	-	-	-

NOTES: Coefficients are estimated using Tobit regressions. N is the number of observation in the regression and df is the degrees of freedom; The regression coefficients are in the top line of the cells followed by the standard deviation in the parentheses; log likelihood gives a measure of how good the regression fit is.
** indicates significant at 5% level or better; * indicates significance at 10%.

For the WTP conservation fee, gender was significant at 10% with male respondents likely to pay more compared to females. German, British and Other nationalities had significantly higher WTP than did Italians. The type of survey was also significant, with mail survey respondents willing to pay significantly less than in-person survey respondents. This supports the "social desirability bias" hypothesis. It was also surprising to find a negative income effect with low income groups willing to pay more on average than medium income groups and, not willing to pay significantly less than high income groups. The variable "Medium Income" had a very strong negative coefficient which was highly significant at the 5% level. This anomaly is discussed later in this section. Despite the high percentage of users who responded to the mail

survey, it was also surprising to find that the variables "User", "Environment Concern", "Visit" and "Education" had no statistically significant impact on WTP conservation fee for improved management of Dhigali Haa, once other factors were controlled. While the "Age" categories and "Employment" were not significant, their estimated coefficients were of high magnitude, which showed employed people and those less than 50 years of age had a higher WTP compared to the unemployed and people over 50 years. But technically, the fact that these coefficients were not significant would mean they are not distinguishable from zero responses.

For the WTP user fee the only significant variables were the "Age" group and "High Income" variables, all significant at 10%. Here, the significance of the high income effect is positive, so that, as more conventionally expected, those divers with nominal household incomes in excess of US$70,000 were willing to pay more in user fees than those with nominal household incomes less than US$40,000. Older people have the highest percentage of retired people and therefore, they would have a lower household income compared to employed respondents. All nationalities (British, Italian and Others) although not very significant, all had very strong coefficients. As with the WTP conservation fee, the variables "User", "Environment Concern", "Visit" and "Education" were not significant at all and had very small estimated coefficients.

The negative income relation found in the WTP conservation fee estimation was not observed for WTP user fee. The highly negative and significant coefficient for "Medium Income" (HI was also negative but not significant), was a bit unusual, as conventional economic behaviour would not expect people with a higher income to have a lower WTP than those with a lower income. Further approaches were used to see if this anomaly was associated with any problems in the survey methods or the data itself. First, regressions were conducted for a single nationality only to see if the noise introduced by nominal currency conversions to US$ had any effects. As the different nationalities would have different costs of living, the conversion into US$ using nominal exchange rates may have caused an error. This was tested using German only and Italians only sub samples, but the negative income effect was still present[18].

Further looking into the mean WTP traits for the "Household Income" variable (Table A8.1 in Appendix 8), I noticed the mean WTP was very high for those respondents who declined to give their income during the in-person survey. Therefore, another regression model (2) was run where an additional income variable "Income Not Stated" was used. While the "Income Not Stated" variable was not significant in estimating WTP conservation fee, the negative income effect was still present.

[18] British nationalities were not used as there already is some element of measurement error in the household income for the mail survey.

CV studies get a high non-response to the income question (Mitchell and Carson 1989). A common method used is to impute missing income values (Schenker et al. 2006). STATA was used to impute missing values for "Household Income" by running a linear regression with "Household Income" as the dependent variable. Using the imputed "Household Income", the regression for "WTP conservation fee" was run to test if the negative income effect still was present. Although the coefficients for both the "Medium Income" and "High Income" variables were negative, they were not statistically significant.

Although, I have made many attempts to identify, the cause of this negative effect, I was not successful at achieving this. Examining the uncontrolled mean WTP conservation fee variations by "Household Income" I found that this negative effect may have arisen due to the considerably high mean WTP value of the respondents who had the lowest "Household Income" of less than US$20,000 (Table A8.1 in Appendix 8). This group had a mean WTP of US$75.07 as opposed to US$43.84 which was reported by the respondents with the second highest reported household income. Therefore, the effect may have arisen from using the low income group as a baseline for the regression. Although this is not in agreement with conventional economic behaviour, this may be due to the fact that visitors to the Maldives and especially Baa Atoll tend to be highly educated and wealthy people[19]. Also the respondents may have added sources of wealth which may not have been captured by the "household Income" variable. The current classification of household income may not give a true representation of such respondents' ability to pay. A meta-analyses on the income effects of CV studies, showed that a large number of CV studies did not report a significant income effect (Schläpfer 2006).

5.6. Discussion and Conclusion

A comparison of my survey sample with the population of tourists, who visited Baa Atoll in 2006, showed that my sample was well represented in terms of gender and age groups, but for nationalities my sample over-represent British, German and Italian tourists while all other nationalities are considerably under-represented. Looking at representation of individual nationalities, my sample is in agreement with the population sample who visited Baa Atoll in 2006 in that the single most frequent nationalities are German, British and Italian and also the "Other" nationalities included mostly tourists from European countries. Looking at other demographic variables, my sample was found to be mostly employed, highly educated and earning a high income but due to lack of data, these variables could not be compared directly with the Baa Atoll population. Results from studies on tourists visiting the Maldives, have

[19] Resorts in Baa Atoll are mostly very high end resorts marketing for exclusive visitor groups.

shown that general visitors to the Maldives are also mostly employed, highly educated and earning a high income.

Overall, the survey results show that visitors to Baa Atoll favour the idea of a conservation fee to improve management of Dhigali Haa. The vast majority of respondents, 85% and 74% respectively for WTP conservation fee and WTP user fee, expressed a willingness to pay a positive amount. Rounding to whole dollars, the means WTP obtained for a one-off conservation fee were US$31 and US$41 respectively for mail and in-person surveys, and the mean WTP user fee to visit Dhigali Haa was US$15. Regression analysis shows that male, non Italian respondents to in-person survey surveys were willing to pay significantly more while medium income respondents were significantly less willing to pay. For the user fees, respondents below 50 years of age and those earning a high income were significantly more likely to pay an entrance fee.

On comparing my survey sample with the population of visitors to Baa Atoll and the Maldives, I found that my sample was well represented except for nationalities. The regression analysis of the WTP variables showed that while nationality was a significant factor in determining WTP conservation fee, it was not a significant factor for WTP user fee. Therefore, my WTP user fee of US$15 need not be adjusted but can be used as it is. Based on nationality representations, my survey sample significantly under-represents ‘Other” nationalities and but at the same time over-represents British and German nationalities. This means that the mean WTP estimate is having two opposing effects, one of over-estimation by having more British and German tourists and the other under-estimation by having significantly less “Other” nationalities. In view of these opposing effects, I have decided that using the lower value of US$31 for future analysis would deem reasonable for the purposes of this study.

6. Discussion and Conclusion

6.1. Introduction

The purpose of this chapter is to synthesise the findings of this study and to discuss the implications. The analyses of the benefits and costs of implementing the proposed Improved Management Scenario (IMS) gives an indication of whether or not, in monetary terms, it is worthwhile implementing the improved management measures. The policy implications of this cost-benefit analysis are discussed. The overall contribution of this research to the area of reef resource valuation is also presented. Finally, the chapter concludes with a discussion of the research gaps within this study and directions for future work.

6.2. Cost-Benefits Analysis of Implementing the Improved Management Scenario for Dhigali Haa

A cost-benefit analysis was done to determine if it was feasible in dollar terms to implement the proposed IMS at Dhigali Haa. I have used the Net Present Value (NPV) method in the analysis of costs and benefits, where the net benefit flows are discounted to reflect the time value of money. The NPV can be formally defined as the sum of the values of the benefits of a project minus its costs, discounted to present value terms. This is represented in Equation 6.1.

$$NPV = \sum_{t=0}^{T} \frac{1}{(1+r)^t}(B_t - C_t) \qquad (6.1)$$

where:
B_t = benefits in period t;
C_t = costs in period t;
r = discount rate;
T = number of periods the project will last.

The discount rate is the rate by which benefits or costs that accrue in some future time period must be adjusted so that they can be compared with values in the present. The United Nations Development Programme (2004) recommends the use of a high discount rate for economic valuation exercises for reef resources in the Maldives as the future benefits of natural resources are given a low importance by developing communities. According to Barton (1994), a 10% discount rate is usually used for economic analysis of renewable resources in general. Many

studies have used a 10% discount rate in the economic analysis of reef resources (Fahrudin 2003; Pet-Soede et al. 1999; Ruitenbeek et al. 1999). I have used a discount rate of 12% as this is the present interest rate used by the Maldives Monetary Authority for issue of government loans. A range of discount rates from 8 to 20% were used for sensitivity analysis.

In order to choose a timeframe for discounting the costs and benefits, I had to consider that longer timeframes would increase future uncertainty in the valuation components but also shorter timeframes would understate the benefits of conservation and the sustainable use of the reef resources. Fahrudin (2003), uses a timeframe of 25 years based on the number of years live coral cover would deplete to zero from continued use of a reef in Indonesia. Pet-Soede et al. (1999) and Berg et al. (1998) use a 20 year timeframe for the valuation of reefs in Indonesia and Sri Lanka respectively. As this research looks at the value of improving reef health with improving the management of Dhigali Haa, 20-25 years would be too short a timeframe in terms of recovery of coral reefs. Hence for this valuation, the benefits and costs are discounted over a 100-year period. Given the high rate used for discounting, however, the choice of timeframes, 25 or 100 years would not result in considerable differences in the findings.

6.2.1. Calculation of Costs and Benefits

The total cost of implementing the IMS described in Chapter 4 was used in this analysis. The estimated initial capital cost for establishing the IMS, and the ongoing annual operational costs were US$77,027 and US$101,634 respectively. This gives a total cost in year 0 of US$173,661. Capital goods such as the patrol boat, infrastructure and MPA monitoring equipment would need to be replaced over a time period during the life of the project. Therefore, the purchase costs of these goods have been added every 25 years for the patrol boat and infrastructure and every 5 years for equipment, assuming that these are reasonable timeframes for the replacement of these goods. All values used for the costs as well as benefits are in nominal dollar terms. I am forecasting an inflation rate of 3.5% in the change in prices of costs and benefits from figures by the Ministry of Planning and National Development (2006a).

The benefits are obtained from two possible funding scenarios. The first is the valuation of the IMS when it would be funded via a conservation fee for all visitors to Baa Atoll. The second is the valuation of the IMS when it would be funded via a user fees imposed on divers visiting Dhigali Haa.

The NPV is calculated separately for the two benefit scenarios. The benefits are calculated as follows:

$$B_{cf,t} = Visitors_t \times mean\ WTP_{cf} \quad (6.2)$$

$$B_{uf,t} = Divers_t \times mean\ WTP_{uf} \quad (6.3)$$

where:
$B_{cf,t}$ – benefits from conservation fee in year t
$B_{uf,t}$ – benefits from user fee in year t
$Visitors_t$ – total number of tourists visiting Baa Atoll in year t
$Divers_t$ – total number of tourists using Dhigali Haa for diving in year t
$mean\ WTP_{cf}$ – mean WTP a conservation fee
$mean\ WTP_{uf}$ – mean WTP a user fee

In Equation (6.3), I have assumed that each tourist visiting Baa Atoll would dive once at Dhigali Haa during a visit to Baa Atoll. This is because average of stay for the Maldives in 2006 was approximately 8 nights, which I shall assume, carries over for Baa Atoll (personal communication, M. Sharmeela, Statistics Department of Ministry of Tourism, 1 August 2007). Since there are over 30 dive sites for tourists to dive at in Baa Atoll, it is fair to assume that divers would go to Dhigali Haa only once during this assumed short length of visit. However, if the quality of Dhigali Haa improved with better management, while quality of other unprotected dive sides decreased, then divers may want to visit Dhigali Haa more often. I have also assumed that only divers with an Open Water certificate level of experience would be allowed to dive at Dhigali Haa as this would minimise impacts on the MPA from inexperienced divers. The CV survey conducted showed that 45% of the survey respondents planned to dive during their visit and 77% of those intending to dive had a diving qualification of Open Water or higher. From this, I estimated that about 35% of visitors to Baa Atoll would dive at Dhigali Haa.

Aside from the estimate of the mean WTP, the number of tourists visiting Baa Atoll is the key information on which the NPV calculations are based. This is also a variable over which there is great uncertainty as the number of tourists visiting Baa Atoll in the future is not known. Forecast tourist arrivals for the whole of the Maldives from 2007 to 2010 are available from the Ministry of Tourism and Civil Aviation. They use growth rates between 8.5 and 13% for these forecasts but there are no forecasted numbers specifically for Baa Atoll (personal communication, M. Sharmeela, Statistics Department of Ministry of Tourism, 1 August 2007). In order to keep the NPV estimates conservative, I have kept the number of tourists to Baa Atoll constant at 2006

levels. For sensitivity tests I have also estimated the NPV with increasing numbers of tourists to Baa Atoll according to growth rates of 1, 3 and up to 8.5 %.

As discussed in Chapter 5, the CV survey provided estimates of mean WTP conservation fee between US$31 and US$41 respectively from the mail and in person surveys. For the calculation of B_{cf} in Equation (6.2), I have used the more conservative estimate of US$31 in case the difference was caused by in-person respondents seeking to impress the interviewer. The value US$15 was used for WTP user fee, in Equation (6.3).

6.2.2. Estimated Net Present Value

A summary of the NPV estimates are given in Table 6.1 and Appendix 10 gives the detailed calculations for Scenario (1), for the case of benefits from WTP conservation fee, as an example of how the NPV values were estimated. The discount rate and the growth rate in number of visitors to Baa Atoll are varied over eight scenarios to see how sensitive the NPV estimates are to changes in these parameters.

Scenario 3, with a discount rate of 12% and assuming no growth in visitor numbers beyond 2006, is chosen as the base scenario for this analysis. The NPV for Scenario 3 was US$7.49 million and negative US$0.41 million respectively for benefits from a conservation fee and for benefits from a user fee. This suggests that the IMS funded by a conservation fee for all visitors would be a good potential Pareto improvement for the Maldives while an IMS funded by a user fee on experienced divers would not. These results suggest that it would be economically viable to implement the proposed IMS if benefits are obtained from imposing a conservation fee for all tourists visiting Baa Atoll, but not from a user fee. The sensitivity analysis done by varying the number of visitors to Baa Atoll and the discount rate both show that the project is desirable for all cases where the funds would be collected from a conservation fee, but undesirable in almost all cases when the funds are collected from a user fee.

Table 6.1. Net Present Values of the Proposed IMS for Dhigali Haa

Scenario	Number of Visitors	Discount rate	Benefits from conservation fee	Benefits from user fee
			NPV million $US	NPV million $US
1	constant	8	13.49	-1.08
2	constant	10	9.61	-0.62
3	constant	12	7.49	-0.41
4	constant	14	6.16	-0.30
5	constant	20	4.11	-0.15
6	at 1% increase per year	12	8.73	-0.31
7	at 3% increase per year	12	12.56	-0.06
8	at 8.5% increase per year	12	77.25	2.03

The negative NPV from user fees is mainly because the WTP user fee is about half that of the WTP conservation fee and, in addition, the expected number of Dhigali Haa visitors is only a little over a third of the total visitors to Baa Atoll. If adequate MPA management was implemented at Dhigali Haa and it became a place for a special diving experience relative to unprotected dive site, the number of tourists visiting Dhigali Haa and the number of visits per diver would likely increase and the net benefits from user fees would also increase. While I note this possibility, I do not use it in the scenarios considered, preferring to keep a conservative approach to the NPV calculations.

6.3. Policy Implications for MPAs in the Maldives

This study uses Dhigali Haa, an MPA in Baa Atoll in the Maldives as a case study to look at present management of MPAs in the Maldives and to estimate the value of reefs in the Maldives. I hope the findings of this study will be beneficial in shaping future policy directions for the Maldives government to improve management and encourage more sustainable use of MPAs.

6.3.1. Implications of the Improved Management Scenario

The review of the MPA management done for this research supports the need for strengthening the governance of MPAs in the Maldives identified by the United Nations Development Programme (2004) and Zuhair (2003). The MPAs in the Maldives exist as “paper parks”. Interviews conducted with local communities in Baa Atoll revealed that many people were not even aware of the existence of an MPA in that atoll. Although fishermen were more aware of MPAs, they had not received any clear information from the government on restricted activities. All stakeholders interviewed highlighted the need for raising awareness of MPAs, their use and, in particular, the benefits to the local community as the most important activity for management

of MPAs. Therefore, future MPA establishment programmes by the government should consider spending a large portion of their efforts on raising awareness and community education.

The community consultations also identified the lack of monitoring of activities within Dhigali Haa and lack of enforcement of MPA regulations, giving opportunity for people to carry out prohibited activities. These results reveal that the local community is aware of the dormant state of MPA monitoring and enforcement and also the findings suggest that better implementation of monitoring and enforcement activities would help the protection of Dhigali Haa.

Zuhair (2003) identified the resolution of user-conflicts between local fishermen and the tourist industry as a secondary objective of the establishing MPAs in the Maldives, the primary objective being conservation. The local consultations in this study show that the formal establishment of the MPAs alone has not helped resolve these conflicts and even today they are ongoing in Baa Atoll. The lack of awareness, management, monitoring and reporting mechanisms have helped to escalate these problems. The resorts near Dhigali Haa sometimes act as an enforcement group but without the proper authority, these efforts are not efficient and in this process, the tourist industry sometimes misinforms the local fishermen on which reefs are MPAs and what activities are not allowed. This is mainly due to a lack of information both by the resorts and local fishermen. The creation of MPAs does have the potential to resolve these conflicts, but only if greater policy efforts are made to improve their management.

My consultations with the local community groups in Baa Atoll suggest that the locals are eager to understand the benefits to them from the establishment of MPAs and this indicates that, with such added understanding, the locals would support local MPA management. The tourist industry is more aware of the benefits to diving related tourism and hence they are keen to help in the management of MPAs. Therefore, future management plans should include opportunities for the local community and resorts to participate in the management in a collaborative manner. Such areas include monitoring of reef health, monitoring MPA activities and creating local awareness.

Based on my focus group consultations, some specific recommendations for the improvement of Dhigali Haa management, which may be applicable to other MPAs in the Maldives, are:

1. Increase local awareness of the purpose of MPA establishment and the activities allowed and prohibited in the MPA.
2. Provide information on the benefits of MPA designation to locals, especially to fishermen. Some examples of benefits include, benefits to fishermen from the spill-over of targeted fish from marine reserves and migration to adjacent reefs, and the tax revenue

benefits to society from increased tourism that could result from having a special diving attraction in the atoll.

3. Engage the support of the local community in monitoring of MPA use at Dhigali Haa.
4. Engage local dive schools and students in the monitoring of reef health at Dhigali Haa.

6.3.2. Implications of the CV Survey and Cost Benefit Analysis

The need for the strengthening of MPA governance is recognised by the government of the Maldives, yet actual efforts are not being made. One of the biggest barriers is the lack of available and allocated funds for such efforts. The main goal of the CV survey was to see if the estimated benefits to tourists from improved management at Dhigali Haa would justify funding effective management of the MPA. The CV survey elicited tourists mean WTP conservation fee to be between US$31 and US$41, depending on survey type and the mean WTP user fee by divers visiting Dhigali Haa to be US$15. Assuming that respondents were not answering the survey strategically, this would suggest that the respondents prefer that all visitors to Baa Atoll pay a one-off conservation fee than divers alone face a fee for using Dhigali Haa. These results indicate that the introduction of a conservation or user fee can be an avenue for generating revenues to fund improved management at Dhigali Ha, but a broader applied conservation fee would generate more.

A cost-benefit analysis was carried out to compare the estimated cost of improving management at Dhigali Haa with the benefits from the estimated WTP. In a conservative, baseline scenario, this generated a NPV of US$7.49 million when management would be funded from a conservation fee. This shows that the potential benefit would be greater than the estimated cost of improving management at Dhigali Haa. On the other hand, the cost-benefit analysis when the management would be funded from a user fee gave a negative NPV of US$0.41 million, indicating that user fees alone will not be sufficient to sustain long term management costs at Dhigali Haa. These results support the option that potential revenues generated from introducing a conservation fee would be sufficient to fund long-term management at Dhigali Haa. The Government of the Maldives could consider trialling a pilot conservation fee in Baa Atoll and, if successful, this mechanism could be introduced to other MPAs in the Maldives.

In order to introduce a conservation fee for tourists visiting Baa Atoll, the government should carefully consider the level at which the conservation fee is set. Too low a fee may not generate enough funds to sustain the cost of management, while too high a fee may pose the risk of many visitors not being willing to pay the amount and hence not visiting Baa Atoll. The CV scenario presented to the tourists specified that the conservation fee would be used entirely for

improvement of Dhigali Haa via a trust fund established for management of the MPA. The survey results show that it is likely that WTP estimates are sensitive to the perceived fairness of the funding mechanism, and may have been far less if the money collected went into general government revenues. Therefore, based on the findings of this study, actual introduction of such a conservation fee should carefully consider the funding mechanism to be used.

Based on the CV results I have explored the net benefits that could be expected as a function of conservation fee (Figure 6.1). Figure 6.1 also includes a plot of the number of visitors willing to pay a given conservation fee. The dashed lines on Figure 6.1 present the range of WTP values, which would provide a positive "Net Benefit". As seen from the figure, this range is approximately between US$10 and US$65. From the figure, it can be seen that the net benefit is maximized at approximately US$20 and US$50.

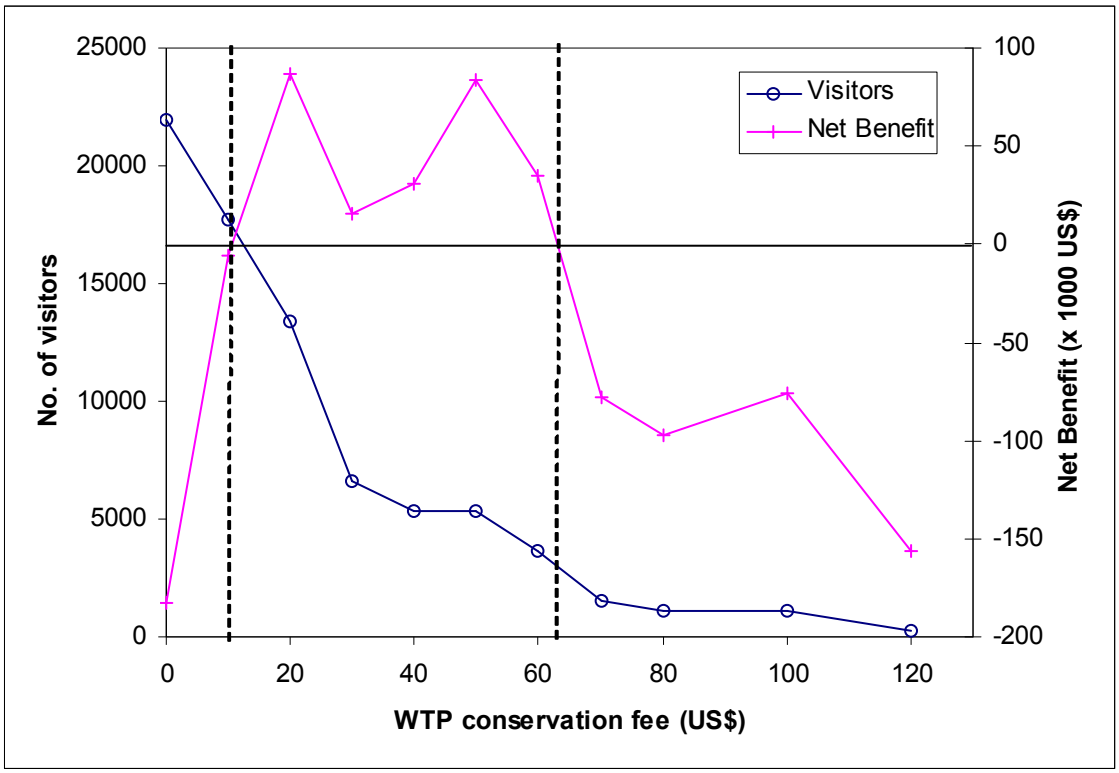


Figure 6.1. Willingness to Pay for Conservation of Visitors to Baa Atoll in 2006 and Net Benefits of Imposing a Conservation Fee at Given WTP values.
Notes: The number of visitors are estimated based on the number of visitors to Baa Atoll in 2006; the calculation of the plot "Visitors" users WTP survey from the mail survey; Dashed lines indicate the lower and upper limits of the conservation fee range which would result in a positive net benefit; Calculations on which this graph is based is presented in Appendix 11)

The WTP of US$20 that corresponds to the peak net benefit may be a suitable value for a conservation fee. However, as seen from the graph, the number of visitors willing to pay

decreases with an increase in WTP conservation fee[20]. Therefore, in order not to risk reducing the number of visitors to Baa Atoll, a conservation fee closer to the lower value, such as US$12 to US$15 may be more suitable. According to Depondt and Green (2006), actual current fees set at MPAs, based on WTP studies, tend to be often lower than the means WTP estimates of the corresponding studies. For example, in Bonaire Marine Park, a successful self-financing MPA in the Caribbean, studies have revealed mean WTP user fees of US$27.40 but the current user fee at the MPA is US$10. Lower fees would minimise the potential negative impacts on tourist arrivals.

As defined in Chapter 3, the difference between the maximum WTP for improved management and what they actually pay would give the compensating surplus of the visitors. Based on number of visitors to Baa Atoll in 2006 (21954 visitors) a set conservation fee of US$12 would generate approximately US$263,000 compared with US$681,000 from the mean WTP conservation fee estimate of US$31. This would mean the visitors' compensating surplus is approximately US$418,000. Dixon et al. (2000) estimated a consumer surplus of US$325,000 for Bonaire Marine Park, based on 1992 visitor rates and an annual admission fee of US$10.

6.4. Contribution to Global Reef Valuation Research

MPAs have become a well regarded institution for the conservation and management of marine resources by the global conservation and scientific communities (Kleypas and Eakin 2007; Pomeroy et al. 2004). While there is less than 1% of the world's marine environment under such protected status, as much as 80% of those areas which are protected remain protected merely on paper (Depondt and Green 2006; Pomeroy et al. 2004). Wilkinson et al. (2006) report that only 7% of MPAs in Southeast Asia are effectively managed. This case study of Dhigali Haa, an MPA in the Maldives, shows that, like many countries of the world and in Southeast Asia in particular, MPAs in the Maldives are poorly managed and the management effectiveness of these MPAs are not known. The lack of management highlighted in this study is similar to many small countries with vast marine resources. These are mainly due to a lack of expertise, field knowledge and political will from the government. The most important barrier identified was a lack of allocated funds for the substantial management costs of MPAs. I believe the findings and policy recommendations of this study would be useful to improving management at other MPAs of the world, which are facing similar problems.

[20] The plot 'Visitors" is essentially a conventional demand curve but with the axis flipped. This was done in order to present the plot of variation of net benefit with WTP on the same graph.

McClanahan (1999) suggests that MPAs in poor countries fail because of an inability to sustain their running costs and that MPAs could only be successful if they reach a self-financing status. Studies mostly done in the Caribbean have looked at the option of sustaining management costs of MPAs through revenues generated from the use of these MPAs by tourists (Arin and Kramer 2002; Dixon et al. 1993; Gallagher-Freymuth 2002; Thur 2003). The present study contributes to such studies which have shown that tourists are willing to pay to use resources within protected areas and, in doing so, to contribute to the conservation of these areas. Many of the previous studies have been based on use of MPAs by divers and their willingness to pay for use of the MPA (Depondt and Green 2006; Gallagher-Freymuth 2002; Thur 2003). This CV study shows that in addition to divers, tourists who would not visit Dhigali Haa are also willing to contribute financially to improve management and, hence, conservation of the MPA. The results of this study show that the mean WTP conservation fee by all visitors to Baa Atoll is higher, almost double, than the mean WTP of divers alone to use the MPA. A probable reason for this is the on the ground of fairness that all visitors should contribute to the conservation whether they directly use the MPA or not. This is because the existence of tourism itself and given the interconnection of the coastal environment, all visitors are contributing to degradation of reefs and the marine environment.

The results of this study show that tourists visiting Baa Atoll, whether or not they are divers who visit Dhigali Haa, are willing to pay a conservation fee between 2006, US$31 and US$41 per visit to Baa Atoll. An open-ended CV study by Spash (2000) for obtaining WTP for improvement in reef quality in Jamaica and Curaçao gave values of 1999, US$25.89 and US$25.21 respectively for the two regions[21]. Seenprachawong (2002) used a payment card method and a payment vehicle similar to Spash (2000) to estimate the WTP for improving reef quality at Phi Phi Islands, Thailand and obtained estimates of mean WTP of 2001 US$7.17 for local visitors and US$7.15 for foreign visitors. Aside from inflation, the higher WTP values in my study might result from my survey being restricted to (wealthy) foreign tourists, while Spash (2000) and Seenprachawong (2002) included both local and foreign tourists. On the other hand, the mean WTP for the two groups were similar for the results from Phi Phi Islands and Curaçao, while for the study in Jamaica, the mean WTP by local tourists was higher than that of foreign tourists.

Another possible explanation for my higher estimated WTP is that I posed the fees as for each visit to Baa Atoll, whereas Spash (2000) and Seenprachawong (2002) posed the fee as a set annual fee for 5 consecutive years. While most tourists visiting Baa Atoll may not visit the area

[21] The payment mechanism in this study was for each individual to pay a set annual fee for 5 consecutive years.

annually, the probability of them having to pay consecutively up to 5 years is lower compared to the studies by Spash (2000) and Seenprachawong (2002), where respondents will definitely be paying each year up to 5 consecutive years, and during that period they would be paying a total of US$129.45, US$126.06 and US$35.75 respectively for foreign tourists from Jamaica, Curaçao and Phi Phi Islands. The total paid by respondents from Phi Phi Islands, is similar to the mean of the one-off payment in my study. As the WTP of respondents would be influenced by their demographic characteristics may be possible reasons for the differences. Due to lack of comparable data, these characteristics could not be compared for the given studies[22]. Although an important variable, income could not be compared as the study by Seenprachawong (2002) gave individual income compared with the use of household income in my survey. From, the choice of individual income categories used in Seenprachawong (2002) and the responses received, I may suppose that my sample had a higher income compared with the foreign tourists visiting Phi Phi Islands.

My CV survey gives an estimate of mean WTP user fee by divers visiting Dhigali Haa to be US$15 per visit per diver. A study by Depondt and Green (2006), which explored existing user fees in MPAs of South-East Asia and the Francophone countries of the Indian and Pacific Ocean, gave a general estimate of mean WTP user fees between US$20 and US$30 per visit per diver. I have also explored WTP user fee estimates from studies done for specific MPAs of the world (Table 6.2).

Although the result from my survey is lower than the estimates given by Depondt and Green (2006), my estimate is higher compared with the estimates presented in Nam and Son (2001) and Yeo (1998) but is within the range provided by Thur (2003). The higher mean WTP compared to Hon Mun Islands MPA and Pulau Payar Marine Park may arise because the tourists visiting these MPAs include a higher percentage of Asians compared to Baa Atoll where the larger percentage of visitors are Europeans with potentially greater environmental sympathies. In addition, the European tourists visiting Baa Atoll may have a higher income compared to those visiting Hon Mun Islands and Pulau Payar Marine Park.

Bonaire Marine Park is similar to the Maldives, in being a very popular diving destination. Comparing available demographic characteristics such as gender, age and household income of respondents for the study by Thur (2003), I found that they were similar to my survey sample. The similarity between samples adds to the strength of the similarity between the two mean WTP user estimates.

[22] Spash (2000) did not contain demographics of the sample. The only comparable variables present in Seenprachawong (2002) were “Gender” and “Education’, which was similar to my study.

Table 6.2. Findings from CV Studies on WTP User Fees to Visit MPAs

Study	Study Area	Reported Mean WTP per visit per person (US$)
Nam and Son (2001)	Hon Mun Islands MPA, Vietnam	1.85
Thur (2003)	Bonaire Marine Park, Caribbean	10.49 – 20.39*
Yeo (1998)	Pulau Payar Marine Park, Malaysia	4.20

* This value is based on a per day use for each diver.

The cost benefit analysis done in this research demonstrates that administering such a fee system would generate sufficient revenues to sustain management costs at Dhigali Haa. The results of this study support the concept that MPAs can be an effective means of protecting marine biodiversity while still generating important economic benefits from recreational and tourism uses. Some examples where such a fee system has been successfully implemented are MPAs in the Caribbean such as the Bonaire Marine Park and the British Virgin Islands Marine Parks (Depondt and Green 2006).

Although many studies have revealed a positive willingness of tourists to pay for improving conditions at MPAs, the successful application of such a fee system is not very common. According to Depondt and Green (2006), in South-East Asian countries complex problems linked to governance and revenue collection have hindered the success of such fee applications. Therefore, I believe policies relating to these issues need to be changed or new policy adopted, in order for successful implementation of such fees.

6.5. Conclusions

In this thesis, I aimed to estimate the potential economic benefits from effective management of MPAs and to see if they justify the funding necessary for such management. The main objective of the research undertaken was to estimate the WTP of tourists visiting Baa Atoll to see improved management at Dhigali Haa. I aimed to achieve this by:

1. reviewing the existing management of the Dhigali Haa MPA and proposing an Improved Management Scenario (IMS) for the MPA,

2. obtaining local community perceptions of MPAs, on the management of Dhigali Haa and of possibilities for improvement,
3. conducting a WTP survey for tourists visiting Baa Atoll and
4. conducting a comparison of the costs of implementing an IMS with the benefits obtained from the WTP estimates.

The findings of the review of existing management at Dhigali Haa MPA and the local community and stakeholder consultations undertaken were presented in Chapter 4. These findings were the basis for the development of the Improved Management Scenario (IMS) proposed in the chapter. An estimated cost for implementing the IMS was also provided in the chapter.

Chapter 5 of the thesis presented the results of the CV survey conducted to obtain WTP of tourists visiting Baa Atoll to improve management at Dhigali Haa. This survey estimated mean WTP values between US$31 and US$40 for a one-off conservation fee per visit to be paid by all visitors to Baa Atoll and a mean WTP of US$15 for a user fee per visit to Dhigali Haa to be paid by divers visiting the MPA. The findings showed that tourists preferred a conservation fee for all tourists visiting Baa Atoll over a user fee imposed on only tourists visiting Dhigali Haa.

A comparison of the costs of implementing the proposed IMS with the benefits obtained from the WTP estimates was given in Chapter 6. The cost-benefit estimates showed that the NPV was positive if benefits were obtained from a conservation fee rather than a user fee. The estimated NPV for improving management at Dhigali Haa was estimated to be US$7.49 million if the management was funded by a conservation fee. This study concludes that the estimated benefits justify funding for proper management of the Dhigali Haa MPA.

6.6. Research Gaps and Future Work

This research has looked at valuing reef resources by estimating the willingness of tourists to pay for improved management of an MPA in Baa Atoll, Maldives. Although the use of the CV method estimates both use and non-use values of the reef, this study does not estimate the value of the MPA to locals. This was not included in this research as the concept of valuation of natural resources would be unfamiliar to the local community of Baa Atoll. But if never asked they would not become familiar with such concepts. To include a more holistic valuation, an economic valuation by locals could be explored to get some idea of the value placed by locals on reef resources. Methods such as the use of Contingent Ranking and Conjoint Analysis, where attributes of the environment are ranked according to the respondents' preference, maybe used to

explore the value placed on reef resources by locals. This understanding would also lead to management practices that take into account local values and, thus, have an improved chance of success.

This study gives recommendations on improving the present management of Dhigali Haa and also provides a cost benefit analysis which demonstrates that sufficient funds could be obtained from conservation fees aimed at tourists to successfully sustain the cost of management. A criticism of the CV method used in estimating the WTP amount is that this method presents a hypothetical scenario and hence the stated WTP amounts by respondents would be higher than what they would give if they were actually asked to pay a conservation fee. The time constraints of this research did not allow for such an in-depth exploration but further studies could be done to determine the amounts tourists would actually be willing to pay for improved management at Dhigali Haa for comparison with the results from the present research.

Although this study shows the potential of revenues from conservation fees to be used in sustaining management costs of Dhigali Haa, it should be noted that there are few studies on actual successful implementation of such fees. Some of the identified barriers to such implementation have been complex problems linked to governance and revenue collection (Depondt and Green 2006). Exploring this area further by application to Dhigali Haa would be an interesting future study. This could be done via a pilot conservation fee system at Dhigali Haa and to explore the issues of implementing such a fee system. In addition, the pilot fee system could be used to experimentally explore the implication of different payment mechanisms.

This research is intended to improve the management at MPAs in the Maldives. In my opinion, the Dhigali Haa MPA in Baa Atoll would be an ideal site to implement a pilot management programme and conservation fee mechanism. The activities under the present conservation project, the AEC Project being implemented in Baa Atoll, provide opportunity for such a pilot programme. The implementation of a proper management plan should be followed by studies on the effectiveness of the MPA management by looking at changes in the use patterns, reef health and impacts on the reef from diving. Such studies would help determine future management actions. Based on the lessons learnt from Dhigali Haa, management of other MPAs in the Maldives and internationally could be improved to conserve marine biodiversity.

References

Allison, W. R. (1996). "Snorkeler damage to reef corals in the Maldive Islands." *Coral Reef*, 15, 215-218.

Allison, W. R. (2005). "Baa Atoll, Maldives: Some Observations by William Allison." Unpublished report, 2.

Anderson, R. C., and Waheed, Z. (1999). "Management of shark fisheries in the Maldives." In: *Case studies of the management of elasmobranch fisheries*, R. Shotton, ed., Food and Agriculture Organisation, Rome.

Arin, T., and Kramer, R. A. (2002). "Divers' willingness to pay to visit Marine Sanctuaries: an exploratory study." *Ocean and Coastal Management*, 45, 171–183.

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., and Schuman, H. (2001). "Report of the NOAA Panel on Contingent Valuation." National Oceanic and Atmospheric Administration, 67.

Balasubramanian, H., Ahmed, M., and Chong, C. K. (Year). "Estimating the 'Total Economic Value' of Coral Reefs in South East Asia and the Caribbean: Trends Identified, Lessons Learned and Directions for Future Research." *International Tropical Marine Ecosystem Management Symposium*, Manila, Philippines.

Barton, D. N. (1994). "Economic Factors and Valuation of Tropical Coastal Resources ", Centre for Studies of Environment and Resources, University of Bergen, Norway.

Bascompte, J., Melian, C. J., and Sala, E. (2005). "Interaction strength combinations and the overfishing of a marine food web." *Proceedings of the National Academy of Sciences of the United States of America*, 102(15), 5443-5447.

Bateman, I. J., and Willis, K. G., eds. (1999). *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries*, Oxford University Press, UK.

Begg, D., Fischer, S., and Dornbusch, R. (1987). *Economics*, McGraw-Hill Book Company London.

Berg, H., Öhman, M. H., Troëng, S., and Lindén., O. (1998). "Environmental economics of coral reef destruction in Sri Lanka." *Ambio*, 27(8), 627-634.

Bers, A. V. (2005). "Biodiversity Assessment for Maldives' Baa Atoll: Baseline Information for UNDP's Atoll Ecosystem-Based Conservation Programme." Ministry of Environment, Energy and Water, Malé, Maldives, 47.

Bishop, R. C., and Heberlein, T. A. (1986). "Does Contingent Valuation Work?" In: *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*, R. G. Cummings, D. S. Brookshire, and W. D. Schulze, eds., Rowman and Allanheld Publishers, USA, 123-147.

Boyle, K. (2003). "Contingent Valuation in Practice." In: *A Primer on Nonmarket Valuation*, P. A. Champ, K. J. Boyle, and T. C. Brown, eds., Kluwer Academic Publishers, The Netherlands, 111-169.

Brown, T. C., Champ, P. A., Bishop, R. C., and McCollum, D. W. (1996). "Which response format reveals the truth about donations to a public good?" *Land Economics*, 72(2), 152-166.

Bryant, D., Burke, L., McManus, J., and Spalding, M. (1998). *Reefs At Risk, A Map - Based Indicator of Threats to the World's Coral Reefs*, World Resources Institute

Carson, R. T. (2000). "Contingent Valuation: A User's Guide." *Environmental Science and Technology*, 34(8), 1413 -1418.

Carson, R. T., Flores, N. E., and Meade, N. M. (2001). "Contingent Valuation: Controversies and Evidence." *Environmental and Resource Economics*, 19(2), 173-210.

Cesar, H., Waheed, A., Saleem, M., and Wilhelmsson, D. (2000). "Assessing the Impacts of the 1998 Coral Bleaching on Tourism in the Maldives and Sri Lanka." CORDIO.

Cesar, H. S. J. (2000). *Collected Essays on the Economics of Coral Reefs*, CORDIO, Kalmar, Sweden.

Champ, P. A., and Bishop, R. C. (2001). "Donation Payment Mechanisms and Contingent Valuation: An Empirical Study of Hypothetical Bias." *Environmental and Resource Economics*, 19(4), 383-402.

Champ, P. A., Boyle, K. J., and Brown, T. C., eds. (2003). *A Primer on Nonmarket Valuation*, Kluwer Academic Publishers, the Netherlands.

Cho, L. (2005). "Marine protected areas: a tool for integrated coastal management in Belize." *Ocean and Coastal Management*, 48, 932–947.

Clark, S., and Edwards, A. J. (1999). "An evaluation of artificial reef structures as tools for marine habitat rehabilitation in the Maldives." *Aquatic Conservation-Marine and Freshwater Ecosystems*, 9(1), 5-21.

The Coral Reef Alliance. (2003). "Effective Coral Reef Marine Protected Areas (MPAs): A solution for survival."

Costanza, R., d'Arge, R., Groot, D. d., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., P, J., Raskin, R. G., Sutton, P., and Belt, M. v. d. (1997). "The value of the world's ecosystem services and natural capital." *Nature*, 387(15), 253-260.

Côté, I. M., Mosqueira, I., and Reynolds, J. D. (2001). "Effects of marine reserve characteristics on the protection of fish populations: a meta-analysis." *Journal of Fish Biology*, 59(Supplement A), 178-189.

Darwin, C. (1888). *On the structure and distribution of coral reefs*, Walter Scott, London.

Davis, D., and Tisdell, C. (1996). "Economic Management of Recreational Scuba Diving and the Environment." *Journal of Environmental Management*, 48, 229–248.

Depondt, F., and Green, E. (2006). "Diving user fees and the financial sustainability of marine protected areas: Opportunities and impediments." *Ocean and Coastal Management*, 49(3-4), 188-202.

Dixon, J. A., Scura, L. F., and van't Hof, T. (1993). "Meeting ecological and economic goals: marine parks in the Caribbean." *Ambio*, 22(2-3), 117-125.

Dixon, J. A., Scura, L. F., and van't Hof, T. (1994). "Ecology and Microeconomics as 'Joint Products': the Bonaire Marine Park in the Caribbean." In: *Biodiversity Conservation: Problems and Policies*, C. A. Perrings, ed., Kluwer Academic Publishers, Dordrecht, 127-146.

Dixon, J. A., Scura, L. F., and van't Hof, T. (2000). "An Economic and Ecological Analysis of the Bonaire Marine Park " In: *Collected Essays on the Economics of Coral Reefs*, H. S. J. Cesar, ed., CORDIO, Kalmar, Sweden.

Edmunds, H. (2000). *The Focus Group Research Handbook*, NTC/Contemporary Publishing Group, Chicago.

Ethier, R. G., Poe, G. L., Schulze, W. D., and Clark, J. (2000). "A comparison of hypothetical phone and mail contingent valuation responses for green-pricing electricity programs." *Land Economics*, 76(1), 54-67.

Fahrudin, A. (2003). "Extended Cost Benefit Analysis of Present and Future Use of Indonesian Coral Reefs: An Empirical Approach to Sustainable Management of Tropical Marine Resources," Christian-Albrechts-Universität Kiel, Germany.

Food and Agriculture Organisation. (2000). "Applications of the contingent valuation method in developing countries - A survey." Food and Agriculture Organization (FAO).

Freeman, A. (2003). "Economic Valuation: What and Why." In: *A Primer on Nonmarket Valuation*, P. A. Champ, K. J. Boyle, and T. C. Brown, eds., Kluwer Academic Publishers, The Netherlands, 1-26.

Gallagher-Freymuth, L. (2002) "The Bonaire National Marine Park. Solutions case study 2001.", accessed on 11th August 2007, http://www.solutions-site.org/cat1_sol117.htm.

Ghina, F. (2003). "Sustainable Development in Small Island Developing States: The Case of the Maldives." *Environment, Development and Sustainability*, 5(1-2), 139-165.

Greenley, D. A., Walsh, R. G., and Young, R. A. (1981). "Option Value - Empirical-Evidence from a Case-Study of Recreation and Water-Quality." *Quarterly Journal of Economics*, 96(4), 657-673.

Guénette, S., Chuenpagdee, R., and Jones, R. (2000). "Marine Protected Areas with an Emphasis on Local Communities and Indigenous Peoples: a Review." Fisheries Centre Research Reports 8(1), University of British Columbia Canada.

Gunn, J., Naseer, A., Adam, M. S., Adnan, S. A., Brando, V., Dekker, A., Dews, G., Engel, L., Haleem, I., Milton, D., Naeem, I., Najeeb, A., Parnell, K., Rasheed, S. M., Shafiu, Y., Sweatman, H., Thompson, A., Wachenfeld, D., Waheed, Z., and Zahir, H. (2005). *An Assessment of Damage to Maldivian Coral Reefs and Baitfish Populations from the Indian Ocean Tsunami*, Australian Government & Government of the Republic of the Maldives, Canberra, Australia.

Hackl, F., and Pruckner, G. J. (2005). "Warm glow, free-riding and vehicle neutrality in a health-related contingent valuation study." *Health Economics*, 14(3), 293-306.

Halpern, B. S. (2003). "The Impact of Marine Reserves: Do Reserves Work and Does Reserve Size Matter?" *Ecological Applications*, 13(1 Supplement), S117–S137.

Hammack, J., and Brown Jr., G. M. (1974). *Waterfowl and Wetlands: Toward Bioeconomic Analysis*, The John Hopkins University Press for Resources for the Future, Baltimore.

Hammitt, J. K., and Graham, J. D. (1999). "Willingness to pay for health protection: Inadequate sensitivity to probability?" *Journal of Risk and Uncertainty*, 18(1), 33-62.

Hanemann, W. M. (1994). "Valuing the Environment through Contingent Valuation." *Journal of Economic Perspectives*, 8(4), 19-43.

Hausman, J. (1993). *Contingent Valuation: A Critical Assessment*, North-Holland, Amsterdam.

Hicks, J. R. (1943). "The Four Consumer Surpluses." *Review of Economic Studies*, 11, 31-41.

Hodgson, G. (1999). "A global assessment of human effects on coral reefs." *Marine Pollution Bulletin*, 38(5), 345-355.

Jameson, S. C., Ammar, M. S. A., Saadalla, E., Mostafa, H. M., and Riegl, B. (1999). "A coral damage index and its application to diving sites in the Egyptian Red Sea." *Coral reefs*, 18, 333–339.

Jameson, S. C., Tupper, M. H., and Ridley, M. J. (2002). "The three screen doors: Can Marine Protected Areas be Effective? ." *Marine Pollution Bulletin*, 44, 1177-1183.

Jordan, W. (2007). "Ethical Tourism Hits Malé's Souvenir Shops." In: *Minivan News*, Maldives, accessed on 10th June 2007, http://www.minivannews.com/news/news.php?id=2875.

Kahneman, D., and Knetsch, J. (1992). "Valuing public goods: the purchase of moral satisfaction." *Journal of Environmental Economics and Management*, 22, 57-70.

Kitzinger, J. (1995). "Qualitative Research: Introducing focus groups " *British Medical Journal*, 311, 299-302

Kleypas, J. A., and Eakin, C. M. (2007). "Scientists' Perceptions of Threats to Coral Reefs: Results of a Survey of Coral Reef Researchers." *Bulletin of Marine Science*, 80(2), 419–436.

Live and Learn Environmental Education. (2006). *Environmental Education and Community Mobilisation*, Ministry of Environment, Energy and Water, Maldives.

McClanahan, T. R. (1999). "Is there a future for coral reef parks in poor tropical countries?" *Coral Reefs*, 18, 321-325.

McClanahan, T. R., and Mangi, S. (2000). "Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery." *Ecological Applications*, 10(6), 1792-1805.

McDaniels, T. L. (1992). "Reference Points, Loss Aversion, and Contingent Values for Auto Safety." *Journal of Risk and Uncertainty*, 5(2), 187-200.

Ministry of Environment and Construction. (2005). *State of the Environment: Maldives, 2004*, Ministry of Environment and Construction, Maldives.

Ministry of Home Affairs, Housing and Environment. (2001). *First National Communication to the United Nations Convention on Climate Change (UNFCCC)*, Ministry of Home Affairs, Housing and Environment Malé', Maldives.

Mitchell, R. M., and Carson, R. T. (1989). *Using Surveys to Value Public Goods: the Contingent Valuation Method*, Resources for the Future, Washington D.C.

Moberg, F., and Folke, C. (1999). "Ecological goods and services of coral reef ecosystems." *Ecological Economics*, 29, 215-233.

Mosqueira, I., Côté, I. M., Jennings, S., and Reynolds, J. D. (2000). "Conservation benefits of marine reserves for fish populations." *Animal Conservation*, 4, 321–332.

Ministry of Tourism. (2003). "Review and Recommendations: Maldives Tourism Master Plan 1996-2005." Ministry of Tourism, Maldives.

Ministry of Tourism. (2005). "Tourist Opinion Survey Report 2004." Ministry of Tourism, Maldives, 73.

Marine Protected Areas System. (2001). "National Listing of Potential Sites for Protected Area Establishment." Maldives Protected Areas System Project, Ministry of Home Affairs, Housing and Environment, Maldives.

Ministry of Planning and National Development. (2004). *Statistical Yearbook of Maldives 2004*, Ministry of Planning and National Development, Maldives.

Ministry of Planning and National Development. (2006a). "National Consumer Price Index: 2006." Ministry off Planning and National Development, Maldives.

Ministry of Planning and National Development. (2006b). *Statistical Yearbook of Maldives 2006*, Ministry of Planning and National Development, Maldives.

Ministry of Tourism and Civil Aviation. (2006). *Tourism Year Book 2006*, Ministry of Tourism and Civil Aviation, Maldives.

Murphy, J. J., Allen, P. G., Stevens, T. H., and Weatherhead, D. (2005). "A meta-analysis of hypothetical bias in stated preference valuation." *Environmental & Resource Economics*, 30(3), 313-325.

Nam, P. K., and Son, T. V. H. (2001). "Recreational Value of the Coral-surrounded Hon Mun Islands in Vietnam." In: *Economy and Environment Program for Southeast Asia*.

Naseer, A. (2003). "The Integrated Growth Response of Coral Reefs to Environmental Forcing: Morphometric Analysis of Coral Reefs of the Maldives," Dalhousie University, Halifax, Nova Scotia.

Naseer, A., and Hatcher, B. G. (2004). "Inventory of the Maldives' coral reefs using morphometrics generated from Landsat ETM+ imagery." *Coral Reefs*, 23, 161-168.

Nayga Jr., R. M., and R.Woodward. (2005). "Experiments on the Divergence between Willingness to Pay and Willingness to Accept: The Issue Revisited." *Economics Bulletin*, 17(4), 1−5.

Nunes, P. A. L. D., and Schokkaert, E. (2001). "Identifying the warm glow effect in contingent valuation." *Journal of Environmental Economics and Management*, 45, 231–245.

Pendelton, L. H. (1995). "Valuing Coral Reef Protection." *Ocean and Coastal Management*, 26(2), 119-131.

Pet-Soede, L., Cesar, H. S. J., and Pet, J. S. (1999). "An Economic Analysis of Blast Fishing on Indonesian Coral Reefs." *Environmental Conservation*, 26(2), 83 - 93.

Polunin, N. V. C., and Roberts, C. M. (1993). "Greater Biomass and Value of Target Coral-reef Fishes in Two Small Caribbean Marine Reserves." *Marine Ecology Progress Series*, 100, 167-176.

Pomeroy, R. S., Parks, J. E., and Watson, L. M. (2004). *How is your MPA doing? A Guidebook of Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness*, International Union for Conservation of Nature and Natural Resources, Gland, Switzerland and Cambridge, UK.

Rajasuriya, A., Venkataraman, K., Muley, E. V., Zahir, H., and Cattermoul, B. (2003). "Status of Coral Reefs in South Asia: Bangladesh, India, Maldives, Sri Lanka." In: *Status of Coral Reefs of the World: 2002*, C. Wilkinson, ed., Australian Institute of Marine Sciences, 101-121.

Rajasuriya, A., Zahir, H., Venkataraman, K., Islam, Z., and Tamelander, J. (2005). "Status of Coral Reefs in South Asia: Bangladesh, Chagos, India, Maldives, Sri Lanka." In: *Status of Coral Reefs of the World: 2004*, C. Wilkinson, ed., Australian Institute of Marine Sciences, 213-233.

Riopelle, J. M. (1995). "The Economic Valuation of Coral Reefs: A Case Study of West Lombok, Indonesia," Dalhousie University, Halifax, Nova Scotia.

Roberts, C. M., and Polunin, V. C. (1993). "Marine Reserves: Simple Solutions to Managing Complex Fisheries." *Ambio*, 22(6), 363-368.

Ruitenbeek, J., Ridgley, M., Dolar, S., and Huber, R. (1999). "Optimization of Economic Policies and Investment Projects Using a Fuzzy Logic Based Cost-Effectiveness Model of Coral Reef: Empirical Results for Montego Bay, Jamaica." *Coral Reefs*, 18(4), 381-392.

Saleem, M. R., and Adam, M. S. (2004). *Review of Aquarium Fishery of the Maldives - 2003*, Marine Research Centre, Malé, Maldives.

Salih, A. (2000). "Divers' Perceptions Maldives," University of Otago, Dunedin, New Zealand.

Sattar, S. A., and Adam, M. S. (2005). "Review of Grouper Fishery of the Maldives with additional notes on the Faafu Atoll Fishery." Marine Research Centre, Malé, Maldives.

Schenker, N., Raghunathan, T. E., Chiu, P.-L., Makuc, D. M., Zhang, G., and Cohen, A. J. (2006). "Multiple Imputation of Missing Income Data in the National Health Interview Survey." *Journal of the American Statistical Association*, 101(475), 924-933.

Schläpfer, F. (2006). "Survey Protocol and Income Effects in the Contingent Valuation of Public Goods: a Meta-Analysis." *Ecological Economics*, 57(3), 415-429.

Schwab-Christe, N. G., and Soguel, N. C. (1995). *Contingent Valuation, Transport Safety and the Value of Life*, Kluwer Academic Publishers, the Netherlands.

Seamarc. (2006). "Report on the Willingness to Pay for Waste Management in Baa Atoll." Ministry of Environment, Energy and Water, Maldives, 34.

Seenprachawong, U. (2002). "An Economic Analysis of Coral Reef Benefits from Phi Phi Islands, Thailand." In: *Coastal Zone Asia Pacific Conference*, Bangkok, Thailand.

Lead Agency Parks and Wildlife Service. (2000). "Best Practice in Protected Area Management Planning." Lead Agency Parks and Wildlife Service, Tasmania

Shaig, A. (2006). "Climate Change Vulnerability and Adaptation Assessment of the Maldives Coastal Infrastructure." Centre for Disaster Studies School of Tropical Environment Studies and Geography, James Cook University, Townsville, 25.

Sluka, R. D., and Miller, M. W. (1999). "Status of crown-of-thorns starfish in Laamu Atoll, Republic of Maldives." *Bulletin of Marine Science*, 65, 253-258.

Souter, D. W., and Lindén, O. (2000). "The health and future of coral reef systems." *Ocean & Coastal Management*, 43 657-688.

Spalding, M. D., Ravilious, C., and Green, E. P. (2001). *World Atlas of Coral Reefs*, University of California Press, Berkeley, USA.

Spash, C. L. (2000). "Assessing the Benefits of Improving Coral Reef Biodiversity: The Contingent Valuation Method." In: *Collected Essays on the Economics of Coral Reefs*, H. S. J. Cesar, ed., CORDIO, Kalmar, Sweden, 40-54.

Spash, C. L., Bosch, J. D. v. d. W. t., Westmacott, S., and Ruitenbeek, J. (2000). "Lexicographic Preferences and the Contingent Valuation of Coral Reef Biodiversity in Curaçao and Jamaica." In: *Integrated Coastal Zone Management of Coral Reefs: Decision Support Modeling*, K. Gustavson, R. M. Huber, and J. Ruitenbeek, eds., the World Bank, 97-118.

Spurgeon, J. (1998). "The Socio-Economic Costs and Benefits of Coastal Habitat Rehabilitation and Creation." *Marine Pollution Bulletin*, 37(8-12), 373-382.

Stoddart, D. R. (1965). "The shape of atolls." *Marine Geology*, 3, 369-383.

Thur, S. M. (2003). "Valuing Recreational Benefits in Coral Reef Marine Protected Areas: An Application to the Bonaire National Marine Park," University of Delaware.

United Nations Development Programme. (2004). "Project Document: Atoll Ecosystem-Based Conservation of Globally Significant Biological Diversity in the Maldives' Baa Atoll." United Nations Development Programme and Government of Maldives, 179.

United Nations Environmental Programme. (2003). "http://coral.unep.ch/atlaspr.htm.", accessed 1st June 2007.

United Nations Environment Programme. (2005a). *After the Tsunami: Rapid Environmental Assessment*, United Nations Environment Programme.

United Nations Environment Programme. (2005b). *Maldives Post-Tsunami Environmental Assessment*, United Nations Environment Programme.

United Nations Environment Programme. (1988). *Coral Reefs of the World. Volume 2: Indian Ocean, Red Sea and Gulf* IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya

Westmacott, S., Cesar, H. S. J., Pet-Soede, L., and Lindén, O. (2000). "Coral Bleaching in the Indian Ocean: Socio-economic Assessment of Effects." In: *Collected Essays on the Economics of Coral Reefs*, H. S. J. Cesar, ed., CORDIO, Kalmar, Sweden, 94-106.

Wilkinson, C., Caillaud, A., DeVantier, L., and South, R. (2006). "Strategies to reverse the decline in valuable and diverse coral reefs, mangroves and fisheries: The bottom of the J-Curve in Southeast Asia?" *Ocean & Coastal Management*, 49, 764-778.

Wilkinson, C., Green, A., Almany, J., and Dionne, S. (2004). *Monitoring Coral Reef Marine Protected Areas: A Practical Guide on How Monitoring can Support Effective Management of MPAs*, Australian Institute of Marine Sciences and the IUCN Marine Program.

Wilkinson, C. R. (1999). "Global and local threats to coral reef functioning and existence: review and predictions." *Marine and Freshwater Research*, 50(8), 867-878.

Yeo, B. H. (1998). "The Economic Valuation of Protected Areas in Malaysia. A Case Study on Pulau Payar Marine Park, Kedah, Malaysia," University College London.

Zakaia, D., and Chadwick-Furmanb, N. E. (2002). "Impacts of intensive recreational diving on reef corals at Eilat, northern Red Sea." *Biological Conservation*, 105, 179–187.

Zuhair, M. (2003). "Evaluating Management Effectiveness of Marine Protected Areas (MPAs) of Maldives." James Cook University, Townsville, 17.

Appendix 1: A Brief Description of the AEC Project

The objective of this project is the conservation and sustainable use of globally significant biological diversity in the Maldives' Baa Atoll. The project's three-pronged strategy is to:

1. Mainstream biodiversity conservation objectives into sectoral policies and programs and reinforce multi-sectoral institutional fora,
2. Conserve biodiversity "in the water" and "on the ground" by establishing protected areas and managing them through innovative national-local and public-private partnerships in Baa Atoll, and
3. Relieve livelihood-related pressure on biodiversity by enhancing reef fishery property rights and enabling local people to pursue more sustainable, alternative livelihoods.

It is expected that by the end of the project, modified sectoral policies and programs would enable institutions to more effectively manage biodiversity. Further expected outcomes of the project are that government, local communities, and the private sector would be partnering to secure the long-term conservation of three protected areas in Baa Atoll, and local people would be applying new knowledge and accessing new sources of financing in pursuit of alternative livelihoods.

Appendix 2: Guiding Questions for Local Focus Group Interviews

Part I: Importance of Dhigali Haa to locals

I want to focus this part of the discussion on how Dhigali Haa (DH) was used by locals before it was declared an MPA.

1. What sort of uses did you make from DH?
    a. Fishing
        i. Bait fishery
        ii. Reef fishery
        iii. Shark fishery
        iv. Tuna
        v. Grouper
        vi. Lobster
        vii. Sea Cucumber
        viii. Aquarium fish
        ix. Other
    b. Coral/Sand Mining
    c. Recreation
    d. Souvenir Trade
    e. Other

For each activity in turn.

2. What percentage of people from this island was involved in this activity?
3. Are there other areas where you would uses for the same activity?
4. Looking at the catch from all areas, what percentage of your catch would you say came from DH?
5. How many visits per week would you make to DH? Compare to other sites.
6. What would you estimate to be the income/benefits you used to get from DH?

Since October 1999, DH has been declared an MPA. Local communities play an important role in establishment and management of MPAs. As the local communities will know most, about the place, consulting with them is very important in effective MPA management. But it is my understanding that there weren't any consultations done with local communities during the establishment of DH Marine Park.
I want to find out on what has been missed and try to find ways to improve things .in the future. So I would like to discuss with you on some of aspects of establishing DH as an MPA and listen to any issues you may have on the establishment.

7. First of all, I would like to get your views on general MPAs?
    a. What do u think is the purpose of MPAs
    b. Do you think there may be any benefits?
    c. Are there any reasons to do so?
    d. Do you think they are suited for a place like the Maldives?
8. Moving specifically to DH, do you think DH is the most suited reef in Baa Atoll to be declared an MPA?
    a. In terms of diversity of marine life forms?
    b. In terms of use by locals & divers
    c. Are there other similar kinds of reefs that locals don't use as much (maybe due to difficulty in access)
9. How has DH being an MPA affected its use?

For each group of users ask:

10. Were you able to find other reefs for similar use?
11. Did you have to travel more or less distances to these reefs?
12. Does not having access for fishing in Dhigali Haa, cause a change in the fish catch? Or income? If so,
    a. Estimated change in fish catch?
    b. Estimated change of income??

    (**Emphasise from loss of Dhigali Haa only, not other impacts)**
13. Do fishermen of your island still use Dhigali Haa for bait fishing?
14. How important a bait fishing ground, is Dhigali Haa?
    a. What percentage of bait comes from Dhigali Haa
    b. Are there other grounds you visit? And do these provide similar types of bait?
    c. How does Dhigali Haa compare with these other sites
        i. Quantity of bait?
        ii. Types of bait?
        iii. Catch per effort??
        iv. Travel distance & time?
15. Although any type of fishery, except bait fishing is prohibited, do you know if any illegal fishing is still going on? Things you may have seen, or heard from people while out fishing??
16. If so, why do you think it is? What can be done to prevent such things?

Part II: Dhigali Haa and its Management

This part of the discussion focuses on establishment, management and enforcement at Dhigali Haa.

17. What are your views on Dhigali Haa being declared an MPA?
    a. Do you support the decision?
    b. What do you think are its benefits?
18. Had you been consulted during the establishment process (hypothetically now), what sort of suggestions would you have made to the government?
    a. Alternative sites
    b. Compromise between users
    c. Enforcement and management
    d. Local involvement
    e. Others?

The state it is now is called a ‘paper park’, where it is only protected in name. Presently there is no management, at DH There is no warden to monitor illegal activity. There is no monitoring of the health of the reef. Despite being protected, the umbers of threatened marine life forms are not improving. In short, quality of DH is no different to any other unprotected reef exposed to similar stresses.
My research involves looking at improving management at Dhigali Haa. In that effect, I am proposing some improvements.
(Briefly describe, the proposed improvements and discuss its key issues)

1. Establishment of an enforcement office (employment opportunities)
2. Role of enforcement officers,
    a. How does the community feel about patrolling
    b. effectiveness of their job (support from community on reporting of illegal activities)

3. Levying fines
    a. How do you feel about fines?
    b. Discuss different fine level for different illegal activities?
4. Marker buoys and mooring buoys
5. Monitoring health of reef
6. Zoning (bait fishery vs. diving)
7. Establishment of a conservation trust fund.
    a. Trustees
    b. Conservation fees from tourists

Some issues to discuss are:

19. The role of your community in its implementation
20. School kids involvement in monitoring reef health
21. Any suggestion/ changes from the community

Appendix 3a: Questions for Background Information Gathering- for Resort Management

My name is Mizna Mohamed and I am a Masters student at University of Canterbury in New Zealand. I am trying to get background information on the recreational use of dive sites. I am working on a research project that looks at the management of protected dive sites in the Maldives.

Aim:

- ***To gather background information on diving sites and diving pattern of tourists in Baa Atoll***

1. Just to confirm, the name of your resort is _____, right?
2. And your name is _____.
3. Again to confirm, your phone number and email are _____, and _____, right?

4. Does your resort have a house reef?
5. Is it used for snorkelling by tourists?
6. Is it used for diving by tourists?
7. Do you collect the following information about tourists staying at your resort?
    a. Nationality
    b. Gender
    c. Age
    d. Length of stay
    e. Recreational activities
8. Approximately what percentage of tourists staying at your resort speaks English fluently? What are the other major languages spoken?
   (As I am going to be interviewing tourists, it will be helpful to know what languages are most commonly spoken)
9. What is the major currency used in your resort? Are there any other currencies that are commonly used?

Thanks very much for providing the above information.

Appendix 3b: Questions for Background Information Gathering- for Dive Schools and Operators

My name is Mizna Mohamed and I am a Masters student at University of Canterbury in New Zealand. I am trying to get background information on the recreational use of dive sites. I am working on a research project that looks at the management of protected dive sites in the Maldives.

Aim:

- ***To gather background information on diving sites and the diving pattern of tourists in Baa Atoll***

1. Does the resort you are attached to have a house reef?
2. Do tourists use it for snorkelling?
3. Do tourists use it for diving?
4. Of the dive sites in Baa Atoll, what do you think are the 3 most popular dive sites with your customers?

   1. _____

   2. _____

   3. _____

5. Taking _(insert 1. here)_ first, how far is it from your resort?
   What are its special features?

   Taking _(insert 2. here)_ second, how far is it from your resort?
   What are its special features?

   Taking _(insert 3. here)_ third, how far is it from your resort?
   What are its special features?

6. Other than the resorts operating in Baa Atoll, do you know if other people such as safari boats or locals make use of these sites?
7. How much does a dive cost for a tourist? Does this include equipment hire? If not, what additional costs will there be for equipment hire?
8. Does the total cost of a diving trip change over the season? If so, how?
9. How many divers did you have in 2005?
10. On average how many dives does a tourist do during the time he/she stays in your resort?
11. What countries do most of the divers come from?
12. Approximately what percentage of divers speak fluent English? What are the other major languages spoken?
13. Is there good diving throughout the year? Or is there seasonal diving? If so, when do most of the divers come?

Appendix 3c: Questions on use of Dhigali Haa Marine Protected Site in Baa Atoll

My name is Mizna Mohamed and I am a Masters student at University of Canterbury in New Zealand. I am trying to get background information on the recreational use of dive sites. I am working on a research project that looks at the management of protected dive sites in the Maldives.

Aim:

- ***To gather information on diving intensity at Dhigali Haa, a Marine Protected Area in Baa Atoll***

14. Name of your dive operation/school: _____
15. Do you do diving trips to Dhigali Haa/Horubadhoo Thila?
16. Approximately, how many boat trips are made each month to Dhigali Haa/Horubadhoo Thila?
17. On average, how many divers go on one boat trip to Dhigali Haa/Horubadhoo Thila?
18. On average, how many dives would a diver make during a trip to Dhigali Haa/Horubadhoo Thila ?
19. Based on your experience, diving at Dhigali Haa/Horubadhoo Thila, please provide information on the types of corals found in Dhigali Haa/Horubadhoo Thila and their approximate percentage cover?
20. How experienced are divers who go to Dhigali Haa? (Express in percentage of divers)
21. Do you allow wearing of diver gloves when diving at Dhigali Haa?
22. Do you give briefing and instructions on caring for the coral reefs and good practices in diving to divers just before they go into the water?
23. From your experience, diving at Dhigali Haa/Horubadhoo Thila, please provide information on the types of corals found in Dhigali Haa/Horubadhoo Thila and their approximate percentage cover?

Coral Type	Estimated % Cover
Branching corals	
Table corals	
Finger corals	
Foloise corals	
Massive corals	
Encrusting corals	

Others(specify)	
Others(specify)	

24. This question is to compare the number of some of the marine life forms spotted at Dhigali Haa during a dive. Please fill the table below to give an average number of animals spotted during a dive.

Marine Animal	Average number spotted during a dive	
	in 1999 (just before being declared a protected site)	in 2006
Grey reef shark		
White-tipped shark		
Dolphins		
Turtles		
Others(specify)		
Others(specify)		
Others(specify)		

25. If an abundance indicator (ABU %) can be used to express qualitatively the health of the reef, how would you rate (in a percentage) the present state of Dhigali Haa?
(The abundance indicator is measuring the abundance of corals, fish, marine animals and other benthic organisms. An abundance of 0% (ABU=0%) would mean that all of the coral has disappeared. An abundance of 100% (ABU=100%) means that the reef is in its natural pristine state.)

Thanks very much for providing the above information.

Appendix 4: Contingent Valuation Survey Questionnaire (In-Person Survey)

Questionnaire on *Dhigali Haa*

Hello, my name is Mizna Mohamed. I am a Masters student at the University of Canterbury in New Zealand. I am trying to improve the management of marine parks in Maldives. You can help by answering a few questions.

You have been selected at random to participate in the survey. It would take roughly 20 minutes in total. I would give you some background information on marine park management and then ask your views regarding certain management options.

The survey is anonymous and your name would never be associated with your answers. Everything you tell me would be kept confidential. You may withdraw your participation, including withdrawal of any information you have provided, until your questionnaire has been added to the others collected. Your identity cannot be associated with your answers after that.

Date: …/… /2006 Time interview starts: …….. Time interview ends: …….

Resort:

1. Reethi beach 2. Sonevafushi 3. Royal 4. Coco Palm 5.Kihadhuffaru

Would you be willing to do the survey, either now, or at another more suitable time?

_____ ***Now***

_____ ***Another time***

_____ ***No***

(If another time; determine when and where)
When would be convenient?

When: _____

Where: _____

Are you comfortable doing the survey in English?

a. Yes ☐

b. No ☐——— Italian? ☐

German? ☐

Japanese? ☐

SECTION A: VISIT TO THE MALDIVES AND DIVING EXPERIENCE

First I will be asking some general questions on your visit to the Maldives.

A1. How many times have you visited the Maldives, including this visit? _____

(If answer is 1 go to question A3)

A2. Of these visits how many times have you stayed in Baa Atoll?? _____

A3. What is the main purpose of your current visit?

a. Relaxation □

b. Diving or other water based sport □

c. Honeymoon □

d. Business/Professional □

e. Other (SPECIFY) _____ □

A4. Have you or do you plan to go snorkelling during your visit? Yes / No

A5. Have you or do you plan to go diving during your visit? Yes / No

(If yes to diving, tick the box at the top of p.5 and continue this section. Otherwise skip to section B)

I would like to next ask about your diving experience:

A6. Do you dive (with SCUBA)? Yes / No

(If answer is yes, go to A7. Otherwise skip to Section B)

A7. Are you a certified diver?: level certification/agency Yes / No

level of certification: _____

Agency: _____

A8. Have you taken a specialty course in marine life (coral, fish, sharks etc)? Yes / No

A9. For how many years have you been diving? _____

A10. During your dive here, were you given any briefing regarding behaviour in the coral reef environment? Yes / No

A11. Have you dived in other countries beside the Maldives? Yes / No

(If yes go to question A12. Otherwise skip to Section B)

A12. How does the quality of dive sites in the Maldives compare with other countries you have visited? *(Probe about quality of reef, number of fish seen, the different variety of fish)*

_____

_____

_____

SECTION B1: BACKGROUND INFORMATION

What I'd like to do next is to provide some background information on sea life in Baa Atoll. This is a map of Baa Atoll. As you can see Baa Atoll has over 35 dive sites. Dive sites in Baa Atoll are less crowded than other tourist areas in the Maldives.
(SHOW CARD 1: Map of Baa Atoll showing dive sites and resorts)

These reefs are very rich in their diversity of marine life. There are many species of soft and hard corals. Some of these include a species of pink coral which may be unique to Baa Atoll. While diving in Baa Atoll, you might see grey reef and whitetip sharks, stingray, eagle rays, barracuda, groupers, turtles, and napoleon wrasse and spinner dolphins. *(SHOW CARD 2: Marine Life forms in Baa Atoll)*

This survey looks at one of these dive sites, Dhigali Haa, which is the only Marine Protected Area in Baa Atoll. *(Show location of Dhigali Haa on CARD 1)*

Dhigali Haa was recommended for protected status by resorts and dive schools because of frequent sightings of grey reef sharks, white tipped reef sharks, barracudas, jacks and turtles. During the wet season, Dhigali Haa is a popular cleaning station for Manta Rays.

I am now going to show you a stylized dive site map of Dhigali Haa as it is now.
(SHOW CARD 3: Dhigali Haa in its Present State)

As a marine protected area, Dhigali Haa allows recreational diving but officially prohibits other activities. *(READ from CARD 4: Activities prohibited in Dhigali Haa)*
As with all Marine Protected Areas in the Maldives, the management of Dhigali Haa is currently inadequate to enforce these restrictions or ensure the continued health of the reef. For example, *(SHOW CARD 5: Present management in Dhigali Haa - Status quo)*

Dive guides report that divers regularly remove fishing lines and hooks found entangled in the hard corals. They also frequently observe damage to corals consistent with that caused by boats dropping anchors on the sea floor.

This lack of management and diving pressure is believed to have led to a decline in the health of Dhigali Haa. For example grey reef sharks, tawny nurse sharks and white tipped reef sharks, have declined since 1999. Dive schools report that about a dozen sharks may be seen per dive in 2000, but now there are hardly any seen.

The main reason for the lack of management at Dhigali Haa has been lack of funds allocated by the government. In some parts of the world like the Caribbean, user fees are charged to enter marine parks and the revenues used to improve park management. Presently there are no user fees charged at any dive site in the Maldives.

SECTION B2: IMPROVED MANAGEMENT SCENARIO
(SHOW CARD 6: Improved Management Scenario at Dhigali Haa)

The Ministry of the Environment is considering implementing an improved management scenario at Dhigali Haa *(SHOW CARD 6a: Expected Benefits from the Improved Management)*

Based on research done elsewhere and also on expert opinion on the local coral reefs, it is expected that with better enforcement of rules and increased diver education, the damage to the reef would be reduced, and the health of the reef would improve.
(SHOW CARD 7: Expected Changes at Dhigali Haa and compare with Card 3)
This card shows what the expected changes would be from enforcing the improved management.

Before we continue, do you have any questions?

SECTION C: WILLINGNESS TO PAY QUESTION ☐ Diver

I'd next like to ask you some questions on your views on paying for improved management at Dhigali Haa. Please bear in mind that there are many other dive sites in Baa Atoll. Many currently offer a diving experience similar to that at this marine protected area. But improved management at Dhigali Haa should improve sea life and therefore dive experience at the protected site.

Suppose that a trust fund was established to fund the improved management that I just described. The trust would be managed by a board of trustees which represent the local community, fishermen, resort owners and the government. Funding for this trust would be collected from a conservation fee collected from all tourists visiting Baa Atoll by the resort at which you stay.

C1. If you could be certain that the funds obtained from the conservation fee would be used only to improve management of *Dhigali Haa*, what is the maximum amount you would be willing to pay per visit to Baa Atoll?

(If willing to pay a fee go to C2 and if not willing to pay go to C3)

C2. You indicated that you would be willing to pay up to $.... as a conservation fee. What is the main reason you would be willing to do so? *(Print exact answer. Probe fully)*

_____

_____

_____

C3. You indicated that you would not be willing to pay a fee. What is your main reason for this? *(Print exact answer. Probe fully)*

_____

_____

_____

(ASK THE FOLLOWING QUESTION ONLY IF THE BOX AT THE TOP OF THE PAGE IS TICKED. IF NOT GOTO SECTION D)
Suppose that, rather than charge a fee to all visitors to Baa Atoll, the trust decided charge only visitors to Dhigali Haa through an entrance fee. This entrance fee would be collected by the dive schools in addition to what they already charge for dives, equipment and boat fees.

C4. If you could be certain that the funds obtained from the entrance fee would be used only to improve management of *Dhigali Haa*, what is a maximum amount you would be willing to pay as an entrance fee to visit *Dhigali Haa*?

(If willing to pay a fee go to C5 and if not willing to pay go to C6)

C5. You indicated that you would be willing to pay up to $.... as an entrance fee. What is the main reason you would do so? *(Print exact answer. Probe fully)*

_____

_____

_____

C6. You indicated that you would not be willing to pay an entrance fee. What is your main reason for this? *(Print exact answer. Probe fully)*

_____

_____

_____

SECTION D: DEMOGRAPHIC AND INDIVIDUAL QUESTIONS

Finally, I would like tot ask you some questions on your views about coral reefs and some demographic information. Everything I ask you will be kept confidential but helps with my analysis of this survey.

D1. In your opinion, do you think the world's coral reefs are deteriorating, holding steady or improving?

D2. What, if any, do you think are some major threats to coral reefs? *(Print exact answer. Probe fully)*

_____

_____

_____

D3. Do you belong to any environmental or conservation organizations? Yes / No

D4. Are you involved in any conservation projects? Yes / No

(If yes go to D5, else go to D6)

D5. Apart from membership fees, do you make donations to any environmental/conservation groups or activities? Yes / No

D6. What is your nationality? _____

D7. What is your current country of residence?

D8. From this card, please tell me into which age range you fall?

a. Under 20 □

b. 20 to 29 □

c. 30 to 39 □

d. 40 to 49 □

e. 50 to 59 □

f. 60 to 69 □

g. 70 or over □

D9. What is the highest level of education you have obtained?

a. Some high school or less □

b. High school diploma □

c. Trade certificate □

d. Some university or college □

e. University or college degree, diploma or certificate □

f. Postgraduate degree □

g. Other (SPECIFY) _____ □

D10. From the following, what best describes your current work status?

a. Employed full time/part time □

b. Unemployed □

c. Retired □

d. Full time student □

e. Home Duties □

f. Other (SPECIFY) _____ □

D11 What is your current occupation? _____

I understand this final question is a very personal one. The answer to this question will help me in the analysis of the data collected.

D12. Have a look at the card and tell me which category best describes your total household income in 2005, **before** taxes?

a. □

b. □

c. □

d. □

e. □

□

SECTION E: Interviewer complete

E1. Sex

a. Male ☐

b. Female ☐

E2. Please provide comments on the responses provided by the respondent.

_____

_____

_____

Thank you for participating in this survey.
You will be able to view my analysis of the survey results at the following website within 6 months.
http://www.econ.canterbury.ac.nz/dhigali_haa/
Enjoy the rest of your stay!

Card 1

Dive Sites of Baa Atoll


Card 2: Marine Life Forms in Baa Atoll

CARD 3: Dhigali Haa

CARD 4: Officially Prohibited Activities in Marine Protected Areas in the Maldives

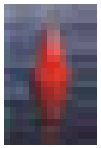
- anchoring (except in emergency)

- coral and sand mining
- rubbish dumping

- removal of any natural object or living creatures
- fishing of any kind except traditional live bait fishing

- any other activity which may cause damage to the area

CARD 5: Present Management in Dhigali Haa



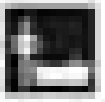
There are NO marker buoys to identify the boundaries of the protected areas

There are NO mooring buoys provided for boats to anchor so as not to drop anchor onto the sea floor

There are NO wardens hired to enforce regulations

There are NO monitoring programs to assess the health of the reef

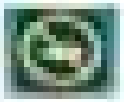
CARD 6: Improved management Scenario at Dhigali Haa



Set up an enforcement office and hire wardens
Equip the enforcement office with a motor boat for patrolling

Set up marker buoys to identify the site

Set up mooring buoys for boats to anchor



Set up appropriate signs

Start annual monitoring of the health of the reef

Increase diver education on good diving practices

Set and impose fine systems for offenders and create awareness of these


CARD 7: Expected Changes at Dhigali Haa

Demographic Cards for Question D9 (Age) and D13 (Household Income)

a. Under 20

b. 20 to 29

c. 30 to 39

d. 40 to 49

e. 50 to 59

f. 60 to 69

g. 70 or over

Question D9:Age

a. Under 18,000
b. 18,001 - 37,000
c. 37,001 - 64,000
d. 64,001 - 91,000
e. More than 91,000
f. Don't know
g. Not comfortable answering

Question D13 – Euro (€) (Germany)

a. Under 17,000
b. 17,001 - 34,000
c. 34,001 - 60,000
d. 60,001 - 85,000
e. More than 85,000
f. Don't know
g. Not comfortable answering

Question D13 – Euro (€) (Italy)

a. Under 2, 2000,000
b. 2, 2000,001 – 4,400,000
c. 4,400,001 – 7,700,000
d. 7,700,001 - 11, 000,000
e. More than 11, 000,000
f. Don't know
g. Not comfortable answering

Question D13 – Japanese Yen (¥)

a. Under 13,000
b. 13,001 - 25,000
c. 25,001 - 44,000
d. 44,001 - 63,000
e. More than 63,000
f. Don't know
g. Not comfortable answering

Question D13 –Great Britain Pounds (£)

a. Under 20,000
b. 20,001 - 40,000
c. 40,001 - 70,000
d. 70,001 - 100,000
e. More than 100,000
f. Don't know
g. Not comfortable answering

Question D13 – United States Dollars (US$)

Appendix 5: Contingent Valuation Survey Questionnaire (Mail Survey)

Form No: CP-

Tourist Opinion Survey on Improving Marine Protected Areas Management in the Maldives

Please read the following note before completing the questionnaire.

NOTE: You are invited to participate in a research project being undertaken for a Masters degree by completing the following questionnaire. The research is aimed on improving management of marine protected areas in the Maldives. Baa Atoll, at which you are staying, has been selected as the study location for this research.

The information you provide would be kept confidential. Results of the survey will be included in my thesis, in the form of grouped results only. Individual information will not be made available to anyone other than me and my supervisors. To ensure the survey is anonymous, I will not ask for your names or any other form of identification.

Please DO NOT print your name or any other information that can associate your identity with the answers.

SECTION A: VISIT TO THE MALDIVES AND DIVING EXPERIENCE

A1. How many times have you visited the Maldives, including this visit? _____

(If answer is 1 go to question A3)

A2. Of these visits how many times have you stayed in Baa Atoll?? _____

A3. What is the main purpose of your current visit? (Tick more than one if appropriate)

a. Relaxation □

b. Diving or other water based sport □

c. Honeymoon □

d. Business/Professional □

e. Other (SPECIFY) _____ □

A4. How long are you staying during this visit? _____

A5. Have you or do you plan to go snorkelling during your visit?

a. Yes □

b. No □

A6. Have you or do you plan to go diving during your visit?

a. Yes □

b. No □

(If answer is yes to diving, go to question A6. Otherwise skip to section B)

A7. This question is about your diving experience. Please tick from below the appropriate box.

a. I have never dived before. □

b. I have an Open Water Certificate □

c. I have an Advanced/Advanced Plus level Certificate or □

d. OTHER (Please specify): _____

(If answer is 'a' go to section B. Otherwise go to Question A8)

A8. For how many years have you been diving? _____

A9. Have you taken a specialty course in marine life (coral, fish, sharks etc)?

a. Yes □

b. No □

A10. During your dive here, were you given any briefing regarding diver behaviour in the coral reef environment?

a. Yes □

b. No □

A11. Have you dived in other countries beside the Maldives?

a. Yes □

b. No □

(If yes go to question A12. Otherwise go to Section B)

A12. How does the quality of dive sites in the Maldives compare with other countries you have visited? *(Quality of reef, number of fish seen, the different variety of fish)*

_____

_____

_____

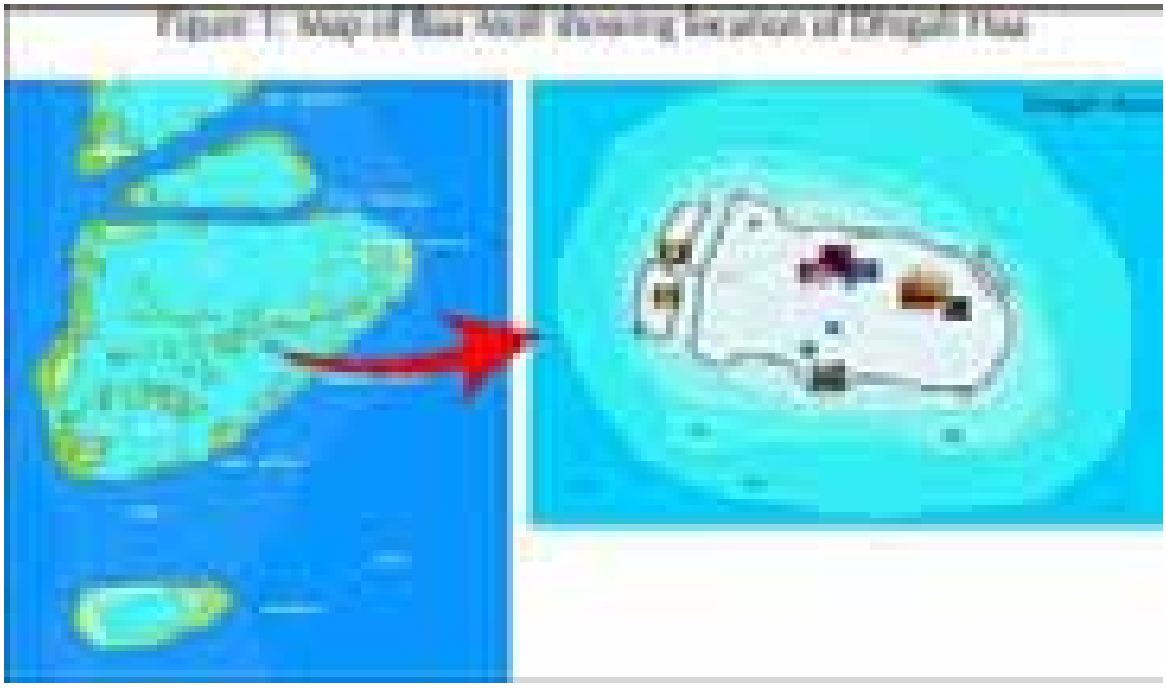
_____

SECTION B1: BACKGROUND INFORMATION ON MARINE PROTECTED AREAS IN MALDIVES

This section will provide some background information on sea life in Baa Atoll. Baa Atoll is the focus for this research because the Ministry of Environment is planning to establish new protected areas there. Baa Atoll has over 35 reefs which are used for diving by tourists. These reefs are very rich in their diversity of marine life.

Dhigali Haa is currently the only Marine Protected Area in Baa Atoll, and is used as a pilot study for this research. Dhigali Haa was recommended for protected status by resorts and dive schools because of frequent sightings of grey reef sharks, white tipped reef sharks, barracudas, jacks and turtles. During the wet season, Dhigali Haa is a popular cleaning station for Manta Rays.

Figure 1 shows a map of Baa Atoll, showing the location of Dhigali Haa. Figure 2a is a stylized dive site map of Dhigali Haa as it is now.



As a marine protected area, Dhigali Haa allows recreational diving but officially prohibits other activities that will cause harm to the area. These include anchoring, all fishing except bait fishing, coral and sand mining or removal of any other natural objects. As with all Marine Protected Areas in the Maldives, the management of Dhigali Haa is currently inadequate to enforce these restrictions or ensure the continued health of the reef. Currently, for example:

- ***There are NO wardens hired to enforce regulations***
- ***There are NO marker buoys to identify the boundaries of the protected areas***
- ***There are NO mooring buoys provided for boats to attach to so as not to drop anchor on the sea floor***
- ***There are NO monitoring programs to study the health of the reef***

This lack of management and diving pressure is believed to have led to a decline in the health of Dhigali Haa. For example dive schools report that about a dozen sharks were typically seen per dive in 2000, but now they see only a couple of sharks each year. Dive guides also report that divers regularly remove fishing lines and hooks found entangled in the hard corals.

Part of this study is to develop an improved management scenario, that the Ministry of Environment, could consider implementing.

Proposed Improved Management in Dhigali Haa

- *Set up an enforcement office and hire wardens to patrol the protected area*
- *Set and impose fine systems for offenders and create awareness of these*
- *Set up marker buoys to identify the site and set up appropriate signs*
- *Set up mooring buoys for boats to anchor*
- *Start annual monitoring of the health of the reef*
- *Give special instructions to divers going to protected sites*

Based on research done elsewhere on effectiveness of marine protected areas, it is expected that with better management and enforcement of rules the health of the reef would improve. Figure 2b shows what the expected changes would be from enforcing the improved management.

The main reason for the lack of management at Dhigali Haa has been lack of funds allocated by the government. In some parts of the world like the Caribbean, user fees are charged to enter marine parks and the revenues used to improve park management. Presently there are no user fees charged at any dive site in the Maldives. This research also looks at ways to raise funds for implementing the proposed management scenario.

It is proposed that a trust fund be established to fund the improved management. The trust would be managed by a board of trustees which include the local community, fishermen, resort owners and the government.

SECTION C: WILLINGNESS TO PAY QUESTION

The section is regarding your views on paying for improved management at marine protected areas. One proposed methods to raise funds for the trust is to collect a conservation fee from all tourists visiting Baa Atoll by the resort at which you stay. This would be a one time payment for your visit.

Before responding please bear in mind that you have other uses for your income and that you are also currently paying for other things during your holiday in the Maldives. Also bear in mind that currently there are many other areas in Maldives that you can visit without paying such a fee.

C2. If you could be certain that the funds obtained from the conservation fee would be used only to improve management of *Dhigali Haa*, what is the maximum amount you would be willing to pay per visit to Baa Atoll? US$ _____

(If willing to pay a fee go to C3 and if not willing to pay go to C4)

C3. What is the main reason that you would be willing to do so?

_____

_____

_____

C4. You indicated that you would not be willing to pay a fee. What is your main reason for this?

_____

_____

_____

(ANSWER THE FOLLOWING QUESTION ONLY IF YOU HAVE OR PLAN TO GO DIVING DURING YOUR STAY. IF NOT GO TO SECTION D)

Suppose that, rather than charge a fee to all visitors to Baa Atoll, the trust instead decided to charge only visitors to Dhigali Haa through an entrance fee. This entrance fee would be collected by the dive schools in addition to what they already charge for dives, equipment and boat fees.

Please remember that there are many dive sites in Baa Atoll. Many of these areas currently offer a diving experience similar to that at *Dhigali Haa*. But improved management at *Dhigali Haa* should improve sea life there and therefore the dive experience it offers.

C5. If you could be certain that the funds obtained from the entrance fee would be used only to improve management of *Dhigali Haa*, what is the maximum amount you would be willing to pay as an entrance fee to visit *Dhigali Haa*? US$ _____

(If willing to pay a fee go to C6 and if not willing to pay go to C7)

C6. What is the main reason you would do so?

_____

_____

_____

C7. You indicated that you would not be willing to pay an entrance fee. What is your main reason for this?

_____

_____

_____

SECTION D: DEMOGRAPHIC AND INDIVIDUAL QUESTIONS

This section includes questions on your views about coral reefs and some demographic information. This information helps with my analysis of this survey.

D1. In your opinion, do you think the world's coral reefs are generally deteriorating, holding steady or improving?

a. Deteriorating □

b. Holding steady □

c. Improving □

d. Don't know □

D2. What, if any, do you think are some major threats to coral reefs? *(Print exact answer. Probe fully)*

_____

_____

_____

D3. Do you belong to any environmental or conservation organizations?

a. Yes □

b. No □

D4. Are you involved in any conservation projects?

a. Yes □

b. No □

D5. Apart from membership fees, do you make donations to any environmental/conservation groups or activities?

a. Yes □

b. No □

D6. What is your nationality? _____

D7. What is your current country of residence? _____

D8. Gender

a. Male □

b. Female □

D8. From this card, please tell me into which age range you fall?

a. Under 20 □

b. 20 to 29 □

c. 30 to 39 □

d. 40 to 49 □

e. 50 to 59 □

f. 60 to 69 □

g. 70 or over □

D9. What is the highest level of education you have obtained?

a. Some high school or less □

b. High school diploma □

c. Trade certificate □

d. Some university or college □

e. University or college degree, diploma or certificate □

f. Postgraduate degree □

g. Other (SPECIFY) _____ □

D10. From the following, what best describes your current work status?

a. Employed full time/part time □

b. Unemployed □

c. Retired □

d. Full time student □

e. Home Duties □

f. Other (SPECIFY) _____ □

D11 What is your current occupation? _____

D12. Have a look at the card and tell me which category best describes your total household income in 2005, **before** taxes?

a. Under $20,000 □

b. $20,001 - $ 40,000 □

c. $40,001 - $70,000 □

d. $70,001 - $100,000 □

e. More than $100,000 □

Thank you for participating in this survey.
You will be able to view my analysis of the survey results at the following website within 6 months.
http://www.econ.canterbury.ac.nz/dhigali_haa/
Enjoy the rest of your stay!

Appendix 6: IMS Costing

Table A6.1. Details of the Estimated Cost for the Proposed Improved Management at Dhigali Haa, Baa Atoll

Area	Activity	Fee Type	Qty	Unit Price (US$)	Cost (US$)	Source/ Basis of Estimated Costs
Dhigali Haa Management Office - establishment	Development of operational guidelines for Dhigali Haa Management Office	Consultancy fee	1	1000	1000	Previous costs for similar consultancies contracted out by the Ministry of Environment.
	Awareness on MPA rules/regulation	Announcements	1	1500	1500	Previous costs by the Ministry of Environment to advertise in the 3 local newspapers (NAPA Project)
		Awareness material	1	980	980	Previous cost of developing and printing awareness material by the Ministry of Environment (RETDAP Project)
	Infrastructure	Office Building	1	5000	5000	Personal communication, A.M. Didi, AEC Project, 5/07/2007 [US$47 per square foot x 212 square feet]
		Work stations & other interior	1	2000	2000	Available market cost in the Maldives
		IT equipment	1	4300	4300	Available market cost in the Maldives
	MPA maintenance and monitoring equipment	Patrol boat	1	31128	31128	personal communication, M. Hassan, Frenzy Boat Construction, 29/06/2007
		Diving and snorkelling equipment	1	16404	16404	personal communication, H.R. Didi, Villa Diving, 4/12/2006
		Camera, communication devices, etc.	1	400	400	Available market cost in the Maldives
		Mooring buoys	10	250	2500	From the Protected Areas Adopt a Buoy Programme, Hawaii http://www.malama-kai.org/buoys/funding.htm, accessed 26/6/2007
		Signboards for mooring buoys	1	1000	1000	Estimate signage cost in the Maldives
		Reef monitoring equipment (underwater camera, GPS, and other miscellaneous equipment such as slates, flagging, paper)	1	1847	1847	Web search for prices of equipment including shipping costs to the Maldives http://www.bizrate.com/; http://cars.er.usgs.gov/Monitoring_Manual.pdf

	Staff Training	Reef Monitoring	2	500	1000	Estimated cost for hiring instructors and producing instruction material
		Scuba Diving	2	485	970	Prices of scuba diving courses in the resorts of Baa Atoll
		Rescue Diving	2	500	1000	Prices of rescue diving courses in the resorts of Baa Atoll
		Local Environment & Environmental regulations	4	55	220	Based on costs for sending 2 instructors from the Ministry of Environment to Baa Atoll
Dhigali Haa Management Office - operation	Staff wages	MPA management staff	4	5136	20545	The Maldives Government wage scheme for patrol police
		Administrative staff	1	3715	3715	The Maldives Government wage scheme for A'level standard
	Office Operation	electricity	12	78	934	Data collected from RETDAP Project, Ministry of Environment on electricity consumption in island offices
		phone	12	117	1401	Allocated amount based on estimated monthly telephone bills
		consumables (stationary, paper, etc)	12	156	1868	Allocated estimated amount
	Awareness Raising	Dhigali Haa website	1	778	778	Personal communication, M. Inaz, 03/07/07
		Awareness workshops	2	500	1000	Allocated estimated amount
	MPA monitoring	Reef Monitoring (Twice a year)	2	500	1000	Estimated travel costs to Dhigali Haa from management office
		patrol boat running & maintenance	1	68171	68171	Personal communication, A.M. Didi, AEC Project, 28/02/2007
		boat insurance	1	2000	2000	
		mooring buoys maintenance	10	100	1000	From the Protected Areas Adopt a Buoy Programme, Hawaii http://www.malama-kai.org/buoys/funding.htm, accessed 26/06/2006
				TOTAL	**$173,661**	

Appendix 7: Demographics and Individual Attributes of Survey Sample

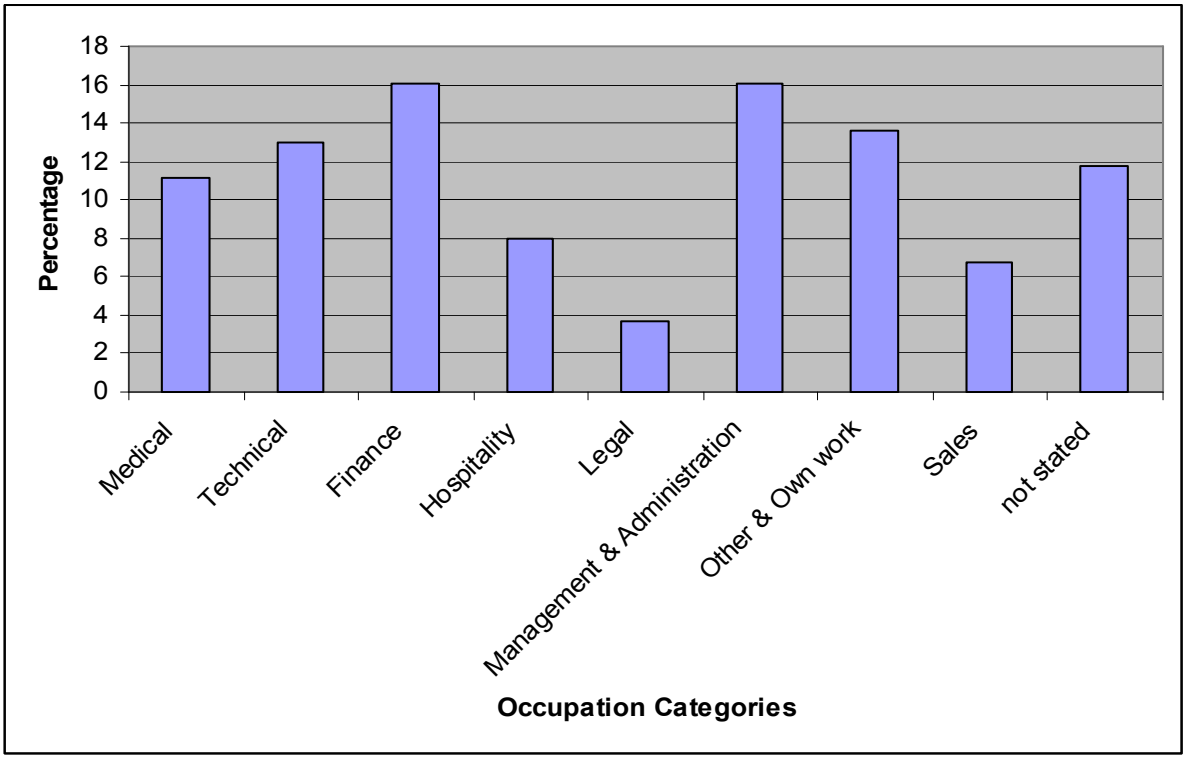


Figure A7.1. Analysis of Occupation of Respondents

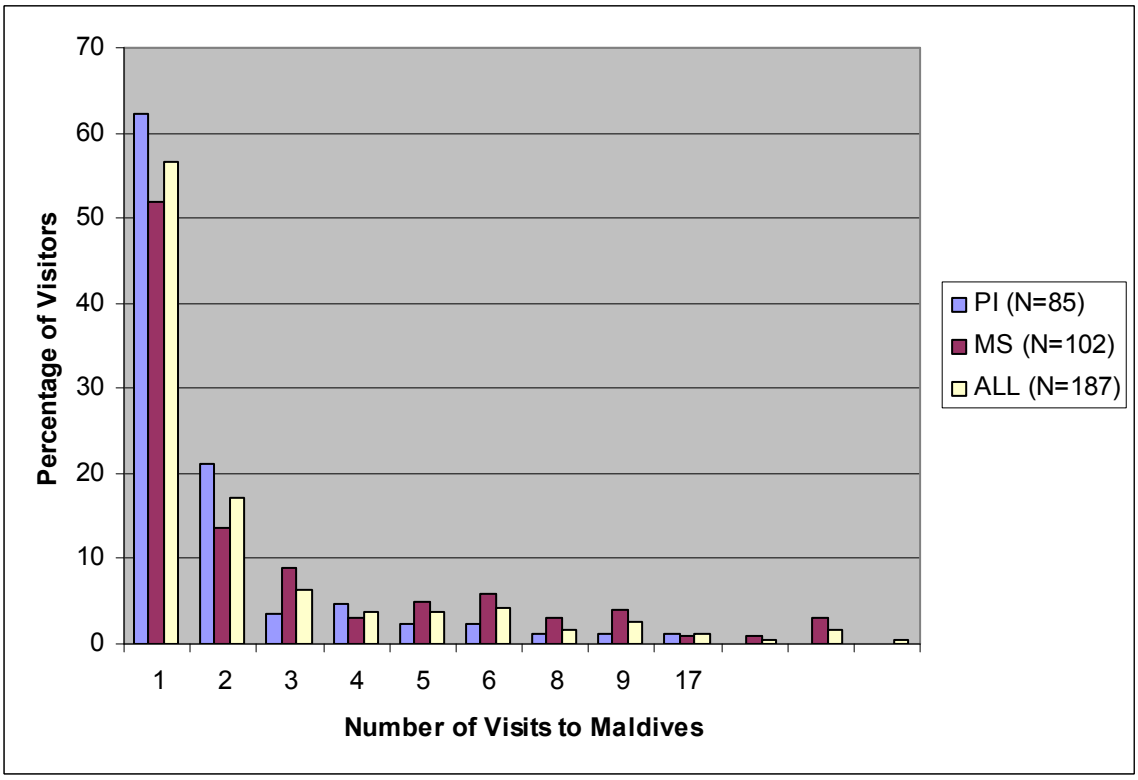


Figure A.7.2 Number of Visits to the Maldives of Survey Respondents

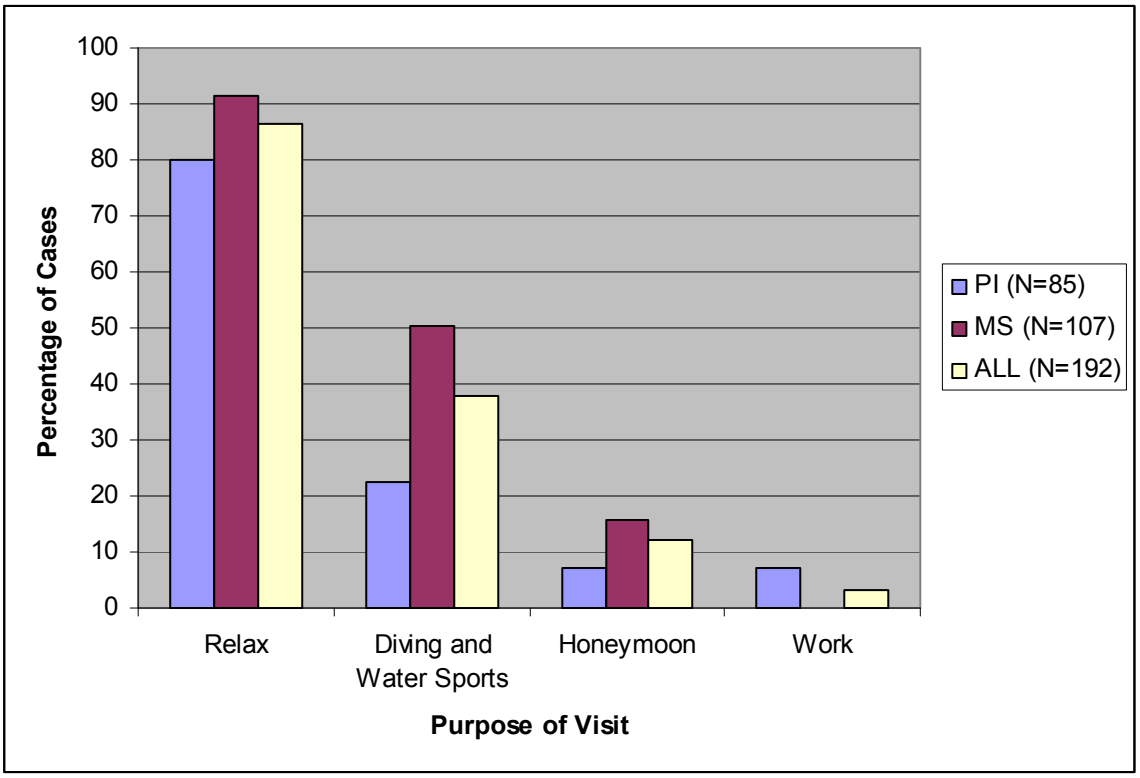


Figure A7.3. Purpose of Visit of Survey Respondents

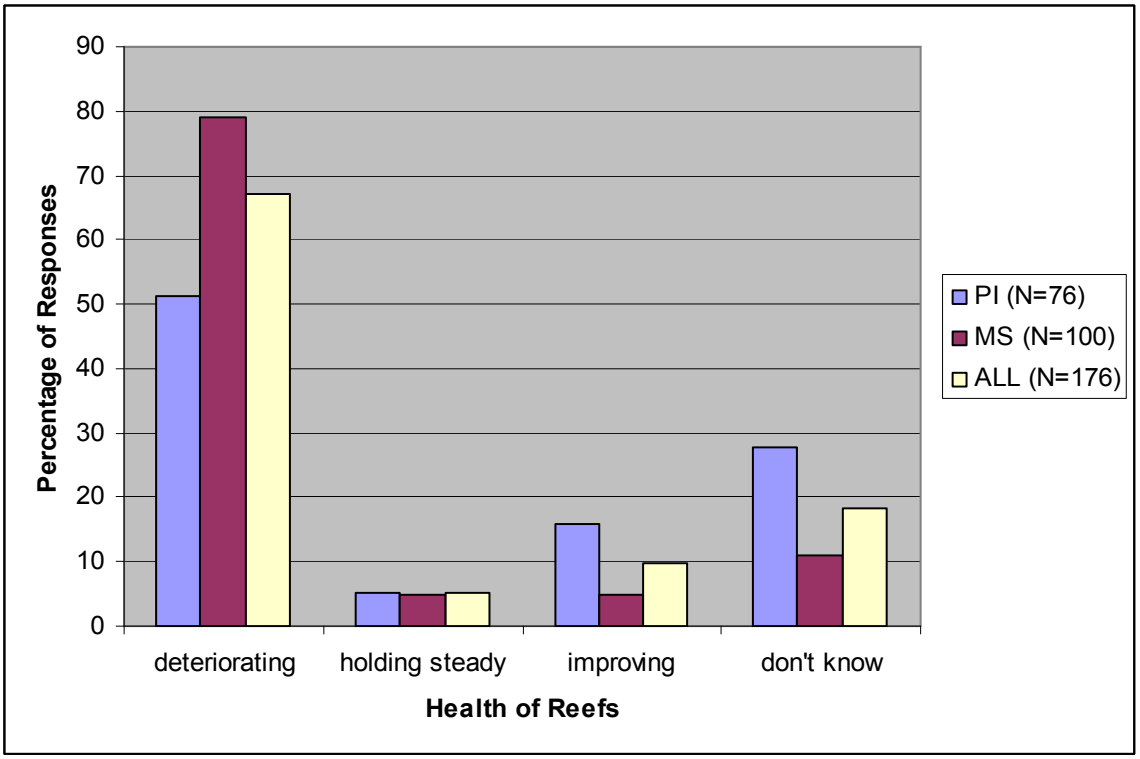


Figure A7.4. Respondents' View on Present Health of Worl Coral Reefs

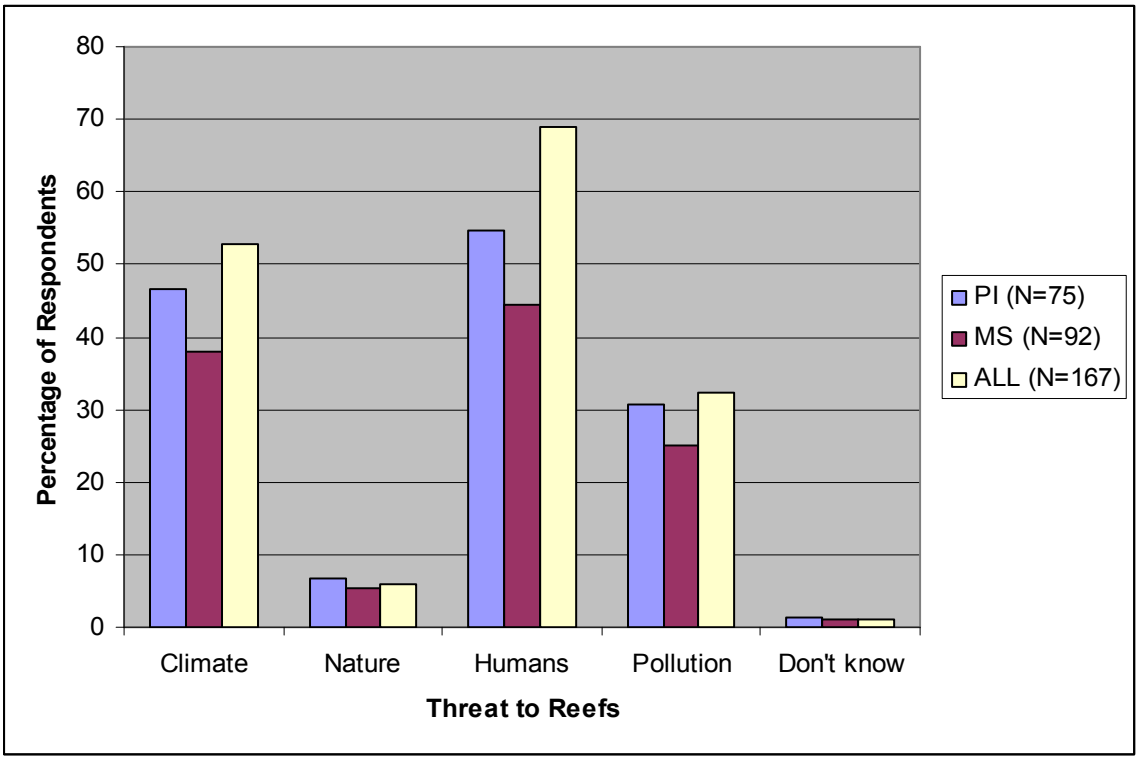


Figure A7.5. Respondents' Perceived Threats to Coral Reefs

Table A7.1. Descriptive Statistics Comparing Users and Non-users for the Survey Types Personal Interview and Mail Survey

Variable	in-person survey				mail survey			
	User (N=33)		Non-User (N=51)		User (N=54)*		Non-User (N=54)*	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
GEN	0.55	0.51	0.47	0.50	0.69	0.47	0.59	0.50
NAT	2.30	1.02	1.76	1.11	1.43	0.79	1.02	0.81
AGE	2.27	0.98	2.80	1.18	2.67	0.95	2.89	1.27
EDU	2.91	1.63	3.12	1.62	3.43	1.45	3.24	1.71
WORK	0.94	0.24	0.75	0.44	0.94	0.24	0.76	0.43
HINC0ME	2.36	1.56	2.82	1.42	3.44	1.33	3.31	1.18
VISIT	2.45	3.20	1.63	1.22	3.30	3.39	2.56	2.76
ECONCERN	0.39	0.50	0.49	0.50	0.49	0.50	0.42	0.50

* N differs for variables VISIT (N=50), WORK (N=53) and ECONCERN (N=53) for users and for non-users N=52 for the variables VISIT and ECONCERN.

Appendix 8: Variations of Mean WTP

Table A8.1. Comparison of mean willingness to pay a Conservation Fee for Different Variable Categories

Variable	Categories	in-person survey			mail survey		
		N	Mean	Std. Dev	N	Mean	Std. Dev
All	All	79	40.94	38.77	103	29.77	28.38
GEN	Male	41	45.67	39.71	65	32.64	29.95
	Female	38	35.85	37.58	38	24.86	25.09
NAT	British	15	47.71	30.68	33	35.76	28.56
	German	20	51.84	47.61	44	30.50	28.07
	Italian	32	31.16	35.35	2	0.00	0.00
	Other	12	40.42	27.51	24	22.68	27.98
AGE	20-29	11	35.82	30.36	9	33.74	26.16
	30-39	29	42.24	41.70	33	33.72	31.64
	40-49	23	48.31	42.23	35	29.12	29.91
	50-59	10	42.16	37.09	16	25.91	21.87
	Over 60	6	13.81	18.28	9	22.92	25.85
WORK	Not Employed	12	29.16	28.26	14	21.06	19.33
	Employed	67	43.05	40.16	84	31.36	29.79
EDU	some high school	4	18.00	21.97	10	17.02	23.38
	high school	16	46.01	41.81	8	36.23	25.74
	trade certificate	5	65.46	36.71	11	46.28	42.23
	some university	8	20.27	31.57	9	38.12	29.08
	undergraduate	31	39.20	38.59	40	26.16	25.16
	postgraduate	15	48.10	40.27	25	28.32	26.75
HINCOME	Under $20,000	6	75.07	40.87	3	25.52	12.89
	$20,001-40,000	10	29.24	30.11	4	23.61	30.67
	$40,001-70,000	23	19.92	19.92	21	32.34	28.19
	$70,001-100,000	13	43.84	37.51	15	26.36	29.11
	Over $100,000	18	45.49	39.61	46	33.11	29.60
	Not Stated	9	71.67	51.12	14	21.28	27.18
USER	User	32	41.75	34.90	51	30.35	29.84
	Non-user	47	40.40	41.55	52	29.20	27.16

Table A8.2. Comparison of mean willingness to pay a User Fee for Different Variable Categories

Variable	Categories	N	Mean	Std. Dev
All	All	80	15.40	24.78
GEN	Male	52	18.49	29.26
	Female	28	9.65	11.28
NAT	British	12	18.75	17.47
	German	37	10.28	13.56
	Italian	18	18.07	22.46
	Other	13	23.15	48.25
AGE	20-29	9	19.78	19.47
	30-39	32	19.24	33.69
	40-49	26	12.88	17.62
	50-59	11	9.36	9.21
	Over 60	2	0.00	0.00
WORK	Not Employed	4	15.00	12.91
	Employed	74	15.31	25.61
EDU	some high school	6	8.59	10.52
	high school	11	15.10	19.24
	trade certificate	9	13.44	10.10
	some university	5	20.58	19.68
	undergraduate	34	18.00	33.39
	postgraduate	15	11.88	17.39
HINCOME	Under $20,000	6	13.68	11.12
	$20,001-40,000	6	10.61	9.46
	$40,001-70,000	19	13.13	19.51
	$70,001-100,000	8	9.29	9.58
	Over $100,000	28	24.17	36.19
	Not Stated	13	6.56	8.53

Appendix 9: Description of Regression Models

Table A9.1. Descriptions of Regression Models

Regression Model	WTP Variable	Description
(1)	WTP conservation fee	Includes all variables except "Income Not Stated"
(2)	WTP conservation fee	Includes all variables except "Visit" and "User"
(3)	WTP conservation fee	Regression model (2), but excluding the variable "Education"
(4)	WTP conservation fee	Regression model (3), but excluding the variables "Income Not Stated" and "Environment Concern"
(5)	WTP conservation fee	Regression model (1), but excluding the German nationality
(6)	WTP conservation fee	Regression model (1), but excluding the Italian nationality
(7)	WTP conservation fee	Regression model (1), with imputed incomes
(8)	WTP conservation fee	Regression model (5), but excluding the variables "Visit", "User" and "Education"
(9)	WTP conservation fee	Regression model (6), but excluding the variable "Environment Concern"
(10)	WTP user fee	Includes all variables
(11)	WTP user fee	Includes all variables except "Survey Type", "Visit" and "Environment Concern"
(12)	WTP user fee	Regression model (11), but excluding the variable "Education"
(13)	WTP user fee	Regression model (12), but excluding the variable "Employment"
(14)	WTP conservation fee	Regression model (4), but excluding "protest bids"
(15)	WTP user fee	Regression model (13), but excluding "protest bids"

Table A9.2. Comparison of Rergression Models with and without "Protest Bids"

Regression Model	**(4)**	**(14)**	**(13)**	**(15)**
N	177	154	83	66
df	10	10	8	8
log likelihood	-766.97	-725.35	-308.83	-288.58
Constant	3.87 (11.68)	18.84* (10.79)	-26.11** (12.57)	-17.15 (11.96)
Gender	10.59* (5.92)	11.65** (5.46)	11.69 (7.65)	10.74 (7.53)
Other	16.95* (10.07)	13.45 (9.57)	13.28 (9.95)	14.26 (9.53)
British	35.08** (9.74)	18.74** (9.18)	16.75 (10.46)	15.22 (10.03)
Italian	-	-	10.09 (8.91)	12.71 (8.80)
German	26.34** (9.15)	19.16** (8.93)	-	-
Age1	16.62 (10.44)	4.95 (9.36)	25.49* (13.07)	19.94 (12.19)
Age2	11.23 (7.29)	9.79 (6.77)	16.11* (9.44)	15.46* (8.90)
Education	-	-	-	-
Employment	13.97 (8.60)	15.66** (7.77)	-	-
Medium Income	-16.88** (7.83)	-20.28** (7.24)	7.02 (8.91)	5.86 (8.77)
High Income	-9.93 (7.37)	-8.80 (6.93)	14.74* (8.41)	15.85* (8.19)
Income Not Stated	-	-	-	-
Visit	-	-	-	-
Environment Concern	-	-	-	-
User	-	-	-	-
Survey Type	-22.39** (6.43)	-20.63** (6.01)	-	-

** indicates significant at 5% level or better; * indicates significance at 10%.

Note: Regression models (4) and (13) are the regression which includes the "protest bids" for WTP conservation fee and WTP user fee, respectively. Regression models (14) and (15) are the respective regressions which does not include "protest bids"

In comparing Regression Models (4) and (14), all previously significant variables remained significant except for "Other" nationalities, which was not significant without the protest bids[23]. The notable difference was that, when "protest bids' were excluded the respondents who were employed were significantly more likely to have a higher WTP compared to those not employed. While the significance of the "constant" term increased with the "protest bids', this significance

[23] In some variables, for example 'Gender" the significance level had increased.

was not apparent when comparing Regression models (13) and (15). For WTP user regressions, the two models (13) and (15) were very much similar except the significance of respondents less than 30 years being WTP more than those above 50 years was not present when the "protest bids" were excluded[24].

[24] The significance dropped to 0.107.

Appendix 10: Results of Net present Value Calculations

Table A10.1. Example NPV Calculations for WTP Conservation fee
(Discount Rate = 8%; Inflation Rate = 3.5%; WTP = US$31)

Year	# visitors	Bt (US$)	Ct (US$)	Bt-Ct (US$)	dt	dt*(Bt-Ct) (US$)
0	21954	680574.00	173661.00	506913.00	1.0000	506913.00
1	21954	704394.09	105191.19	599202.90	0.9259	554817.50
2	21954	729047.88	108872.88	620175.00	0.8573	531700.10
3	21954	754564.56	112683.43	641881.13	0.7938	509545.93
4	21954	780974.32	116627.35	664346.97	0.7350	488314.85
5	21954	808308.42	153612.97	654695.45	0.6806	445574.72
6	21954	836599.21	124934.14	711665.08	0.6302	448469.72
7	21954	865880.19	129306.83	736573.36	0.5835	429783.48
8	21954	896185.99	133832.57	762353.42	0.5403	411875.83
9	21954	927552.50	138516.71	789035.79	0.5002	394714.34
10	21954	960016.84	182444.02	777572.82	0.4632	360166.67
11	21954	993617.43	148382.56	845234.87	0.4289	362506.75
12	21954	1028394.04	153575.95	874818.09	0.3971	347402.30
13	21954	1064387.83	158951.11	905436.72	0.3677	332927.20
14	21954	1101641.41	164514.40	937127.01	0.3405	319055.24
15	21954	1140198.86	216686.27	923512.59	0.3152	291129.68
16	21954	1180105.82	176231.94	1003873.88	0.2919	293021.22
17	21954	1221409.52	182400.05	1039009.46	0.2703	280812.00
18	21954	1264158.85	188784.06	1075374.79	0.2502	269111.50
19	21954	1308404.41	195391.50	1113012.91	0.2317	257898.52
20	21954	1354198.57	257355.31	1096843.25	0.2145	235325.75
21	21954	1401595.52	209308.26	1192287.26	0.1987	236854.72
22	21954	1450651.36	216634.05	1234017.31	0.1839	226985.77
23	21954	1501424.16	224216.24	1277207.92	0.1703	217528.03
24	21954	1553974.00	232063.81	1321910.19	0.1577	208464.36
25	21954	1608363.09	420728.50	1187634.59	0.1460	173415.91
26	21954	1664655.80	248592.55	1416063.25	0.1352	191454.25
27	21954	1722918.75	257293.29	1465625.46	0.1252	183476.99
28	21954	1783220.91	266298.56	1516922.35	0.1159	175832.11
29	21954	1845633.64	275619.01	1570014.64	0.1073	168505.78
30	21954	1910230.82	363025.08	1547205.73	0.0994	153757.18
31	21954	1977088.90	295249.97	1681838.93	0.0920	154756.17
32	21954	2046287.01	305583.72	1740703.29	0.0852	148308.00
33	21954	2117907.05	316279.15	1801627.91	0.0789	142128.50
34	21954	2192033.80	327348.92	1864684.88	0.0730	136206.48
35	21954	2268754.98	431159.92	1837595.06	0.0676	124284.90
36	21954	2348161.41	350664.35	1997497.06	0.0626	125092.41
37	21954	2430347.06	362937.60	2067409.46	0.0580	119880.22
38	21954	2515409.20	375640.41	2139768.79	0.0537	114885.21
39	21954	2603448.53	388787.83	2214660.70	0.0497	110098.33
40	21954	2694569.23	512082.73	2182486.49	0.0460	100461.89
41	21954	2788879.15	416479.24	2372399.91	0.0426	101114.61
42	21954	2886489.92	431056.02	2455433.90	0.0395	96901.50
43	21954	2987517.07	446142.98	2541374.09	0.0365	92863.94
44	21954	3092080.16	461757.98	2630322.18	0.0338	88994.61
45	21954	3200302.97	608193.65	2592109.32	0.0313	81205.29
46	21954	3312313.57	494646.69	2817666.88	0.0290	81732.90

47	21954	3428244.55	511959.33	2916285.22	0.0269	78327.36
48	21954	3548233.11	529877.90	3018355.20	0.0249	75063.72
49	21954	3672421.27	548423.63	3123997.64	0.0230	71936.07
50	21954	3800956.01	994284.53	2806671.48	0.0213	59841.68
51	21954	3933989.47	587485.10	3346504.37	0.0197	66066.28
52	21954	4071679.10	608047.08	3463632.02	0.0183	63313.52
53	21954	4214187.87	629328.73	3584859.14	0.0169	60675.46
54	21954	4361684.45	651355.23	3710329.21	0.0157	58147.31
55	21954	4514343.40	857917.21	3656426.19	0.0145	53057.92
56	21954	4672345.42	697748.01	3974597.41	0.0134	53402.65
57	21954	4835877.51	722169.19	4113708.32	0.0124	51177.54
58	21954	5005133.22	747445.11	4257688.11	0.0115	49045.15
59	21954	5180312.89	773605.69	4406707.19	0.0107	47001.60
60	21954	5361623.84	1018936.52	4342687.32	0.0099	42887.75
61	21954	5549280.67	828705.76	4720574.91	0.0091	43166.40
62	21954	5743505.49	857710.46	4885795.04	0.0085	41367.80
63	21954	5944528.19	887730.32	5056797.86	0.0078	39644.14
64	21954	6152586.67	918800.89	5233785.79	0.0073	37992.30
65	21954	6367927.21	1210176.95	5157750.25	0.0067	34667.00
66	21954	6590804.66	984242.48	5606562.18	0.0062	34892.23
67	21954	6821482.82	1018690.97	5802791.86	0.0058	33438.39
68	21954	7060234.72	1054345.15	6005889.57	0.0053	32045.12
69	21954	7307342.94	1091247.23	6216095.71	0.0049	30709.91
70	21954	7563099.94	1437310.59	6125789.35	0.0046	28022.00
71	21954	7827808.44	1168971.31	6658837.12	0.0042	28204.07
72	21954	8101781.73	1209885.31	6891896.42	0.0039	27028.90
73	21954	8385344.09	1252231.30	7133112.80	0.0036	25902.69
74	21954	8678831.14	1296059.39	7382771.75	0.0034	24823.42
75	21954	8982590.23	2349737.92	6632852.30	0.0031	20649.93
76	21954	9296980.88	1388371.22	7908609.66	0.0029	22797.89
77	21954	9622375.21	1436964.21	8185411.00	0.0027	21847.98
78	21954	9959158.35	1487257.96	8471900.39	0.0025	20937.65
79	21954	10307728.89	1539311.99	8768416.90	0.0023	20065.25
80	21954	10668499.40	2027468.54	8641030.86	0.0021	18309.02
81	21954	11041896.88	1648949.49	9392947.39	0.0020	18427.98
82	21954	11428363.27	1706662.72	9721700.55	0.0018	17660.15
83	21954	11828355.98	1766395.91	10061960.07	0.0017	16924.31
84	21954	12242348.44	1828219.77	10414128.67	0.0016	16219.13
85	21954	12670830.64	2407996.62	10262834.02	0.0014	14799.54
86	21954	13114309.71	1958434.72	11155874.99	0.0013	14895.69
87	21954	13573310.55	2026979.94	11546330.61	0.0012	14275.04
88	21954	14048376.42	2097924.24	11950452.18	0.0011	13680.24
89	21954	14540069.60	2171351.58	12368718.01	0.0011	13110.23
90	21954	15048972.03	2859944.61	12189027.42	0.0010	11962.75
91	21954	15575686.05	2326006.10	13249679.95	0.0009	12040.48
92	21954	16120835.06	2407416.31	13713418.75	0.0008	11538.79
93	21954	16685064.29	2491675.89	14193388.41	0.0008	11058.01
94	21954	17269041.54	2578884.54	14690157.00	0.0007	10597.26
95	21954	17873458.00	3396717.05	14476740.95	0.0007	9669.72
96	21954	18499029.03	2762565.59	15736463.43	0.0006	9732.55
97	21954	19146495.04	2859255.39	16287239.65	0.0006	9327.03
98	21954	19816622.37	2959329.33	16857293.04	0.0005	8938.40
99	21954	20510204.15	3062905.85	17447298.30	0.0005	8565.97
100	21954	21228061.30	5553006.36	15675054.93	0.0005	7125.80
					NPV =	**13493262**

Appendix 11: Data and Calculations for Figure 6.1

Table A11.1. Data Used in Figure 6.1

(1)	(2)	(3)	(4)	(5)
WTP (US$)	**Percentage of Survey Respondents[1]**	**Number of Visitors 2006[2]**	**Benefits[3] (US$)**	**Net Benefit[4] (x 10^3 US$)**
0	100	21,954	0	-182.29
10	81	17,691	176911	-5.38
20	61	13,428	268564	86.28
30	30	6,608	198225	15.94
40	24	5,329	213146	30.86
50	24	5,329	266432	84.14
60	17	3,623	217409	35.12
70	7	1,492	104441	-77.85
80	5	1,066	85258	-97.03
100	5	1,066	106571	-75.72
120	1	213	25577	-156.71

[1] The number of survey respondents who had a willingness to pay equal or greater than the given WTP value.
[2] The number of visitors in 2006, corresponding to the percentage of survey respondents willing to pay the specified in column (2).
[3] Benefits are based on the number of visitors in 2006 and are calculated by multiplying the total number of visitors for 2006 by the WTP amount given in column (1). The total number of visitors to Baa Atoll in 2006 was 21954.
[4] The estimated total cost for year 0, of implementing the IMS is used to calculate the net benefit. This cost of US$182,288 is subtracted from the Benefits given in column (4)

For example, from Table A11.1, a WTP of US$20 in Column (1) corresponds to 61% of survey respondents being willing to pay US$20 or more, Column (2). The total number of visitors in 2006 was 21954. Therefore, 61% of the total number of visitors as given in column (3) is 13,428 visitors.

Column (4) calculates the benefit if 13,428 visitors, each paid a conservation fee of US$20 for their visit. This value is US$268,563. Column (5) calculates the net benefit being the Benefit in Column (4) minus the estimated total cost of implementing the IMS, in Year 0. Therefore, US$4268,563 minusUS$2182,288 gives a net benefit of US$86,280.