THE EFFECTIVENESS OF PRIVATELY MANAGED MARINE RESERVES IN SUSTAINING NEARSHORE FISHERIES IN THE TROPICAL COASTAL ZONE

By

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The effectiveness of privately managed marine reserves in sustaining nearshore fisheries in the tropical coastal zone

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Abstract

There is an emergent need to increase protection of nearshore resources from a growing human population, which is deteriorating coral reef ecosystems through coastal development, overfishing and destructive fishing practices. A possible solution involves increasing the number of smaller Marine Protected Areas (MPAs), creating a network of reserves with greater fisheries potential, while locally remaining small enough not to overly impinge on fishers available fishing grounds. Coral reefs are often found in developing countries, where governments financially struggle to establish successfully managed MPAs. A growing number of Hotel Managed Marine Reserves (HMMRs) have partly therefore, recently been established. Hotels arguably often have adequate funding, resources, and incentive to protect adjacent coastal areas - an HMMR could allow hotels to establish a market niche for a growing environmentally aware tourist.

The principals of an Ecosystem-based Management (EBM) approach was adopted to test protection potential of an HMMR in Vietnam (Whale Island Resort: WIR) from a biological and socioeconomic point of view. Biannual visual fish census surveys (October 2005-April 2007) were conducted at the two marine reserves adjacent to WIR. The 6-year protected Whale Island Bay Reserve (WIB: 11 ha) showed significantly higher fish densities, richness, average size and number of fish >15 cm compared with two unprotected control sites. Fish stocks at the second, newer reserve, Whale Island Bay Peninsula Reserve (WIBP: 5 ha), quickly increased following protection. Fish assemblages at the 5 Artificial Reefs (ARs), made from clay pots (AR areas: 4.2-14.9 m^2) in WIB, were greater than adjacent area-equivalent Natural Reefs (NRs) (11.15 greater biomass), showing larger fish assemblages with increasing AR size, adding to local fish stocks enhancement.

Surveys were conducted with local fishermen to gauge socioeconomic impacts and management performance of the HMMRs. Fishermen mainly dependent on beach seining mostly opposed the HMMRs, while fishermen using other fishing techniques were generally in favour of the HMMRs, welcoming more protection and confirming spillover of fish, including large food fishes. In a Willingness to Pay (WTP) survey (n=211), 97.5 % of tourists at WIR supported HMMRs and 86.3 % were willing to pay an extra 10 % of the average room rate to stay at such hotels. In a worldwide survey of existing HMMRs, protecting areas from 1-700 ha (average 110 ha +/-13.22 SE), the average management rating attained was high (Good - HMMR is enforced). The accumulated findings from WIR and HMMRs globally, support the great potential of HMMRs as an added tool to protecting a part of our nearshore natural resources.

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Abbreviations

ANOSIM	Analysis of Similarities
ANOVA	Analysis of Variance
C1	Control Site 1
C2	Control Site 2
CCEF	Coastal Conservation and Education Foundation Inc.
CHICOP	Chumbe Island Coral Park
CPUE	Catch per Unit Effort
CS	Consumer Surplus
EAF	Ecosystem Approach to Fisheries
EBM	Ecosystem-based Management
EEZ	Exclusive Economic Zone
ENSO	El Niño Southern Oscillation
FAD	Fish Aggregating Devices
FAO	Food and Agriculture Organization
FEE	Foundation for Environmental Education
GDM	Gross Domestic Product
HMMR	Hotel Managed Marine Reserve
IM	Integrated Management
IUCN	World Conservation Union
MDS	Multidimensional Scaling Ordination
MOFI	Ministry of Fisheries
MPA	Marine Protected Area

NGO	Non-Government Organization
NM	Nautical Miles
OECD	Organization for Economic Cooperation and Development
PVC	Polyvinyl Chloride
SD	Standard Deviation
SE	Standard Error
SIMCA	Sugud Islands Marine Conservation Area
SMMA	Soufriere Marine Management Area
SNK	Student-Newman-Keuls
STEP	Sustainable Tourism Eco-Certification Program
STSC	Sustainable Tourism Stewardship Council
TON	Total Oxidized Nitrogen
UNCED	UN Conference on Environment and Development
UNCLOS	UN Convention on the Law of the Sea
VND	Vietnamese Dong
W	Watt
WIB	Whale Island Bay
WIBP	Whale Island Bay Peninsula
WIR	Whale Island Resort
WTO	World Tourism Organisation
WTP	Willingness to Pay

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Author's declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

This was a part-time, remote, self-financed study, carried out in collaboration with a Hotel Managed Marine Reserve (HMMR) in Vietnam (Whale Island Resort).

Relevant courses (e.g. statistics course) were attended and several papers were prepared for publication.

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1. Introduction and thesis rationale

Coral reefs and related ecosystems are essential elements of the marine environment. These biologically-rich habitats provide important ecosystem services (i.e. the benefits human populations derive, directly or indirectly, from ecosystem functions) on local, regional and global levels (Costanza et al. 1997). Despite their importance, a large percentage of coral reefs are threatened by human activities, including overfishing, destructive resource extraction methods, coastline construction and pollution (Kleypas & Eakin 2007).

To combat increasingly deteriorating marine resources, a large number and various forms of management tools have been employed, ranging from deploying Artificial Reefs (ARs) to attract fish and decrease fishermen's Catch per Unit Effort (CPUE), to establishing Marine Protected Areas (MPAs), which have been very popular over recent decades. MPAs can potentially provide biodiversity conservation benefits, as well as fisheries benefits (Sale et al. 2005). Various management approaches for MPAs have been employed to ascertain reserve objectives are fulfilled, including top-down, centralized management (covering the largest area of protection), bottom-up or community-based management, co-management involving resource users (at times also the private sector) and the government, which generally focuses on local level protection, as well as private management. To be effective on a holistic scale, it has been suggested that MPAs should be embedded within management frameworks such as Integrated Management (IM) or Ecosystem-Based Management (EBM), which aim to restore or improve the quality of marine ecosystems and the societies they support (Christie & White 2007).

The need for more effective marine reserve systems has been recognised at the World Summit on Sustainable Development (Johannesburg 2002), and later at the World Parks Congress (Durban, September 2003), suggesting networks of marine reserves covering 20-30 % of habitats by 2012 (IUCN 2003a). Included in global concerns is the need to specifically protect nearshore coastal areas, as these are under heavy pressure from overfishing and coastal development, caused by an ever growing population migrating to coastal areas (Kleypas & Eakin 2007). It is suggested that several smaller MPAs could be advantageous in these situations, as they do not deprive locals of all their fishing grounds (Jennings et al. 1996), which will have a less significant effect on the socio-economic welfare of dependent communities, likely to result in a higher level of compliance (Unsworth et al. 2007). A network of these MPAs could increase important fish stocks over a larger area (Roberts et al. 2001). Small MPAs can rapidly increase the density, biomass and average size of target species within their borders following effective protection (Halpern 2003). The increasing fish stocks within the reserve, compounded by the favourable size/area ratio of small reserves, could provide suitable settings for spillover of fish to adjacent fished areas (Kramer & Chapman 1999).

A large majority of MPAs are, however, reported as failing to reach reserve objectives (Jameson et al. 2002). Securing adequate funding was found to be a crucial basis to MPA success (Davis & Tisdell 1996). Hotels often have adequate financial backing and resources to practically protect smaller coastal areas (Colwell 1999), with the added incentive of establishing a market niche directed at an increasingly aware eco-tourist (Weaver & Lawton 2007) to secure future funding and business. A network of thousands of small Hotel Managed Marine Reserves (HMMRs) lining tropical coastal countries could perhaps result in a win-win situation for the environment, local communities and hotel, if effectively managed. As resource users, especially those under foreign management, it could be implied, that hotels have a socioeconomic obligation to adjacent communities foremost, but also to the region and nation.

1.1 Thesis aims

The aims of this thesis were to research whether HMMRs are able to restore or improve the quality of the marine ecosystem and the adjacent communities they support, as well as determining support for HMMRs from the general public. An HMMR in Vietnam (Whale Island Resort: WIR) with two marine reserves (WIB: 11 ha and WIBP: 5 ha) was adopted as a study site. The findings were used to establish its success in achieving said aims, and these were further extrapolated to identify the global consequences of promoting HMMRs as an added tool to marine protection. A worldwide survey of existing HMMRs was additionally conducted to corroborate local findings.

1.2 Thesis objectives

This thesis takes an ecosystems approach to determine HMMR success at realising the aims set by the author. In order to establish whether the aims were met, the following objectives were set:

<u>Biological (Chapter 4)</u>

1. Do the HMMRs at WIR successfully compete with other recognised MPA management regimes with regards to sustaining or improving the biophysical environment, increasing the diversity of fish assemblages and enhancing stocks?

2. Can a small HMMR increase fish stocks within its borders? If so, over what time period is there likely to be evidence of fish stock enhancement?

<u>Artificial Reefs (ARs) (Chapter 5)</u>

1. Is there a correlation between the size of ARs and their potential at increasing fish assemblages?

2. Are the ARs in the HMMR at WIR contributing to increasing fish stocks to adjacent fished areas?

3. How do ARs compare with Natural Reefs (NRs) at enhancing fish stocks?

Community (Chapter 6)

1. What are the perceived benefits and costs of the HMMR at WIR to local fishermen?

2. What lessons can be learnt from the experience of HMMRs at WIR and how can these be transferred to other case studies considering the establishment of more HMMRs?

Wider public (Chapter 7)

1. Do tourists support the establishment of HMMRs?

2. How much are tourists willing to pay extra to stay at HMMRs?

3. What factors influence their Willingness to Pay (WTP)?

HMMRs worldwide (Chapter 8)

1. What management approaches and marine projects do other HMMRs pursue?

2. How do hotel managers perceive their HMMR's success in restoring or improving the quality of adjacent marine ecosystems and the communities they support?

3. How does hotel managers' perceived management method of HMMRs rate against community or co-managed MPAs in the Philippines?

4. How eco-friendly are HMMRs?

1.3 Thesis outline

This thesis takes an ecosystem-based approach to marine protection. The first sections provide a thorough literature review describing the values and threats to coral reef ecosystems. I discuss MPA governance and various management regimes currently existing, introducing HMMRs as a growing management approach to coastal resource protection.

In the second chapter, I describe the theoretical and conceptual frameworks this thesis builds upon, detailing the history and development of frameworks such as Integrated Management (IM), Ecosystems Approach to Fisheries (EAF), and Ecosystem-based Management (EBM).

In the third chapter I detail the case study site used for this thesis, starting with background information on Vietnam, its existing MPAs, tourism potential and fisheries management capacity and legal framework. I then focus more on the wider area surrounding the study site (Van Phong Bay), before describing WIR and its 11 ha and 5 ha marine reserves.

The following five chapters are the main analytical chapters, each representing the backbones of articles which have already been accepted, are currently in review, or which may still be sent to various journals for publication. Accepted articles can be found in Appendix 8.

In the fourth chapter, I describe the biological effectiveness of the HMMR in terms of increasing fish density, species richness and size compared with nearby geomorphologically similar unprotected areas. This research involved underwater visual monitoring over a two-year time span.

In the fifth chapter, I assess the importance of AR size at increasing the density and size of fish, report on their role at increasing fish assemblages, and compare these results with NRs. These underwater AR surveys were similarly conducted over a two-year period; the natural reef data for comparison were provided from the surveys conducted in Chapter 4.

In the sixth and seventh chapters, I consider the socio-economic aspects of the HMMRs, with regards to local fishermen's perceptions of the management of the reserves, and tourists' support and WTP extra to stay at HMMRs. The support attained from these different groups of people could serve as important reference points when considering promoting HMMRs as an added or alternative tool for increasing the number, and thereby size of marine resource protection. The results of these two chapters derive from questionnaires which were either completed independently by the two target groups or completed through interviews. Tourist surveys were collected over a two-year period, whilst the fishermen surveys were conducted twice, separated by a six-month interval.

Since thorough analysis of the biological and socioeconomic management effectiveness of one HMMR does not suggest HMMRs' entitlement to be promoted as an alternative management approach on a larger level, I attempted to determine the effectiveness of several HMMRs. In the eighths chapter, I therefore review existing HMMRs, their conservation projects, objectives, management approaches and perceived effectiveness at improving the quality and quantity of local biota, as well as attempt a rating approach to their marine management and eco-friendliness. This concludes the main analytical chapters. These results were similarly, mostly attained by questionnaires sent to, and returned by hotel managers by email, but also by telephone, having searched for, and contacted suitable hotels and several others over a four-year period.

The ninth chapter concludes the thesis with a short summary of my findings, problems encountered, highlights, recommendations and suggestions for further research.

1.4 Value of coral reefs

Coral reefs are critical components of the marine ecosystem, not only to the diverse life they and their affiliated ecosystems support and the vast potential of curative drugs that can be prospected (Aldridge 2006), but they are also fundamental to the development of coastal countries providing food, minerals, construction material and income to local and regional economies, including fisheries, tourism and shoreline protection (Dixon et al. 1993). It is estimated that coral reefs are providing economic revenues of US$ 30,000 million/year to local communities (WWF 2003). This study also found that destroying just one kilometre of reef range costs between US$ 137,000 - 1.2 million over a 25-year period, when fishery, tourism, and protection values alone are considered.

1.4.1 Tourism

Over recent decades, reef tourism has become a major global industry, attracting millions of tourists each year wanting to experience the biodiversity and rich colours of the corals, fish and invertebrates, contributing to local income generation and foreign exchange (Cesar 2000). More than 100 countries accommodating nearly 500 million people living within 100 kilometres of a coral reef, benefit from the production, protection and recreational values associated with reefs (Bryant et al. 1998) and the world's population is still growing! It is estimated that the median predicted world population will reach 9.3 billion by 2050 (United Nations 2001) and the number of coral reef tourists are increasing. Visitors to the Great Barrier Reef alone increased from 1.1 million in 1985 to over 10 million in 1995 (Spalding et al. 2001). Driml (1994) estimated the financial value of tourism to this area to US$ 586 million annually, while Caribbean tourism earned US$ 8900 million in 1990 and employed over 350,000 people (Dixon et al. 1993). The World Tourism Organization (WTO) estimated that some 1600 million international tourists will visit the leading destinations by 2020, spending more than US$ 5000 million each day (IHEI 2003). Forecasts for international tourist arrivals to East Asia and the Pacific, suggest 397 million arrivals in 2020. This represents an annual growth rate of 6.5 % between the period 1995 - 2020, which is above the global growth rate of 4.1 % (IHEI 2003). With such a large predicted growth in tourism, it is vital that we ensure sustainable development of coastal regions and protect coral reefs, in order to safeguard revenue from reef tourists.

1.4.2 Pharmaceuticals

As a result of the environmental conditions in which marine organisms are found, these have developed chemical weapons (i.e. sponges for example produce a substance to ward off would-be predators), which have evolved into highly potent inhibitors of physiological processes in the prey, predators or competitors of the marine organisms that use them (Haefner 2003). The pharmaceutical industry has discovered the vast potential for making new drugs from these substances to develop anticancer, AIDS-inhibiting, antimicrobial, anti-inflammatory and anti-coagulating drugs from seaweeds, sponges, molluscs, corals, sea fans, sea anemones and gorgonians (Carte 1996; Hunt & Vincent 2006). The Nobel Prize in

Chemistry 2008 was awarded to three scientists who initially discovered and subsequently developed the Green Fluorescent Protein as a tagging tool in bioscience. It can, for example, illuminate growing cancer tumours, show the development of Alzheimer's disease in the brain or the growth of pathogenic bacteria. This glowing green fluorescent protein was first discovered in the jellyfish *Aequorea victoria* (The Royal Swedish Academy of Sciences 2008). Marine bioprospecting, or developing drugs from the marine ecosystem, only started its evolution in recent decades but as of 2003, over 14,000 new chemical entities have been identified from marine resources (Proksch et al. 2003), and at least 300 patents have been issued on marine natural products (Kerr & Kerr 1999).

1.4.3 Shoreline protection

One of the functions coral reefs perform is that of self-repairing breakwaters. Healthy, reef ecosystems tend to be accreting systems or at least in equilibrium with the eroding power of the waves (Talbot & Wilkinson 2001). These protect the shoreline from wave action and the impact of storms. The benefits from this protection are widespread, ranging from maintaining highly productive mangrove fisheries and wetlands, to supporting local economies by providing sheltered areas to build protected ports and harbours (Bryant et al. 1998). They also tend to be sources of sand for the lagoons and beaches they protect (Talbot & Wilkinson 2001). If coral reefs are destroyed or mined, waves will eventually cause erosion on land, which especially low-lying island nations will hugely suffer from. Land erosion on the densely populated coastline of Sri Lanka has, for example, led to large-scale evacuations, causing thousands to loose their homes, not to mention the inevitable high financial strain on the government (Rajasuriya & White 1995).

1.4.4 Fisheries

Over a quarter of the world's marine fish species are found on coral reefs, comprising over 4000 species (Spalding et al. 2001). According to the UN Food and Agriculture Organization (FAO) statistics (FAO 1997), 10% of total world marine fishery landings were composed of reef-associated fisheries in 1997 and in some parts of the Indo-Pacific region, reef fisheries constituted as much as 25 % of the total fish catch, providing food for one billion people in Asia alone (Hinrichsen 1997; Jameson et al. 1995). As much as 20 % of all animal protein consumed globally by humans comes from marine environments, representing an annual catch valued at US$ 50-100 billion (White & Cruz-Trinidad 1998). In Asian countries, such as Bangladesh, Malaysia, Vietnam, Thailand and the Philippines, protein from fish contribute to over 30 % of the population's total animal protein consumption; over 50 % in Indonesia and Sri Lanka (Stobutzki et al. 2006). These countries together produce 23 million tonnes of fish annually. It is estimated that 1 km^2 of healthy reef can produce 10-30 tonnes of fish biomass through sustainable fishing (White & Cruz-Trinidad 1998). Unfortunately, due to overfishing and other anthropogenic influences, most reefs will not reach these levels. Coral reef fisheries in the Philippines provide livelihood to more than a million small-scale fishers. These contribute almost US$ 1 million annually to the country's economy (White et al. 2000), but more important than the actual monetary amount, is the benefit fishermen receive from open access reef fisheries, providing a safety net in times of social and economic hardship by securing a source of income and employment in areas where often few employment alternatives exist (Jameson et al. 1995; Sadovy 2005).

1.5 Threats to coral reefs

Many human activities directly impact reefs: significant threats are caused by overfishing (Kleypas & Eakin 2007), coral mining (Rajasuriya & White 1995), destructive fishing practices (Cesar et al. 1997), trampling and SCUBA diving (Harriott et al. 1997; Hawkins & Roberts 1993), sedimentation due to deforestation and coastal development (Davenport & Davenport 2006; Huber 1994; Shackley 1999; Talbot & Wilkinson 2001), industry and agriculture (Corniaux et al. 1997), and pollution (Davenport & Davenport 2006; Dulvy et al. 2003). Indirect impacts of human activities, such as coral bleaching are the most obvious effect of climate change on biodiversity (Hoegh-Guldberg 2004; Lough 2008). Natural disasters such as hurricanes, tsunamis or disease are also threats to coral reefs and may, to a certain extent, be influenced by climate change (Garcin et al. 2008; Gardner et al. 2005; Jones et al. 2004).

1.5.1 Overfishing

Fishing pressure on coral reefs has increased remarkably over the years due to human population growth, which has the potential of making this ecosystem less productive and biodiverse and no longer sustainable (McClanahan & Mangi 2004). McClanahan et al. (2008) estimated high fishing yields (approximately 16 tonnes km^{-2} yr^{-1}) along 75 km of Kenya's most populated coastline, but reported declines in Catch per Unit Effort (CPUE), mean trophic level and functional diversity of fished taxa over 10 years as a result of an increase in fishing effort and competitive/destructive gear use, due to population growth and declining resources. The estimated potential yield of all fishes for Philippines' Exclusive Economic Zone (EEZ) was estimated at approximately 1.9-2.2 million tonnes in 2000. Coastal sector catches were, however, already estimated to be double the maximum sustainable yield in 1994 (White et al. 2000). Similarly, overfishing was reported a primary threat to approximately 64 % of Southeast Asia's coral reefs (Chou et al. 2002). More effective fishing methods have been developed, as well as accessibility to reefs through an increase in the number of fishing vessels (Spalding et al. 2001). Also, trawling fish and storing them in mass refrigerators makes transportation to overseas markets possible as well as fishing in bulk (Spalding et al. 2001). A big problem is that in many countries, fish catch is not adequately managed, funded or monitored, especially for coral reef fishing (Sadovy 2005), so the policies of maximum sustainable yield or maximum economic yield, defined as the yield which gives the highest possible economic return for the effort expended, can not be upheld (Cesar et al. 1997; Gibson et al. 1998; Spalding et al. 2001; White et al. 2000). Overfishing has been recognised as one of the three most significant threats to ecosystems (Kleypas & Eakin 2007). It can cause considerable change in the community structures of fish and other organisms and there is also the risk of over-exploitation, leading to extinction of certain species or even functional group (Roberts 1995). Overfishing can also disrupt the natural ecology of the reef, making these systems less resilient when confronting natural destructive events such as hurricanes (Roberts 1995).

1.5.2 Destructive fishing

Destructive fishing techniques such as blast fishing or cyanide fishing are detrimental to the coral reef ecosystem, threatening approximately 56 % of Southeast Asia's coral reefs (Chou et al. 2002). Blast fishing is the most destructive fishing method on reefs (Spalding et al. 2001). One blast can undo the work of decades of coral growth, with the corals requiring just as long or longer to recover since coral rubble makes for a poor stable substrate for coral re-growth (Fox et al. 2003). In a study researching hard coral recovery in rubble fields created by blast fishing in Komodo National Park and Bunaken National Park, Indonesia, there was no significant natural recovery within nine sites after a 5-year monitoring period (Fox et al. 2003). Explosives are commonly home-made, often using fertilizers, although dynamite is also used. This fishing practise is non-selective, the shock waves killing all species with gas-filled swim bladders. There are also a high number of individuals lost as they sink to the ocean floor or get caught among the corals (Spalding et al. 2001). Unfortunately these practices are still widespread in the Indo-pacific (Fox 2004; White et al. 2000).

Poison fishing (sodium cyanide) used in the illegal capture of live fish also has a damaging effect on corals. Jones and Steven (1997) demonstrated that at concentrations which could be accredited to various cyanide fishing techniques, the corals died in experiments with high concentrations, lost their zooxanthallae at medium concentrations leading to bleaching, and even lost some zooxanthallae at low concentrations, but not in sufficient numbers to cause discoloration. The ornamental fish trade is a large business worth millions each year (Chapman et al. 1997), the main exporters of ornamental fish being Indonesia and the Philippines (80 %). It is estimated that the world-wide import value of marine ornamentals is US$ 200-330 million annually (Shuman et al. 2004), unfortunately making it a valuable investment for poor countries.

1.5.3 Coral mining

Specifically in countries with very low levels of income, communities help themselves to the natural resources surrounding them. Corals can be used in the production of mortar and cement, as a pH regulator in agriculture (lime - calcium carbonate) and crushed coral debris can be used as fertilizer (Cesar 1996; Kuhlmann 1988). When too much coral reef is extracted, eventually waves will pound the remaining coral to sand and rubble and cause massive erosion on land.

In the Maldives and Sri Lanka, a large proportion of the reefs have been excavated over the years as a basis for building materials, and massive erosion has taken place along the coasts (Clark & Edwards 1994; Rajasuriya & White 1995). Since the population density near the coasts of the Maldives and Sri Lanka is very high, the habitation of these people has been severely compromised. Thousands of dollars have therefore been invested in building artificial reefs and detached breakwaters made of concrete tetrapods (Clark & Edwards 1994; Rajasuriya & White 1995). In the Maldives, the breakwaters cost US$ 10,000 per linear meter, indicating the importance of healthy reefs for the economy of the country (Clark & Edwards 1994).

1.5.4 Tourism impacts

Local communities are not the only reef users who can cause significant damage. The tourism business is booming. Wherever there are coral reefs, impacts from tourism through diving, snorkelling or trampling of the coral has caused considerable damage (Barker & Roberts 2004; Harriott et al. 1997; Hawkins & Roberts 1993). For example, benthic communities of dived areas were compared to control sites in Sharm-el-Sheikh, Egypt. In the heavily dived areas, there were significantly more damaged coral colonies, loose fragments of live coral, fragments of coral reattached to the substratum and partially dead and abraded coral, compared with the controls (Hawkins & Roberts 1992). Off the Caribbean Island of Bonaire, Hawkins et al. (1999) compared fish and coral communities between an undived reserve and a reserve which hosted a maximum of 6000 divers per year. They found no difference in fish assemblages but a difference in coral assemblages. There was a significant decline in old colonies of massive coral (19.2 % loss) at the dived site compared with 6.7 % loss in the reserve. It is also suggested that background stress can cause a shift in community structures. Abrasions from divers on massive corals can increased their susceptibility to disease, causing a community shift to branching corals at the expense of massive corals (Hawkins et al. 1999).

A more damaging impact from tourism, rather than mere direct physical contact, is coastal development to support tourism (Kleypas & Eakin 2007). Infrastructure needs to be developed, including building roads, airports etc., landfill or beach enhancements may be needed and resorts need to be built, which may result in large quantities of sediment to be released into the sea, which can kill corals directly or reduce their growth rate and ability to settle (Hawkins & Roberts 1994; Rogers 1990). To be able to accommodate tourists, there will be need for sewage disposal facilities, which, if insufficiently treated, and/or discharged into the sea, will cause nutrient enrichment or eutrophication, which enables algae to thrive, overgrow and kill corals (Walker & Ormond 1982). Further nutrient enrichments may also originate from desalination, irrigation or rubbish. Local damage to corals can be caused by the hot brine effluent produced by desalination plants or generator cooling water, nutrient seepage from irrigation water of treated wastewater, which percolates through porous coastal rock and enters the sea, or plastic bags and other litter, which can smother corals (Hawkins & Roberts 1994).

Already in the early 90's, a part of the Red Sea (Egypt, Israel and Jordon) experienced a big boom in tourism. As a result, 100 % of Israel's coast containing coral reefs was affected by tourism (resort development, diving snorkelling or fishing); 50 % and 19 % were affected in Jordon and Egypt respectively (Hawkins & Roberts 1994).

In fact, coral reef damage starts already when tourists board a plane. The increasing number of tourists travelling abroad, specifically long flights to warmer climates, e.g. flying to the Seychelles from northern Europe, increases the amount of atmospheric carbon dioxide, contributing to 90 % of a typical journey's environmental impact (Gossling 2000; Gossling et al. 2002). High concentrations of atmospheric carbon dioxide can reduce the concentration of a mineral in the sea water which corals need to grow, weakening the coral skeleton (Spalding et al. 2001).

1.5.5 Sedimentation

Erosion and sedimentation from land can also have a destructive effect on coral reefs (Abelson et al. 1994; Brown et al. 2002; Gibson et al. 1998; McLaughlin et al. 2003). As sediment is suspended in the water column, it reduces or blocks the amount of light available, preventing growth and even survival. While corals are able to remove the sediment by secreting mucus, such an activity uses energy and nutrients, weakening the corals and reducing growth or reproductive potential, leaving them less able to compete with other benthic organisms such as algae or filter feeders (Spalding et al. 2001). Sedimentation can be caused by deforestation, agriculture, raising of cattle and other animals, dredging of ports and marinas, bottom-fish trawling and cleaning of prawn and fishponds after harvest and coastal development (clearing of land for housing and the now wide-spread tourism development projects) (Spalding et al. 2001).

Chou et al. (2002) found that 88 % of Southeast Asia's coral reefs were at risk. Coastal development, defined by dredging, land filling, mining of sand and coral, coastal construction, and discharge of sewage, threaten 25 % of the coral reefs at medium to high threat. Reefs of Singapore, Vietnam, Taiwan, the Philippines, and Japan were the most threatened by coastal development, each with over 40% at medium or high threat.

Terrestrial runoff of red clay soils is a major threat to Islands in Japan. The Ryukyu Island corals receive runoff from poor land development and agriculture, road building, forestry and other coastal developments aiming to attract more tourists. In 2001, there was a mass mortality of *Porites* corals caused by heavy runoff of red clay soil and fresh water from Todoroki River on Ishigaki Island. More than 75 % of corals died in an 8 ha area; 25 % in another 27 ha area nearer the river. In Sesoko Island, 5000 m^2 of coral reef was destroyed during shoreline construction (Chou et al. 2002).

McClanahan and Obura (1997) have, however, shown that on shallow coral reefs, (<5 m) in the Sabaki River catchment basin, Malindi, Kenya, no evidence for decreased diversity and ecological health of sediment-influenced reefs could be found. Instead, they found that different genera of corals have different tolerance levels for sediment, which could alter the community structure. On the other hand, Yentsch et al. (2002) suggest that light limitation due to high levels of sedimentation forces corals off Florida to grow at very shallow depths. At these depths, corals are functioning close to the compensation point, where respiration (of coral polyp and zooxanthellae) consumes the products of photosynthesis of the zooxanthellae, with little, if any, remaining for growth. The skeleton of the corals thus become very thin and fragile, often breaking in the higher wave actions of the shallower regions.

1.5.6 Pollution

In many cases, the influence of sedimentation and pollution are combined (Edinger et al. 2000). Over 20 % of coral reefs of Southeast Asia are at risk from land-based sediment and pollution (Burke et al. 2002). Agricultural runoff contains nitrogen- and phosphorous-enriched sediment from fertilizing efforts, which leads to eutrophication in water, which in turn provides a more competitive environment for the growth of planktonic algae and macroalgae (Spalding et al. 2001). Human, agricultural and industrial wastes contain organic compounds. Marine bacteria break down this organic pollution and increase inorganic pollution (nitrate, nitrite, ammonium and phosphate etc.) which also causes eutrophication (Talbot & Wilkinson 2001). Pollution is common around cities and farms and where increased population growth has occurred. The South Western Island Nations have seen rapid population growth and development in rural areas, resulting in loss of coastal habitats, overfishing, pollution and eutrophication in inshore reefs (Zann 1994). Eutrophication reduces the coral's growth and reproductive potential, making them less resilient to changing environments and stresses. Wielgus et al.

(2004) demonstrated that levels of 0.4 μM Total Oxidized Nitrogen (TON:NO_2, NO_3) showed significantly lower live stony coral cover and abundance per m^2 and higher partial mortality of coral colonies than sites exposed to lower TON. After a mass mortality of coral reefs following a period of low tide exposing the coral reefs in Eilat, Israel, in 1970, the coral reefs located further away from sources of pollution recovered more quickly and retained their coral abundance and diversity, unlike the corals closer to the source of the pollution (Wielgus et al. 2003).

Apart from pollution from inland sources, pollution also has a marine-based origin. In Southeast Asia, pollution from ports, oil spills and leakage, ballast and bilge discharge, and dumping from ships threaten 7 % of the coral reefs, with Japan and Taiwan having the highest threats at 15 %. Cambodia and Singapore have few coral reefs, but most of these are threatened (medium or higher) by marine pollution (30 and 100 % respectively) (Burke et al. 2002).

Pollution such as oil, heavy metals and pesticides have all been shown to increase the level of stress in symbiotic cnidarians, which may cause (or at least help cause) coral bleaching, together with increasing sea temperatures and irradiance (Brown 2000).

1.5.7 The effect of climate change on coral reefs

A few decades ago, the link between increased greenhouse gases, climate change, and regional scale bleaching was not understood, but today the connection is irrefutable (Hoegh-Guldberg 1999; Hughes et al. 2003). Coral bleaching results from the expulsion of the symbiotic zooxanthellae by the coral polyps and/or by the loss of chlorophyll by the zooxanthellae themselves, making them pale or white (Spalding et al. 2001). It is caused by various types of stresses, mainly related to climatic change such as sea temperature rises above the corals' tolerance level, exposure to air, fresh water flooding, sedimentation, disease or pollution (West & Salm 2003).

Worldwide, corals can survive in temperatures ranging from approximately 16 - 36°C, but on a regional scale, the range within which corals can survive is much lower. Temperature changes on any given reef slope rarely shifts more than 4°C (Spalding et al. 2001). There is evidence that corals (especially in cooler areas) have their bleaching threshold near to the expected upper temperature at that location, giving them a very narrow spectrum, and suggesting a trade-off between the risk of mortality and thermal protective mechanisms (e.g. antioxidant enzymes, heat shock or photoprotective proteins and pigments) (Hughes et al. 2003). Hoegh-Guldberg (1999) suggested that coral-bleaching events such as the mass bleaching event following the El Niño Southern Oscillation event (ENSO) in 1997-98, when in certain areas 90 % of all corals died, will be common place within the next 20 years. He indicates that the sea temperatures in many tropical locations have risen by 1°C over the last century and are currently increasing at the equivalent of 1-2°C per century; the thermal tolerance of reef-building corals will therefore be exceeded every year over the next couple of decades.

Hughes et al. (2003), however, considered the possibility that bleaching susceptibility may change over time as a result of phenotypic and genetic responses. Gene flow varies highly among species (Ayre & Hughes 2000, 2004), suggesting that, if corals would adapt to higher thermal thresholds, or migrate to warmer locations at a fast enough pace, there will be a change in the community structure, but corals will survive.

West and Salm (2003), however, still stress that the single greatest threat to coral reefs worldwide is rising sea surface temperatures as a result of climate change. They have compiled a review of existing literature related to resistance and resilience of corals towards high temperatures, indicating that there are natural "pockets of resistance" where local environmental conditions boost coral survivability during large-scale bleaching events. These pockets are, for examples, in areas of reported small-scale, localized, cold-water upwellings (Goreau et al. 2000); in areas where there is vertical mixing or increased flow rates (Nakamura & van Woesik 2001); in locations which protect the corals from irradiation, such as shaded areas (fissures or clouds), or areas of high turbidity (Glynn & Dcroz 1990; Goreau et al. 2000); finally, in areas that are regularly exposed to high temperatures, which has been reported to increase thermal tolerance of corals and thus resistance to bleaching (Craig et al. 2001). West and Salm (2003) suggest that such described areas should be incorporated into strategic networks of MPAs designed to maximize conservation of global coral reef biodiversity.

The number of bleaching events and disease outbreaks has greatly increased in frequency and magnitude over the last two to three decades (Hoegh-Guldberg

1999; Keller et al. 2009). There is evidence that temperature increases act as a trigger for various outbreaks of coral diseases like black-band, white band, black spots and white plague II disease (Jones et al. 2004; Jordan-Dahlgren et al. 2005; Kaczmarsky et al. 2005; Santavy et al. 2005). In the summers of 2001-2003, a disease outbreak of black-band and white plague occurred on the fringing reefs off Magnetic Island, Australia, simultaneously with a bleaching event, resulting in a 3-4 fold increase in the mean percentage of partial mortality in the hard coral *Montipora aequituberculata*. The reason for the outbreak was attributed to the warmer summer water temperatures (Jones et al. 2004).

Kaczmarsky et al. (2005) have also attributed the outbreak of coral diseases to the proximity of sewage discharges. They observed a significantly higher level of coral impacted by black-band and white plague II disease at Frederiksted (13.6 %) compared with the upstream site Butler Bay (3.7 %) in St Croix, Caribbean. On the other hand, Nugues et al. (2004) suggested that the more frequent disease outbreaks of white plague II over the last decades may have been attributed to the macroalga *Halimeda opuntia*; *Montastraea faveolata* exposed to algal transplants developed the disease, whereas unexposed colonies did not.

Another type of outbreak, which was first reported in the 1960s around Green Island, Australia, saw hundreds of thousands of crown-of-thorn starfish (*Acanthaster planci*) killing 80 % coral cover. Several of these outbreaks have since been recorded in the Indo-Pacific but the reasons for their outbreaks are still not absolutely clear. One theory suggests that it is a behavioural response to aggregate after storms (Spalding et al. 2001). A later study looking at an outbreak on Lizard Island, Australia (1995-1999), however, suggested that outbreaks result from a prolonged build-up in starfish numbers through multiple successive recruitment events (Pratchett 2005).

The frequency and intensity of hurricanes may increase in some regions because of climate change, increasing coral decline, and decreasing the amount of time for recovery between occurrences. Gardner et al. (2005) tried to quantify the contribution of hurricanes to the loss of coral cover in the Caribbean between 1980-2001. Of 286 sites which had been monitored for variable lengths in this period, 177 had been hit by hurricanes. Overall statistics showed that coral cover had declined by 6 % per annum at impacted sites, compared with non-impacted sites (2 %). Full recovery had not been recorded until at least 8 years after a hurricane event.

The long-term sustainability of coral reefs is also threatened by global climate change induced by the release of carbon dioxide into the atmosphere from human activities, such as fossil fuel use and deforestation. Carbon dioxide is readily absorbed by seawater, increasing the acidity. This may cause weakening of coral skeletons and reduce coral animals' ability to construct limestone reefs and the habitats they provide (Andersson et al. 2007), especially at higher latitudes (Kleypas et al. 1999).

Periodic natural catastrophes such as earthquakes and hurricanes have taken place over millennia but coral reefs have been resilient to these disturbances (Connell et al. 1997). Chronic human disturbances over the last few decades appear to be more damaging to coral reefs, decreasing their resilience (Hughes & Connell 1999). As a consequence, reef systems often show poor recovery when affected by natural disturbances if they have already been exposed to chronic human disturbances (Moberg & Folke 1999). Biological diversity enhances the resilience of coral reefs, important to sustain the ecological goods and services of this ecosystem and sustain them from natural and human induced disturbances (Elmqvist et al. 2003). A loss of resilience may alter the state of the ecosystem leading to an invasion of non-reef building organisms such as soft corals or zoanthids, but more often, a change to an algae-infested state. This changes the community from a high diversity coral-based ecosystem, to a macroalgae-dominated system, with diminished genetic, species and functional diversity (Done 1992).

1.6 Mangroves and seagrasses

Mangroves and seagrass beds are highly productive systems, which play a critical role as part of the interdependent coral reef ecosystem. They are, however, disappearing rapidly despite their well-documented biodiversity and the ecosystem services they provide (Hogarth 2007).

Global loss of mangrove forests were estimated to exceed 35 % (Valiela et al. 2001). Only approximately 18,000,000 ha mangrove forest still exist in the world (8 % of the coastline) (Spalding et al. 2001); between 16,000,000 and 50,000,000 ha for seagrass meadows (10 % of the coastline) (Green & Short 2003). By the early 1990's, it was estimated that both Malaysia and Myanmar had lost almost 75 % of their original mangrove cover; Thailand 84 %; Vietnam 37 %. Estimates from the late 1980's suggested that the Philippines had lost 67 % of its mangroves, Brunei 20 %, and Indonesia 55 % (Chou et al. 2002).

Similar to coral reefs, Southeast Asia is also a hotspot for mangrove forests and seagrass beds, containing 51 of the world's 70 mangrove species and 23 of the 50 seagrass species. Approximately 35 % of mangroves are found in Southeast Asia (Burke et al. 2002).

Mangroves and seagrasses bind soft sediment, providing coastal protection and facilitating the development of coral reefs in areas that might otherwise have too much silt for coral growth. In turn, reefs buffer wave impacts, helping to minimize erosion of the soft sediments that mangroves and seagrasses need to grow. They provide other services such as water purification, and they absorb CO_2, while protecting a vast number of species. Mangroves provide habitat for many mammals, amphibians, reptiles, unique plants, fish and invertebrates. Seagrasses also host a large number of species, including threatened species such as dugongs and seahorses. They not only support substantial fisheries within their waters, but they also help maintain many commercially important offshore species that utilize mangrove or seagrass areas as spawning and nursery grounds (e.g. spiny lobster, snapper, barracuda, jacks) (Spalding et al. 2001). Mangroves provide nutrients by shedding and dropping about 7.5 tonnes of leaf litter per acre and year. These are broken down by bacteria and fungi and released into the water (Hogarth 2007). In California, it was estimated that mangrove-related fish and crab species account for 32 % of the small-scale fisheries in the region (Aburto-Oropeza et al. 2008).

Mangroves are also suggested to strongly influence the community structure of fish on neighbouring coral reefs in the Caribbean. Mumby et al. (2004) found that the biomass of several commercially important species was more than doubled when adult habitat was connected to mangroves. They also discovered that the largest herbivorous fish in the Atlantic, *Scarus guacamaia*, which has a functional dependency on mangroves, suffered local extinction after mangrove removal.

In a field experiment using artificial seagrass leaves and mangrove roots, Verweij et al. (2006) found that during daytime, herbivores and diurnally active zoobenthivores were attracted to mangroves and seagrass beds primarily for food, and nocturnally active zoobenthivores for structure (in interaction with shade) that offers shelter from predation. The barracudas were also attracted primarily to structure, but it was suggested that the larger individuals probably used this to ambush prey rather than for protection.

In a study conducted by Unsworth et al. (2008), on the importance of Indo-Pacific seagrass beds as a nursery for juvenile fish, it was discovered that seagrass beds, which were in close proximity to mangroves, enhanced fish assemblages, supporting at least twice the fish abundance and species richness, when compared with seagrass beds that were distant from mangrove habitats. The reason was attributed to the increased availability of shelter and food in mangroves.

Despite several studies indicating the importance of mangroves and seagrass beds as a nursery habitat for juvenile fish species, offering juveniles additional shelter and higher food availability than on the reefs alone, there is still controversy to which extent they influence fish assemblages and growth on coral reefs (Nagelkerken et al. 2002). In a study conducted by Grol et al. (2008), the growth rate and preferred food of the juvenile *Haemulon flavolineatum* was determined in seagrass, mangrove and coral reef habitats. Copepoda was the most consumed food items in all three habitats. It was found that the abundance of Copepoda and growth rates of the juveniles were higher in coral reef habitats, suggesting that coral reefs would be a more suitable habitat for small juveniles. This finding was, however, in exclusion of other mangrove and seagrass services, such as shelter from predation.

Mangroves and seagrasses are being destroyed by many of the same activities that threaten coral reefs. Seagrasses are being destroyed by land reclamation, pollution, sedimentation, dredging, and trawling, as well as clearing to enhance the seascape for tourism development. Clearcutting for timber, fuelwood, and the creation of aquaculture farms particularly endanger mangroves (Burke et al. 2002).

1.7 Marine Protected Areas

Unfortunately, a high percentage of the coral reefs of the world are at risk. Bryant et al. (1998) predicted that 58 % of the world's reefs are either medium to highly threatened by human activity. Coral Reefs of Southeast Asia, the most species-rich on Earth, are the most threatened (80 %), mainly attributed to coastal development and fishing-related pressures. The Caribbean, with its very high dependence on the tourism industry, has over 60 % under threat.

Marine Protected Areas (MPAs) have long been venerated as a successful management strategy to increasing species richness, biomass and biodiversity of coral reef ecosystems leading to higher resilience (Dayton et al. 2000; Grafton & Kompas 2005; Roberts 2003; Russ & Alcala 1998; West & Salm 2003). A definition of MPAs provided by The World Conservation Union (IUCN), states that an MPA is "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect all or part of the enclosed environment". (Resolution 17.38 of the IUCN general assembly (1988), reaffirmed in Resolution 19.46 (1994)). The earliest marine protected areas may have been some of the reefs of the Pacific, where local communities or community chiefs placed restrictions or total bans on fishing. Legally protected marine areas are a more recent phenomenon, with only a few sites declared by the end of the 19th century. Only in the 1960s did MPAs experience a dramatic increase in numbers. In 2005, the total area of coral reefs was estimated to 527,540 km^2, however, only 18.7 % were covered in the 980 MPAs worldwide; less than 0.01 % were within MPAs defined as no-take zones with no poaching and at low risk (Mora et al. 2006).

The modern concept of protected areas and, the therefrom evolved, marine protected areas, likely stems from the last century, when the governments of industrialising countries began to set aside areas of particular scenic beauty or uniqueness exclusively for conservation. Most of these protected areas excluded local people however, so that local inhabitants were either forced to move, or protected areas were established in isolation, away from societies. This concept of 'isolationism' likely stems from a protection model developed for the Yellowstone National Park in 1872; both the design and management of the park sought to protect the reserve from the surrounding society. Until quite recently, few plans for protected area management made any mention of the people living inside forests, coastal strips, wetlands and other biodiversity-rich areas earmarked for conservation (Pimbert & Pretty 1995).

1.7.1 Values of MPAs

MPAs are recognised as an important and often crucial management tool to conserve biodiversity and maintain or increase stock. Protected areas can increase the animal body size and age, thus increasing the spawning stock size and reproductive output of (rare) species (Alcala et al. 2005; Friedlander et al. 2003; Williamson et al. 2004). Fisheries can benefit from this by augmented catches through the export of offspring to fishing grounds and through the spillover of juveniles and adults (Ashworth & Ormond 2005; Gell & Roberts 2003; Russ et al. 2003).

Kramer and Chapman (1999) argue that the reserve has to be large enough to protect the animals from fishing by encompassing their ranges of movement, but they suggest that for fisheries to benefit, reserves must be small enough so as not to prevent spillover to fished areas. This is because the edge-to-area ratio of a reserve increases as its size decreases. Some research suggests propagule dispersal in coral reef organisms to be on the order of a few tens of kilometres (Mora & Sale 2002; Palumbi 2004; Shanks et al. 2003). It has thus been recommended that MPAs should be 10 to 20 km in diameter and equally far spaced from each other (Shanks et al. 2003). Mora et al. (2006) estimated that in order to obtain an optimal global network of MPAs, each 10 km^2 in area and spaced 15 km apart, an additional 2559 MPAs would be required, protecting another approximately 25,590 km^2 of the world's coral reefs.

Halpern (2003) reviewed 89 studies into the effects of reserves that were at least partially closed to fishing, revealing significant results for density, biomass, size and diversity. It was established that 63 % of reserves increased the abundance of protected animals, 80 % increased their average size, 90 % increased biomass, and 59 % increased diversity. These findings were unrelated to the size of the reserve; the size spectrum analysed, ranging between 0.002 - 846 km^2; the mean was 4 km^2. Roberts and Hawkins (1997) have also shown that spillover can increase fish catch from small reserves such as the small Anse Chastanet reserve in St. Lucia (0.026 km^2).

MPAs can also be a great income-generating tool. El Nido, Philippines is a renowned tourism location, attracting divers from all over the world, but it is only thanks to the marine reserve, which was eventually opened after an ecological and economic study proclaimed that the coral reefs were more valuable than the destructive large-scale logging of the forest which had been smothering coral and killing them since 1985. The reefs could provide more sustainable income from fishing and tourism than the income from removing the timber and destroying the coral reefs by sedimentation (Talbot & Wilkinson 2001).

Coelho and Manfrino (2007), however, suggest that MPAs may not be enough to effectively protect coral communities from degradation. Coral communities in protected and unprotected areas around the relatively undeveloped Little Cayman Island (150 permanent residents) were analysed from 1999 to 2004 to test the hypothesis that a lack of major local anthropogenic disturbances would be enough to prevent a decline in coral populations. Their findings suggested no significant differences in coral reef decline between protected and unprotected areas (each 10 % mean decline in live coral cover). The decline was attributed to disease outbreaks and bleaching events. They propose that coral communities are under multiple stresses and therefore, require complex management strategies on top of merely declaring no-take zones.

Some mechanisms to help slow down the decline have been suggested: restoration initiatives (Epstein et al. 2003; Rinkevich 2005), shading corals when water temperatures reach critical levels (West & Salm 2003), identifying corals particularly resistant to disease and bleaching, harvesting their larvae, and propagating recruits with this genotype (West & Salm 2003), protecting areas of historically low bleaching events caused by advantageous hydrodynamic patterns or other factors,as suggested by West and Salm (2003), establishing international protected areas that take migratory routes and breeding grounds into account (Mora et al. 2006; Sale et al. 2005). These initiatives, not in lieu of, but complementary to establishing more effectively managed protected areas, while enforcing worldwide legal measures to slow down global climate change (CO_2 emissions) (Anderson & Newell 2004), reducing pollution sources e.g. sewage, oil, heavy metal (Bruno et al. 2003; Guzman & Garcia 2002; Negri et al. 2002), will be required to prevent coral reefs from disappearing in the next decades (Coelho & Manfrino 2007).

1.7.2 Governance and MPAs

MPA implementation requires supportive legal and jurisdictional frameworks. MPAs affect resource user behaviour and require large-scale development, which will require trade-offs. A legal framework describing boundaries and management rules of any MPA is a fundamental step that legitimates management decisions. Multiple institutions and various levels of governance will likely become involved in any MPA implementation process (Christie & White 2007). Governance may be conceived as "the formal and informal arrangements, institutions, and mores which determine how resources or an environment are utilized; how problems and opportunities are evaluated and analyzed, what behaviour is deemed acceptable or forbidden, and what rules and sanctions are applied to affect the pattern of resource and environmental use" (Juda 1999).

Christie and White (2007) argue that the key to successful management of marine resources is the establishment of appropriate institutions which ensure meaningful consultation with the public about design and management of MPAs. Hilborn et al.

(2005), furthermore, suggest the inclusion of a reward system so that the individual welfare of fishermen, managers and scientists is maximized. Fundamentally, however, MPA governance is heavily influenced by the particular socio-political history, economic well-being, culture, health and education level of the country or of communities of an affected site (Mascia & Claus 2009).

The system of governance and property laws in Vietnam has changed dramatically during the 1990s from central planning, towards a market-oriented economic policy. As part of this trend, certain productive assets such as agricultural land, forests and marine resources have effectively been privatised. These resources were previously solely managed through state organised cooperatives or through complex hybrid organisations, whereby the local government overlaid traditional common property rights regimes, resulting in local compromises in allocation struggles for land and livelihoods (Adger et al. 2001). The coexistence of customary and official systems is a common phenomenon in wetland areas, resulting from the under-evaluation of these areas and lack of a long history of ownership, clear tenure rights or any official delineation of property rights (Adger & Luttrell 2000). More information on Vietnam's marine fisheries reform can be found in Chapter 3.4.1 Legal framework.

Hughes et al. (2005) propose that in order to restore ecosystems and reduce fishing pressure to enable the rebuilding of stocks and to improve governance, the creation of frameworks that align the marketplace and economic self-interest with environmental stewardship and conservation, will need to be developed. Hence, for MPAs to be effective on a wide scale, it has been suggested that MPAs should be embedded within frameworks such as Integrated Management (IM) or Ecosystem-based Management (EBM) (Browman & Stergiou 2004; Forst 2009). Though EBM is a more recent framework, and largely untested, both these frameworks have been designed to balance resource management and economic development, consider ecologically significant processes, and encourage cross-sectoral planning. Impacts from terrestrial activities, intersectoral conflicts, overfishing and the management of trophic interactions are central issues being addressed by these broad models. As a general premise, how these management frameworks evolve is influenced by whether there are functional common property regimes in place or resources are open access (Christie & White 2007). Important steps for applying EBM are to identify management objectives for the ecosystem, including natural and human goals, and to ensure that the governance structure matches with the scale over which ecosystem elements are measured and managed (Ruckelshaus et al. 2008). These and other frameworks and how common property regimes have evolved in Vietnam will however be covered in more detail in Chapters 2 and 3.

1.7.3 MPA models

The IUCN has categorized six levels of protection for MPAs: Category 1a – Strict Nature Reserve, managed mainly for research; Category 1b – Wilderness area, managed mainly for wilderness protection; Category II – National Park, managed mainly for ecosystem protection and tourism; Category III – Natural Monument, managed mainly for conservation of specific natural features; Category IV –

Habitat/Species management Area, managed mainly for conservation through management intervention; Category V – Protected Landscape/Seascape, managed mainly for landscape/seascape conservation and recreation; Category VI – Managed Resource Protected Area, managed mainly for the sustainable use of natural ecosystems (Salm et al. 2000). There are, however, a number of other forms of marine protection that are variations of these, or named differently, but they are all protected individually or through national or regional systems (Salm et al. 2000). A broader classification differentiates MPAs by which management regime models they have adopted. These including: top-down, bottom-up, co-management, and traditional management regimes (Christie & White 1997).

1.7.3.1 Centralized management

Top-down or centralized management is the most common governance regime adopted by countries with strong national governments and which have considerable financial resources. Many of these have established fisheries agencies as policy makers for catch allocations and MPA design and management (Christie & White 2007). MPAs managed by governments tend to be larger than other management regimes, and may include multinational agreements, although linking issues such as vessel-source pollution and catch allowance has proven difficult (Kaye 2004). Centralized management is perceived as having adequate resources at hand to employ specialists who have experience with MPA planning and are able to use modelling software and other scientific data to establish ecological connectivity, animal migrations and changing climatic conditions to design MPAs (Christie & White 2007). This is, however, not always the case. In Brazil, da Silva (2004) found that competing societal problems such as health, economic development and education will often be prioritized over MPA planning and monitoring, especially when budget cuts are made.

There are limitations of centralized management. The most serious limitations are associated with how stakeholder groups respond to policies that affect them, but for which they do not feel responsible. Many examples exist of extraction limitations or fishing bans being advocated to areas which have historic precedents, potentially leading to socioeconomic and demographic changes and inevitable conflicts (Badalamenti et al. 2000; Jentoft 2000; Viteri & Chavez 2007)

1.7.3.2 Customary management

Traditional or customary ocean governance has existed for millennia in the Pacific Islands, grounded in 'taboos' and social norms, suggesting that these governance systems are sustainable and effective in some contexts (Christie & White 2007). They use similar techniques to those used today, but in light of the limited numbers still existent in today's globalised world, it is suggested that they are potentially fragile and best suited to support modest, local commercial and subsistence activities (Johannes 1981). The number of traditional marine resource managed areas has, however, seen an upsurge lately in a few places in Oceania. In Vanuatu for example, there were 40 areas in operation in 1993; 86 in 2001. The reasons for the unexpected recent increase have, amongst others, been attributed to the perception among islanders of the growing scarcity of their marine resources owing to the demands of growing export markets and local populations, as well as the income some communities can earn from keeping their reefs healthy in order to attract tourists (Johannes 2002). Traditional management is based on customary sea tenure, a situation in which groups of people (e.g. individuals, clans, tribes, etc.) have informal or formal rights to coastal areas and in which their historical rights to use and access marine resources are, in principle, exclusionary, transferable, and enforceable (Ruddle 1996). These customary management practices may limit extraction by spatial areas, time, gear or harvesting technology, effort (through the number of participants), types of species that can be harvested and the number of fishes harvested (e.g. through quotas) (Cinner & Aswani 2007).

1.7.3.3 Community management

Bottom-up or community managed MPAs are widely considered the most effective reef management system in the tropics (White & Vogt 2000), especially where there are weak formal institutions, or in countries where resistance to colonialism is strong. The governments may lack financial or technical resources to effectively serve the public, suggesting such an approach may be the only feasible option (Christie & White 2007). In contrast to top-down management approaches, bottom-up strategies tend to engage resource users more effectively than top-down strategies since they lead to a sense of trust, collaboration, and ownership among participants (Christie & White 1997). Local communities can develop a sense of self-determination, which can engender a sense of pride that attracts participation in management and inspires people to educate others in similar situations. Bottom-up management approaches also represent a means to reassert authority over traditional resources upon which they depend, and their knowledge of local diversity hotspots and ocean currents in surrounding seas can help provide information of possible locations for MPAs (Christie & White 2007; Kiss 2004).

There are challenges to be overcome when implementing community-based management regimes. Some neighbouring communities may not wish to support MPA implementation, communities which have been largely dependent on government agencies may not have enough incentive to undertake such time-consuming and difficult processes, and adequate funding from Non-Government Organisations (NGOs) are generally not long-term; development of successful community-based MPAs needs approximately three years of financial support and ten years of at least part-time external technical support (conflict management, leadership development etc.) (Christie & White 2007).

Difficulties will also be encountered when trying to address large-scale processes affecting coastal environments and communities, such as climate change, overfishing and pollution (Christie & White 2007). Community-managed MPAs, if carefully implemented can, however, lead to sustainable long-term management regimes, especially if resource users eventually engage the government (Christie et al. 2005).

1.7.3.4 Co-management

Co-management has been described as the fundamental principle of such arrangements, where resource users and formal policy makers (e.g. the government) work together in a process of joint decision-making (Christie & White 1997; Nielsen et al. 2004). It is frequently one of the outcomes of community-based management regimes, which have matured to the point whereby resource users and policy makers (and other entities such as the private sector) have comparable influence and are willing to collaborate. This management regime may represent a sound framework, as it encompasses the local knowledge and needs of fishermen, while transparent planning processes are formally recognised and sanctioned by government officials (Christie & White 2007).

Some research suggests however, that governments can be quite deceitful when co-management is implemented from the start. Nielsen et al. (2004) found several cases in Southeast Asia and Southern Africa, where governments have only involved fishing communities in the implementation process (instrumental co-management) in order to reach their management objectives, rather than to introduce more democratic principles into fisheries management.

Similar to community-managed MPAs, in order for co-management to be successful, long-term funding is required to maintain a multi-sectoral management board, where mandates are clearly established. They are also relatively resistant to change, which would be necessary to reconcile local and global management agendas in the future (Christie & White 1997; Nielsen et al. 2004).

There are several cases of private sector involvement in co-managed MPAs (Christie et al. 2002). In such situations, the private sector is meant to bring capital, business and marketing know-how and a client base; the community partner usually brings the location, labour and local knowledge, while an NGO or local government may mediate negotiations between the private and community partners, strengthen community capacity, provide basic infrastructure and other necessities (Kiss 2004).

As with centralized management, private management involvement in MPAs tends to generate considerable controversies, especially when agreements are breeched with community-based MPAs, in which case compliance generally declines. There has also been reported criticism of privately managed MPAs, as they have privatised areas that have historically been "community-owned" (MPA News 2003). There are nevertheless several examples of private enterprises pursuing ecosystem-friendly MPA development (Christie & White 2007)

1.7.4 The future

The success of all MPAs depend on the existence of appropriate legal frameworks, acceptance by coastal communities, an effective and well-supported management system and the delineation of areas so their boundaries are clear and they can be treated as self-contained units (Dharmaratne et al. 2000; Salm et al. 2000). If any of these factors were to be met by strong opposition, or if enough funding wasn't secured from the start, it is most likely that the protected area will fail to meet its objectives (Dharmaratne et al. 2000). Such MPAs that have been legally protected but lack management because of the absence of infrastructure, on-site staff or law enforcement are frequently known as 'Paper Parks' (Braatz et al. 1992).

The need for more effective marine reserve systems has therefore been recognised in recent years. At the World Summit on Sustainable Development (Johannesburg 2002), and later at the World Parks Congress (Durban, September 2003), representatives of protected areas recommended networks of marine reserves covering 20-30 % of habitats by 2012. The Durban Action Plan (from the World Parks Congress) also called on the private sector to "financially support the strategic expansion of the global network of protected areas" and states that tourism can provide economic benefits, opportunities for communities, create awareness and greater knowledge of our natural heritage (IUCN 2003a).

Balmford et al. (2004) estimated the running costs of a global MPA network meeting these targets to be US$ 5-19 billion annually, creating around a million jobs. The estimate was based on a survey of the running costs of 83 MPAs worldwide. The countries hosting a large proportion of the world's coral reefs are, however, generally poor, developing nations where government-funded MPAs are often not meeting their conservation objectives (Burke et al. 2002). In some countries, private enterprises (such as hotels or dive operators) have taken the initiative to protect areas of coral reefs, also recognising their importance to the hotels' own business.

1.8 Hotel Managed Marine Reserves

Similar to privately managed parks on land, many of the established privately managed or co-managed MPAs - Hotel Managed Marine Reserves (HMMRs) are believed to have been established because of the government's inability to satisfy the public's and ecotourists' demands for nature conservation in both quantity and quality, while creating a potentially profitable market niche for their business (Langholz & Lassoie 2001; Svensson et al. 2008; Svensson et al. 2009). In these cases, hotel managers generally pay a lease or tax to the owning authority and close the area to fishing, often by buoy markers. Such arrangements generally take the form of fixed-term contracts, which makes long-term conservation initiatives unpredictable. The contracts however, often last over a decade and are mostly open for renewal. The stable income which is procured is mostly very well received, especially in poor, developing countries (Beck et al. 2004). Hotel establishments can also add to local or regional income generation by providing additional or alternative employment opportunities (directly or indirectly) and/or they may help develop local infrastructure, which can strengthen a community.

On the other hand, hotels may try to alienate local communities by hiring foreign staff, or they may try to retain generated income in-house (e.g. all-inclusive hotels), which would negate the purpose of such small protected areas, especially if there was limited or no spillover of fish to adjacent fishing grounds within the first couple of years after establishment. In such situations, especially where foreign management is involved, it is not difficult to realise that affected communities would feel animosity towards the hotel, which could lead to varying degrees of conflict

(Christie 2005). Therefore, community involvement and joint decision making is extremely important when establishing protected areas (Langholz & Lassoie 2001).

Most dive resorts have boats, personnel and other equipment needed to manage local protected areas and they often have the financial backing and incentive to protect their assets (Colwell 1999). Hotels' success does however depend on a relatively stable influx of tourism, which could, amongst other, be influenced by the political stability of the country, natural disasters and the economy (Dearden et al. 2005).

There has recently, nevertheless, been a shift in governance, leading away from government-managed protected areas, towards increased participation of stakeholders, with the private sector, local communities and NGOs having a large influence on protected area decision-making (Dearden et al. 2005). In a report on a change in governance of protected area systems between 1992 and 2002 in 41 countries, Dearden et al. (2005) found increasingly more countries, relying on a broader range of funding sources; the medium and less developed countries relying significantly more on funds from foreign governments, donations and concessions paid by the private sector (25 % compared with 14 % of total funding).

Colwell (1999) undertook a preliminary study of hotels and resorts which have taken over the day-to-day management of a protected area from the government. These hotels, termed "Entrepreneurial MPAs" had in some cases taken over full responsibility of the reserve through a performance contract. Riedmiller (1999) also describes cases where private entities have been able to buy or lease areas of high biodiversity with the aim of protecting the biodiversity of these areas. In researching the coastal states surrounding the United States, Slade et al. (1997) found that nearly one third of submerged lands were owned or leased by the private sector, developing marinas, private docks, fisheries, aquaculture or other ventures. Some MPAs have also been initiated and managed by hotels, only to be expanded and relieved of management by a government body, following their success at increasing fish stocks or sustaining or enhancing biodiversity. These precursors to government managed MPAs can be seen as costs saved by the government for or an area, otherwise previously needing protection (Langholz & Lassoie 2001).

In the northwest corner of Palawan Island, Philippines, blast fishing, cyanide fishing and other sorts of destructive fishing methods are illegal, but are still practiced. The resort in Bacuit Bay allowed government patrols to use their boats, facilities and equipment to protect the area. Staff were also deputised as sanctuary wardens. As a result, the reefs within the reserve were reported to be in relatively good condition, while those on the outside, in relatively poor condition. In 1998 the president of the Philippines proclaimed the El Nido Resort as a Managed Resource Protected Area (Colwell 1999). Similarly, on the Island of Roatan, Honduras, the Anthony's Key Resort was the primary force in establishing the Sandy Bay Marine Reserve in 1989. The resort supplied patrol boats, gas and mooring buoys for the reserve. Within two years of establishing the reserve, there were dramatic increases in lobster, grouper and other marine life (Colwell 1999).

The national and local laws of the country in which a resort or community wishes to manage its own marine reserve have a strong influence on its success. In a study devoted to researching the health of coral reefs in Fiji and Cook Islands, Hoffmann (2002) found that the health of the coral reefs declined with economic development and marine property regimes, rather than increasing population. The Cook Islands have a property system of common access that is owned by the government. The tour operators "compete" to access the waters and fishers "compete" to harvest the fish. This over-competition of multiple stakeholders acting independently, in their own self-interest, can ultimately destroy reef health. This system, termed "tragedy of commons" (Hardin 1968) is disadvantageous, compared with communities in Fiji, which have customary tenure of the reefs and who sell access rights to fishers and dive operators.

This political setting enabled a resort in Fiji to help develop an MPA. The manger of the Shangri-La Fijian Resort, located on an Island linked to the main Island of Viti-Levu, contacted a local NGO in 2000, concerned about the degrading state of the environment surrounding the Island, with declining coral populations and reductions in the number of fish (MPA News 2002). The resort matched project funds raised from outside donors and established a 1.7 km^2 marine reserve adjacent to the Island. Destructive fishing practises such as cyanide fishing and blast fishing were banned, as well as the use of small gill nets and rubbish disposal directly into the sea. The hotel also updated their pre-existing sewage treatment plant and constructed a series of artificial wetlands to filter the resort's wastewater and reused it for irrigation, with wetland plants absorbing nitrates and phosphates and keeping them from leaching onto the reef. The NGO indicated that fish populations had increased dramatically after two years and local fishers were getting secure breeding populations of fish to restore stocks to the fishing grounds. Low-tech reef restoration was foreseen, as were the deployment of marker buoys and training of reef guides. These costs were to be offset by fees collected from snorkelling tours of the no-fishing area, a room surcharge fee, and guest donations (MPA News 2002).

Chumbe Island Coral Park off Zanzibar, Tanzania, is one of few privately managed MPAs officially recognised by the IUCN. It was established in 1994 following approval from the government of Zanzibar. Riedmiller (2000) suggested that privately protected areas can provide important community benefits, particularly in capacity building, biodiversity conservation and restocking of fisheries resources. Evidence of adjacent fisheries profiting from the spillover of the reserve (0.3 km^2) was found (Riedmiller 1999). This suggests that it is possible for hotels and resorts to manage small areas of no-take zones, providing a positive impact on their surrounding environment, while at the same time successfully managing a hotel and engaging the local communities. A hardship related to private protection compared with other MPAs has, however, been identified. Governments and other funding bodies are not very willing to help with grants and subsidised management. Other HMMRs have therefore set up a user fee system for resource-using guests.

1.8.1 User fees

It is suggested that MPAs only start to become successfully managed when funding is secured through self-financing (Davis & Tisdell 1996). The constant supply of funding from user fees could therefore be a solution to financing and thereby effectively managing protected areas (Arin & Kramer 2002). Expected expenses can be associated with various management and maintenance resources, projects, expert advice and salaries and the lease or tax (Colwell 1999).

Surveys have indicated that user fees or room charges are generally accepted by tourists, since they are a direct means to contribute to conserving the natural resources they will enjoy (Chapter 7; Svensson et al. 2008; Svensson et al. 2009; Tongson & Dygico 2004). Visitors to four marine reserves on Olango Island, Cebu, Philippines, expressed 'Willingness to Pay' (WTP) for various activities located in MPAs, such as scuba diving visits to Moalboal Reserve and Siquijor Reserve (locals: US$ 1.60 and US$ 4.00 respectively, and foreigners: US$ 4.00 and US$ 25.00 respectively per day). Beach visitors to Moalboal Reserve were willing to pay US$ 0.80 per day (Rosales 2003). This shows that many tourists are environmentally conscious and willing to invest beyond the costs of their travelling expenses to benefit from protected reefs and related activities. White et al. (2000), in another WTP survey, found that entrance fees to the community-based marine reserves could easily offset the costs of reef management. They calculated that the coral reef around Apo Island, covering slightly more than 1 km^2 to the 60 m isobath, could support an annual revenue from tourism of between US$ 4,500 – 25,000, which could offset the annual maintenance costs of US$ 5,000.

1.8.2 Hotel Projects

With more capital at hotels' disposal, additional projects can be initiated, such as monitoring the coral reefs and other habitats, monitoring marine mammals/sharks, starting coral transplantation projects, or developing education or awareness programs for tourists, staff and local communities.

At the Jean-Michel Cousteau Fiji Island Resort, education programmes are conducted, highlighting the importance of the interplay between mangroves and reefs. They have also built artificial wetlands to replace their septic tank, which will treat waste water, so that it can be used as nutrient-rich irrigation water, while avoiding the harmful leaching of nutrients. At the Sheraton Soma Bay, Hurghada, Egyptian Red Sea, divers and snorkellers are given brief sessions on proper behaviour in the water to protect the fish and corals. Dive boat anchoring has been forbidden and the hotel has developed zoned areas for its various marine activities (IHEI 2003). Aside from educating guests about the fragile ecosystem, The Four Seasons Hotels and Resorts, Maldives, has created the "Adopt-a-Reef Ball" project. These are artificial concrete structures which facilitate the growth of corals. These can host approximately 180 kg of plant or animal life and can be adopted by the guests of the hotel for US$ 250 (Green Hotelier 2002).

Similarly, some hotels have built artificial reefs in their no-fishing area, made out of various materials such as concrete blocks, clay pots and discarded plastic drums, as well as Fish Aggregating Devices (FADs) for the local fishermen. Artificial reefs or FADs are known to be able to significantly increase the number of fish around these structures (Dempster & Taquet 2004; Nelson 2003; Sherman et al. 2002; Walker et al. 2002). Another method of building artificial reefs is that of the patented BIOROCK method which Pondok Sari Hotel, Pemuteran, Bali, and the Aqua Safari Inn, Condumel, Mexico, have adopted. It uses low-voltage electrical currents connected to a metal reef frame to dissipate minerals found in the water to build a limestone structure. Broken corals from nearby destructively fished areas are placed on the reef structure providing a hard substrate for them to grow on. These artificial reefs also aggregate fish by providing a habitat for them. The electro-chemically charged conditions stimulate the corals and nearby organisms to grow. The 'Maldive Barnacle' Biorock reef structure, which was constructed in 1996, showed great resistance to the El Niño event of 1998. Whilst only 1-5 % corals survived overall, 50-80 % of corals survived on Biorock structures (Goreau & Hilbertz 2005).

Several hotels have also helped local communities by financing the building of schools or hospitals, improving infrastructure, or given financial aid to fishermen to compensate for any fishing grounds lost, some, by using portion of user fees (Langholz & Lassoie 2001). The Alegre Beach Resort allegedly pays the salaries of two school teachers (Mar Cruz, aquasports manager, pers. comm.), the manager of Whale Island Resort professes to financing the building of a temple (Michel Galey, resort owner, pers. comm.), The manager of Mnemba Island Lodge claims to have built a small local hospital (Peter Dunning, resort manager, pers. comm.), and Wakatobi Dive Resort supposedly sponsors school material, gives lectures on conservation issues, provides funding for wastewater management and public projects to 17 affected communities (Wakatobi Dive Resort 2008; Lorenz Maeder, resort owner, pers. comm.).

1.8.3 Community Involvement

HMMRs are mostly relatively small and located adjacent to the hotel, which makes overseeing and patrolling the area easy and cost effective. Small MPAs are also more likely to result in a higher level of compliance than large MPAs, as they are less prone to significantly impacting adjacent communities socio-economically (Unsworth et al. 2007). On the other hand, small MPAs are more vulnerable to poaching. Only few, major poaching events could destroy several years worth of protection (Roberts & Hawkins 1997). It is therefore extremely important that there is unity, trust and common understanding between stakeholders. Benefits should be equally distributed between stakeholders and amongst the community (Aswani et al. 2007; White & Vogt 2000).

Shivlani et al. (2002) conducted long-term socio-economic monitoring of the Sambos Ecological Reserve in the Florida Keys National Marine Sanctuary. They addressed the issue whether people who lost the most due to the development of the reserve, also benefited most from the biological and economic consequences of protection. They found that all fishers locally experienced increases in income over the study period. Those displaced by the reserve gained an average of 67 % compared to 22 % gained by fishers further away.

There are however many cases where local communities do not benefit greatly from marine reserves, causing distrust and animosity between stakeholders, which also increases the likelihood of poaching (Christie 2005). In order to gain commitment and to prevent non-compliance from local communities, intensive education programs and involving local fishermen already at the planning stages of the HMMR to ensure that their inherit cultural precepts and socioeconomic needs are considered carefully, have been suggested. This will give them decision power, which will help persuade them that reserve objectives are not only developed for conservation purposes, but also for long-term fishermen benefits (Aswani et al. 2007; White & Vogt 2000). Financial assistance, prospect of alternative livelihoods, showing reserve results and strong support from the government would also increase the likelihood of acceptance of the HMMRs during the first few years of establishment before a major goal of HMMRs can be realised – the tangible increase in fish stocks to adjacent fishing grounds (Chapter 6; Fiallo & Jacobson 1995; McClanahan et al. 2005; White & Vogt 2000).

It is possible that hotel investment in MPAs could create a win-win situation for the environment and biodiversity on one hand, with economic growth for the region and resort on the other, if joint ecological and socio-economic goals can be realised.

1.8.4 Hotel awards

The World Tourism Organization has predicted continued growth in the tourism market over the next decade (IHEI 2003). It could be argued that growth on this scale can only be achieved if the physical and social environment, on which the tourism industry depends, is sustained or enhanced. It is therefore in the hotels' and resorts' best interest to sustain the environment in which they are located. The hotel may be able to market its environmental programmes and enhance its corporate image and out-compete its competitors. To motivate establishments, several environmental awards have been introduced to boost corporate image. There are over 70 sustainable tourism certification programmes in the world, either currently active or in development, which legitimize eco-friendly hotels and grant awards after scrutinized inspections (Rainforest Alliance 2008a).

The Green Globe certification is currently, probably the most recognised on a global level but since the Marrakech Process in 2003, a United Nations-led initiative to direct a shift towards global sustainable production and consumption, there has been further development. The Rainforest Alliance produced the Sustainable Tourism Certification Network of the Americas in 2003, a regional network including all certification programs as well as NGOs, academic institutions and other interested parties in the Americas. In February 2007, the Rainforest Alliance further committed to developing a comparative analysis of different certification standards from around the world to identify common certification criteria that can serve as input for the Sustainable Tourism Stewardship Council

(STSC) standard, a proposed global accreditation body for sustainable tourism and ecotourism certification programs (Rainforest Alliance 2008b).

Meanwhile, other certification bodies with environmental awards exist, and include Ecotourism Australia – the Eco Certification Program, The Foundation for Environmental Education (FEE) - Green Key & Blue Flag award, Sustainable Travel International - The Sustainable Tourism Eco-Certification Program (STEP), International Hotel and Restaurant Association – Environmental Award etc. Most certifications are however not eco-system specific, unless developed on a local level (hence by default will be specific in their criteria to respond to the needs/threats to the local environment), but will include components, which affect the eco-system. Blue Flag for example is a certification scheme for beaches and marinas generally, but some Blue Flag awarded sites are close to hotels, so in a number of cases the hotel management is in charge of ensuring compliance with Blue Flag criteria, such as demands for recyclable waste, sewage treatment, beach clean-ups etc. and in sensitive areas, coral reef monitoring (Blue Flag 2008).

1.9 Concluding remarks

Despite general views, several hotels and resorts are environmentally aware and actively contribute to reef-related conservation (Svensson et al. 2008, 2009). Some are involved in co-managed or community-based MPAs, working together with local communities and national agencies (Christie & White 2007). Others are encompassed in government managed MPAs, following these rules and regulations (Colwell 1999), but there are still many hotels and resorts which have taken the initiative to protect their adjacent 'house reef' as a marine reserve, prohibiting fishing and other destructive practices. Many of these claim to be either directly helping local communities through jobs with the hotel or its reserve, or through financial assistance collected from tourists' reef-user fees, or indirectly through the spillover effect of fish from the marine reserve. Six dive operators in Indonesia report that they are raising funds to manage and protect the closed off areas adjacent to their affiliated hotels from over-fishing along the coastline, creating a network of marine reserves (Jo McFarlane, Vila Ombak Diving Academy dive guide, pers. comm.). Though these claims can not be substantiated at this time, their situation would be interesting to research, were they to be accurate, since it has been suggested that a network of MPAs could have a cumulative positive effect at increasing fish stocks (Roberts 1998; Roberts et al. 2001).

The countries hosting a large proportion of the coral reefs of the world are generally poor, where in many cases, government-funded MPAs are not meeting their objectives of protecting the coral reef ecosystem. Some of these MPAs are also receiving financial assistance from developed countries (Dearden et al. 2005). HMMRs may be a solution to increasing the number or reserves and area of protection and bringing the responsibility of the local marine environment to the users and profiteers.

2. Theory and conceptual framework

Ecosystem-like concepts have existed in numerous ancient societies across the globe for centuries (Berkes et al. 1998; Johannes 2002). Many of these approaches have, however, become forgotten, are no longer practiced, or can no longer be practiced because of population growth (Berkes et al. 1998). In Southeast Asia for example, the use of estuarine polyculture fish ponds (tampak) such as those in Java, Indonesia date back to the 15th century. Often fringed by mangrove forests, tampaks combined the cultivation of fish, vegetables and tree crops. Organic-rich outflow from rice-fish systems were often directed into tampaks to fertilize them. Most of these systems have however fallen into disuse, having been affected by international markets (displaced by fish-pond monoculture), impacted by coastal population growth and urbanisation pressures (Berkes et al. 1998). In some contemporary non-western cultures, traditional resource management, including ecosystem-like thinking, nevertheless continue to exist and even recently to strive (e.g. part of Oceania) (Johannes 2002). These peoples use customary sea tenure, described as ancient property rights of individuals, clans or tribes to restrict and manage access rights to natural resources (Ruddle 1996).

According to the Millennium Ecosystem Assessment (2005), coastal habitats are some of the most heavily degraded areas in the world. Human activities on land and sea can negatively impact or threaten coastal marine environments, which is why alleviating coastal pressures and protecting habitats have been the focus of interest of marine ecologists, policymakers, managers and resource users in the last decades (Garcia et al. 2003). There is an increasing international awareness of the cumulative impacts of sector-based activities on the ecosystem (Jennings & Kaiser 1998) and the need to take a more holistic or Ecosystem-based Management (EBM) approach (Kabuta & Laane 2003) to ensure the sustainability of marine ecosystems. One widely accepted definition of marine EBM is:

... an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors (McLeod et al. 2005)

The ecosystem management concept has formally been around since at least the introduction of conservation ethics by Aldo Leopold in 1966 (Czech 1995) and has developed from founding principals of sustainable development and general systems-based approaches that were developed in ecology, anthropology and other disciplines in the 1960s and 1970s, aimed at both human and ecosystem well-being (Garcia et al. 2003; Kappel et al. 2006). Ecosystem approaches aim to sustainably develop, enhance and increase natural resources, while simultaneously fostering a long-term commitment to the welfare of human societies (Kimball 2001). More formal recognition of EBM can be found in the 1992 UN Conference on Environment and Development (UNCED) in Rio de Janeiro, emanating from the 1982 UN Conference on the Law of the Sea, and resulting UN

Convention on the Law of the Sea (UNCLOS). UNCED highlighted the need to consider resource management from a wider biological, socio-economic and institutional point of view. This led to follow-up conferences and conventions, such as the 1993 Convention on Biological Diversity, the 1995 Fish Stocks Agreement and the 1995 Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries. The FAO put in place International Plans of Action to meet UNCED objectives which were reviewed in Johannesburg at the Rio +10 meeting in August 2002, indicating a growing body of international legislation in support of EBM (Jamieson & Chang-Ik Zhang 2005).

Meanwhile, in preparation of the FAO, a process of selection and reformulation was also conducted to formulate a reference framework for sustainable fisheries, addressing practically all the ecosystem considerations, principles, and conceptual goals needed for an Ecosystem Approach to Fisheries (EAF) (Garcia & Cochrane 2005; Garcia et al. 2003).The term EAF was adopted by the FAO Technical Consultation on Ecosystem-based Fisheries Management held in Reykjavik in September 2002 (Garcia et al. 2003). Kimball (2001) explains that all ecosystem-based approaches of economic activities rely on similar precepts: the need for sound science, adaptation to changing conditions, partnerships with diverse stakeholders and organisations, and a long-term commitment to the welfare of both ecosystem and human societies. There are many definitions of EAF, but the FAO has adopted the following, which is more aligned with the general ecosystem approach concept:

...an ecosystem approach to fisheries (EAF) strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries (De Young et al. 2008).

The approach was adopted as it became apparent that it was insufficient to manage, protect and to take single-species stock assessments into consideration. A broader approach, looking at the surrounding ecosystem – prey and predator species, oceanographic effects, environmental impacts and other human activities needed to be factored in. As a consequence, the management of a whole range of human interactions with the fishery ecosystem, including technical, economic, social or institutional, had to be incorporated (Garcia et al. 2003). EAF is therefore an extension of more conventional fisheries management, recognising more explicitly the interdependence between human well-being and ecosystem health and the need to maintain ecosystems productivity for present and future generations, e.g. conserving critical habitats, reducing pollution and degradation, minimizing waste, and protecting endangered species (Ward et al. 2002).

Unlike EAF which takes a sector-based approach to ecosystems, the scientific consensus statement on marine EBM (McLeod et al. 2005) specifically:

• emphasizes the protection of ecosystem structure, functioning, and key processes;

• is place-based in focusing on a specific ecosystem and the range of activities affecting it;

• explicitly accounts for the interconnectedness within systems, recognising the importance of interactions between many target species or key services and other non-target species;

• acknowledges interconnectedness among systems, such as between air, land and sea; and

• integrates ecological, social, economic, and institutional perspectives, recognising their strong interdependences.

Moving towards a more comprehensive, integrated ecosystem-based approach to address the current and future management challenges of our oceans, it could be useful to understand two other major approaches in global discussions relating to natural resources and spatial area management: the livelihoods approach and the Integrated Management (IM) approach (De Young et al. 2008).

The livelihoods approach grew from the recognition of the need to place fisheries in a larger context of households, communities and socio-economic environments. As an integrated part of an ecosystems approach, this implies that fisheries management must consider the demographics of fishers, socio-cultural aspects, fishers' economic situation affecting institutional framework and policies, marine and community infrastructure and other non-fishing activities (Allison & Ellis 2001).

Ecosystem-related concepts have a lot in common and relate closely to IM. It has been under development for the past 30 years, but is only recently taking root in some countries (Christie & White 2007). IM (whether of oceans, coasts, watersheds etc.) has been designed to manage multiple (competing) uses of certain designated areas – uses such as fisheries, aquaculture, forestry, oil and gas, mining, agriculture, shipping and tourism. This involves the use of a collaborative/participative approach to managing multiple stakeholders (e.g. local communities, industries) in a flexible, responsible and transparent process, as well as managing interactions among people and ecosystems, while dealing with multiple levels of the government to protect the ecosystem in a sustainable fashion (De Young et al. 2008; Garcia et al. 2003). The integrated management approach pays attention to a number of resources (e.g. soil, water, fish stocks, etc.) and habitats (e.g. open ocean, estuaries, wetlands, beaches, lakes, rivers, etc.), as well as a range of environmental factors (e.g. changes in water temperature, turbidity and acidity, chemical pollutants and water flows). It complies with the precautionary approach and considers the characteristics of the designated area: local climate, state of the ecosystem, relevant natural resources and the human community (cultural, economic, social), making use of traditional knowledge and integrating all data to establish objectives and implement a suitable and adaptable framework (De Young et al. 2008; Garcia et al. 2003).

EBM makes use of all these models and practices to design an adaptable framework that balances resource management and socioeconomic development, considers ecologically significant processes and encourages cross-sectoral planning. Terrestrial activities, intersectoral conflicts, overfishing and management of trophic interactions are central issues addressed in EBM. Establishing networks of MPAs, considering social and ecological linkages to provide cumulative positive interactions are also emphasized (Christie & White 2007).

Taking an EBM approach to marine protection therefore requires an interdisciplinary approach of traditionally opposing disciplines. Levin (2006) and others (e.g. (Vincent 2007), more recently, agree that ecologists, economists and other social scientists have much incentive for interaction since ecological and socioeconomic systems are interconnected and key to ensuring environmental protection and economic growth. Combining the teachings of these disciplines and integrating them into a solid framework, could however be very difficult, since natural scientists are concerned with the protection of the biological and physical environment, while social scientists place their focus on the people and human interests (ThiaEng 1997).

To have any possibility of taking an ecosystems approach to fisheries management, Hanna (2001) proposes that institutional changes have to be adopted to create economic incentives (new policies, laws, and regulations) for environmental protection. One essential necessity is for clearly defined property rights to be in place. Property rights define the conditions that guide and control human use of resources, they delineate the population of legitimate owners and define rules and responsibilities so that expectations are consistent and enforcement is possible (Bromley 1991). Without property rights, one possible scenario is the creation of a "tragedy of commons", where, in pursuit of individual's own self-interest, resources are driven down to low levels and users become impoverished because of the great effort they expend on harvesting the resource (Hardin 1968).

The linkages between socio-economic and coastal system dynamics (an ecosystems approach) can only be effectively understood through an assessment across ecosystems, social conditions and management approaches (Bowen & Riley 2003). For the purpose of this thesis, researching the effectiveness of Hotel Managed Marine Reserves (HMMRs) in sustaining nearshore fisheries, the link between the science of the change in the status of nearshore fish stocks and the social and economic responses of people affected by such a policy change, has been evaluated. Such links are best made by identifying and addressing indicators, which act as information tools to characterise the status of the specific environment and social situation (Jennings 2005). A common framework for indicators of environmental analysis is the DPSIR model (Driving forces – Pressure – State – Impact – Response) (Figure 2.1), established by the Organization for Economic Cooperation and Development (OECD) (OECD 1993). This model has recently also been adopted and modified to review the state of reef fishing activities in Kenya (Mangi et al. 2007).

Drivers describe large-scale social, demographic and economic conditions and sectoral developments which exert pressure on the environment, forcing change. External influences such as climate change can augment this pressure. State indicators describe observable changes in environmental dynamics, which in turn can impact social benefit values. Response indicators constitute institutional responses to changes in the system, mainly influenced by state and impact indicators (Holman et al. 2005; Mangi et al. 2007).

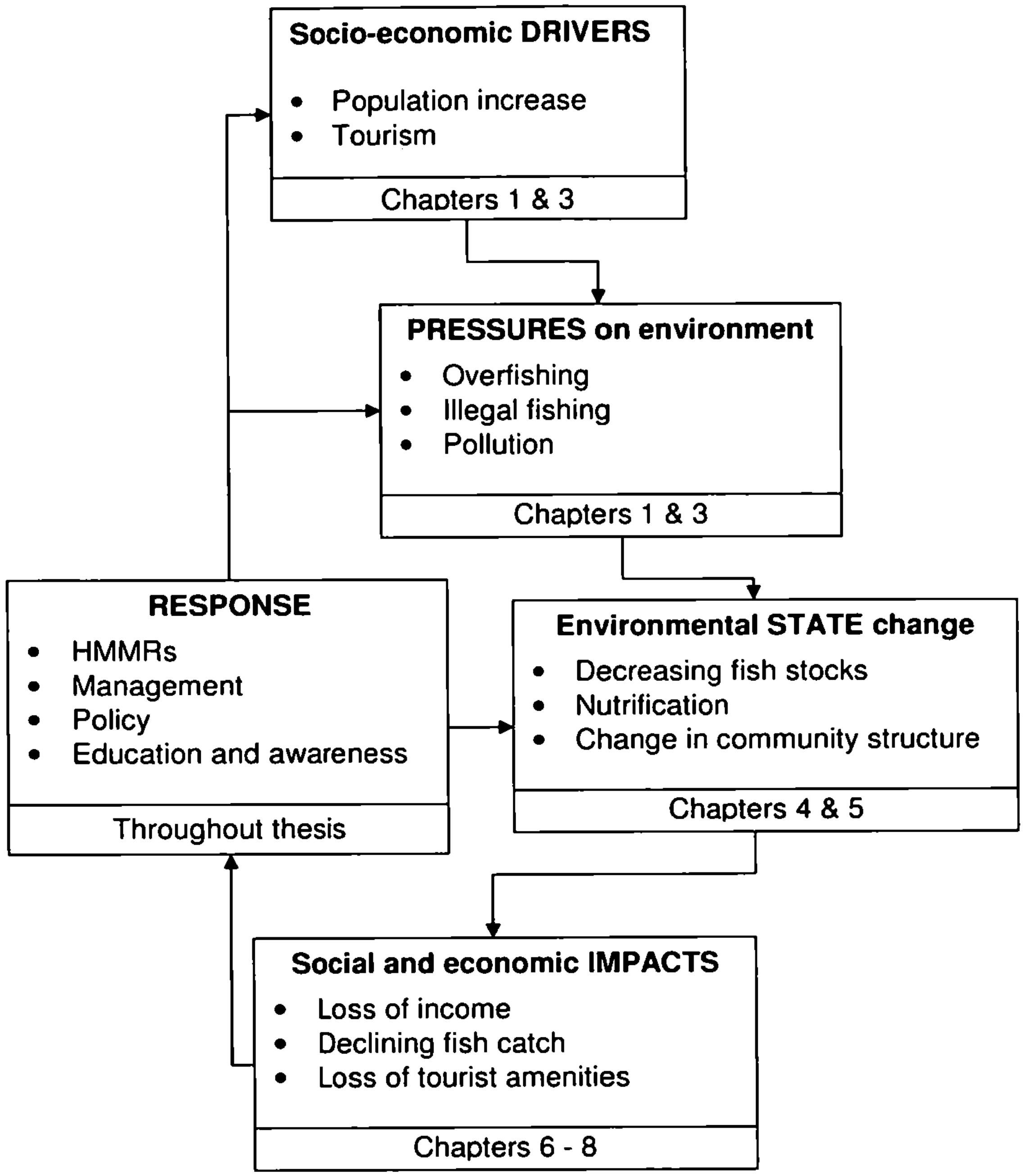

Figure 2.1. A DPSIR framework (adapted from (Holman et al. 2005) describing the main socio-economic drivers exerting pressure on the environment in Vietnam and the study location, Van Phong Bay, in particular. These pressures in turn lead to changes in the state of the environment, which may impact human welfare. Response indicators are formulated to mitigate the damage or problem, or re-orientate drivers or pressures. Chapters indicate where in the thesis issues are predominantly addressed

An overview of some of the key indicators which were considered for this thesis has been diagrammed in Figure 2.1. A major driver exerting pressure on the environment in Vietnam is represented by a rise in the human population, especially the increase in the population rate in fisheries communities, growing yearly by 2.6-2.8 % (national average: 1.3 %) (FAO 2008). While population growth increases local government revenues, it also increases the demand for services provided by local governments, such as public safety, road and street maintenance, and parks and recreation, which could influence decision making processes to invest in the protection and sustainability of natural marine resources (Taylor & Molnar 2006). Fishery rules and regulations in Vietnam are, as such, limited to a modest number of gear size and type restrictions, but are seldom enforced due to budgetary constraints (FAO 2008). This driver is compounded by an increase in tourism. There has been a 3.7 fold increase in tourism from 1997 to 2007 (691,400 - 2,569,150) (GSO 2008). There has also been a major increase in the amount of tourists to the Province of the HMMR. According to the Khanh Hoa tourist department, the tourist arrivals to Khanh Hoa Province in 2008 were 1,597,228, of which 315,585 were international, an approximately 12 % increase in comparison to 2007 (Gasparotti & Nguyen 2009).

These drivers are exerting pressure on the environment (Figure 2.1). Owing to the increase in the number of mouths to feed, the fishing fleet has increased dramatically over the last years (6.5 times from 1990-2004) (Nguyen Long 2002). Since 82 % of national marine catch derives from nearshore fisheries and more than 75 % of income is derived from fishing activities in Khanh Hoa Province (FAO 2008), fishermen are using any kind of fishing technique, including mesh size under legal limits, harmful methods such as beach seining, blast fishing, poison fishing and bottom trawling, in order to survive. Juveniles are captured and not released, fish stocks are being depleted at unsustainable rates and habitats are being destroyed (Pomeroy et al. 2009; Stobutzki et al. 2006). In addition, the increase in population size, fishing fleet and tourism is producing an excess amount of sewage discharge, rubbish dumping, boat pollution and pollution and sedimentation from coastal development, putting further pressure on the environment (Pandolfi et al. 2003; Vo et al. 2004). Direct damage to coral reefs from tourism also includes trampling or handling when swimming, snorkelling or diving. Michael and Tu (2005) found that the 9 dive operators licensed to operate in Nha Trang MPA, Vietnam, bring 100 divers to the reserve every day and run approximately 9800 dive trips annually.

The state of the environment, influenced by these pressures has resulted in decreasing fish stocks, eutrophication and a change in the community structure (Figure 2.1). Fisheries maximum sustainable yield in Vietnam has, for example, been surpassed since 1986 (582,212 tonnes/year). In 2008, fisheries landings had increased to 3.6 times this amount (Nguyen Long 2002). Monitoring work at the nearby MPA of Nha Trang from 2002-2005 has also detected a change in community structure. There has been significant increases in cover of fleshy seaweeds (indicator of nutrient pollution), and significant declines in fish density, mainly the families Chaetodontidae and Haemulidae (indicator of overfishing, blast fishing, poison fishing and aquarium collection), as well as in the density of the invertebrate *Stenopus hispidus* (indicator of aquarium collection) and the massive corals (indicator of blast fishing, poison fishing and nutrient pollution) (Dung 2007;

Tuan et al. 2005). Based on these indicators, the state of the marine environment of Van Phong Bay, specifically the HMMRs and surrounds has been researched in this thesis. Chapter 4 looks at fish stocks, interconnectivity between reserves and community structure of fish, as well as changes in benthic habitats, while chapter 5 compares fish assemblages on artificial reefs and natural reefs and explores the potential of artificial reefs contributing to increasing fish stocks.

The impacts of the change in state of the marine environment has had great influence on Vietnamese people, specifically, directly affected coastal communities (Figure 2.1). The average catch is decreasing. From 1985 to 2000, the average catch per horsepower decreased by 41 %, with a lower percentage of commercial fish compared with trash fish and a lower average size of fish caught. This indicates that the income per fishing trip is decreasing (Nguyen Long 2002). Meanwhile, because of pollution and increased rubbish dumping, 65 % of foreign tourists suggested that the beaches around Nha Trang MPA were unpleasant, which diminished the recreational experience of their visit (Lindsey & Holmes 2002). This could lead to a decrease in tourism, which would create a positive decrease in pressure on the environment, but also a decrease in foreign income. In chapter 6, I attempt to establish the positive and/or negative influences the HMMRs have had on adjacent communities through questionnaires and interviews, considering amongst others, financial loss or gain, and whether local fishermen perceive any change in fish stocks in fished areas resulting from the protection. In chapter 7, I determine tourists' knowledge, interest and concern for marine protection and their resulting support and Willingness to Pay (WTP) extra to stay at hotels which are protecting coastal areas. For this survey, I used the stated preference theory, Contingent Valuation Method (CVM) to establish concern and interest, expressed as an open-ended question for WTP for the use and non-use value of the marine environment. Direct use value involves the utilization of the reef for swimming, snorkelling and scuba diving. Non-use value refers to concern, sympathy with, and respect for marine resources, e.g. conservation for the sake of the environment without tourists deriving any actual use from the marine resource (Subade 2007). An overall impact assessment resulting from a change in the state of the environment was additionally attained from hotel managers across the Indo-Pacific. Questionnaires reported on perceived pressures on the environment, actions taken to alleviate such pressures, the costs and perceived social and economic impacts thereof.

The response, which is ultimately the focus of this thesis, is the potential establishment of more protected areas, possibly in the form of HMMRs on a more global scale to help alleviate financial pressure from governments and to act as a source for the replenishment of fish stocks to nearshore areas (Figure 2.1). For the hypothetical establishment of an increased number of HMMRs in Vietnam and the world, there would, however, ultimately be a need to consider management issues related to MPAs, in terms of existing governance structures, property rights and policies involving all stakeholders. Christie et al. (2009) suggests that the management of resources is, by definition, a societal activity, and can as such, not ignore governance, jurisdictions and societal relationships. Potential changes may be extremely difficult to implement, however, since many countries, including Vietnam hold strong traditional beliefs related to property rights and fisheries policies (Adger & Luttrell 2000). Education and awareness programmes associated with preventing reef decline and responsible fishing are therefore an important part of developing a better understanding of issues amongst user groups as a means of creating a change in attitudes and behaviours (Mangi et al. 2007). Such response indicators will be discussed throughout this thesis.

3. Study site

The site chosen for this study is Whale Island Resort, Vietnam. This hotel was chosen because it was suitable to test the aims of this study: to determine the effectiveness of an HMMR holistically, through its ability and potential to fulfilling predetermined biological and socioeconomic objectives.

In this chapter, I give a brief description of Vietnam, existing Marine Protected Areas (MPAs), status of fisheries and its legal framework, tourism and its potential, focusing further on the larger bay (Van Phong Bay) in which Whale Island (Hon Ong) is found, before describing the hotel and its reserves.

3.1 Vietnam

The Socialist Republic of Vietnam is a country in south-eastern Asia, bordering the Gulf of Thailand, Gulf of Tonkin, and South China Sea, alongside China, Laos, and Cambodia. It covers a total area of 329,560 km^2 and spans 15 latitudes, accommodating over 86 million people (July 2008 est. (CIA 2008)). The political leaders (Communist Party of Vietnam) govern the 59 provinces and 5 municipalities. Most of the population classify themselves as non-religious (80.8 %), although the majority identify themselves mostly with Buddhism (85 %) (CIA 2008; Wikipedia 2008a). Approximately 3 million people attended upper secondary school (86.6 % graduating) in school year 2007-2008 and about 234,000 graduated from a university or college education (GSO 2009c). Living standards are relatively low, with 16.2 % of people living in rural areas falling under the poverty level (GSO 2009c).

Vietnam has a coastline of 3444 km (CIA 2008), and 3700 km of land borders (Le Thac Can et al. 2001). The terrain of the country is low and flat in the south and north deltas, hilly in the central highlands and mountainous in the far north and northwest. Because of differences in latitude and topographic relief, the climate varies considerably from region to region. It is tropical in the south; monsoonal in the north with a hot, rainy season (May to September) and warm, dry season (October to March). Average yearly rainfall amounts to approximately 2000 mm, unevenly distributed among areas that receive 4000 mm and others that receive 700 mm. Over 80 % of this precipitation falls in the rainy season (Le Thac Can et al. 2001).

Vietnam enjoys an extraordinary biodiversity, providing habitats for 109 large mammals (including many rare species), approximately 850 species of birds and between 9600 and 12000 plant species (Timmins & Duckworth 2001; Vo Quy 1995). This remarkably high diversity and distinct flora and fauna are owed to overlapping biogeographic realms (the Palaearctic Himalayan and Chinese sub-regions and the Indo-Malayan Sundaic sub-regions), along with relatively high variations in climate, soils and topography (ICEM 2003).

The coral reefs of Vietnam cover an area of 1122 m^2 (Burke et al. 2002). The 3000 islands belonging to Vietnam all contain a wide range of diversity and structure.

There are 5 main marine areas: the western Tonkin Gulf, middle-central, south-central, south-eastern and south-western Vietnam. The south-central area is the most diverse, containing more than 300 species of hard coral, belonging to 65 genera (country total: 350 species) (Chou et al. 2002). Most of the coral reefs in Vietnam are, however, under medium or high threat (96 %: (Burke et al. 2002). Major threats are attributed to overfishing, causing a decline in marine resources (50 % threatened); destructive fishing, including poison fishing for the live food fish and ornamental trades (over 85 % medium or highly threatened); coastal development (over 40 % at medium or high threat) (Burke et al. 2002), as well as damage caused by careless anchoring, crown-of-thorn starfish outbreaks and river runoff (Chou et al. 2002).

3.1.1 Van Phong Bay

Van Phong Bay is a large bay (45,000 ha) in southeast central Vietnam (roughly: 109° 10' E - 109° 26' E and 12° 26' N - 12° 48' N) (Figure 3.1), Khanh Hoa Province, which, as of 2006, provided for 1.3 million people; the majority are Kinh (dominant ethnic group in Vietnam) (Wikipedia 2008b). Fishing and aquaculture accounts for more than 75 % of the income of fisher households in this area (FAO 2008).

Figure 3.1. Google map of Van Phong Bay in Khanh Hoa Province, south-central Vietnam, showing the location of the study site (Whale Island Resort) and Hon Mun MPA (bottom left)

There are approximately 50 km^2 of islands in Van Phong Bay and roughly 9 different habitat classifications divided into: river mouth beds, mangrove, sand, mud, rock, dead coral, live coral, aquaculture ponds and salt beds (Van Dau 2002). In this region, the months from March through August have the most number of sunny hours (200 per month); November to February, the least (135 per month), with an average annual temperature of about 26℃ (Van Dau 2002). The rainy season lasts from August to January (70-80 % total annual rain), with rainy and cool north-easterly winds from October to February; hot and dry south-easterly winds from May to August. There is a mixed tidal regime, leaning towards diurnal tide (20 diurnal days/month), with an average amplitude of 1.25 m. Currents move south-easterly in summer and north-easterly in winter at approximately 20-40 cm/s.

Underwater visibility is lowest in the winter season and highest in summer, ranging from approximately 4-14 m (Van Dau 2002).

3.2 Marine Protected Areas in Vietnam

In 2000, the Minister of Fisheries (MOFI) was appointed to prepare a representative system of MPAs for Vietnam toward year 2010. A network of 15 national MPAs was approved by the Prime Minister to protect 2 % of the sea area of the country by 2010. The first MPA, Hon Mun Marine Protected Area, was declared in 2002. It is situated approximately 100 km south of the study site, in Khanh Hoa Province (Figure 3.1). This relatively small area (160 km^2), surrounding Hon Tre Island and several others, was chosen because it was considered to harbour the highest diversity of corals in Vietnam, as well as supporting high levels of biodiversity in a diverse array of coastal and marine habitats (Pomeroy et al. 2009). Vo et al. (2004) described a total of about 800 species of corals, fish, molluscs, echinoderms, crustaceans and macro algae. Van Nguyen and Phan (2008) conducted underwater visual census in the MPA and found a total of 266 species, belonging to 40 families in September-October 2005. The location was also interesting because of the great tourist expansion in the area (Tuan et al. 2002). The development of this pilot project MPA was monitored closely by Vietnamese and foreign specialists, performing environmental assessments and socio-economic analysis before final implementation. The aim was to use the knowledge gained as a model for the development of a number of MPAs over the following decade. In the same year, several more MPAs were declared, and in

2004, a total of 22 MPAs had been declared, with an additional 7 proposed, enclosing 11 % coral reefs. Only 8 % of these MPAs are however depicted as having good management (Tun et al. 2004).

3.3 Tourism

Vietnam has become a very attractive tourist destination in the last decade, increasing tourist numbers 3.7 fold from 1997 to 2007 (691,400 – 2,569,150) (GSO 2008), but rising only by approximately 1 % in 2008. Numbers increased mainly because of visitors from China, Singapore and Thailand (GSO 2009a). Nha Trang (population 300,000), in Khanh Hoa Province, 80 km south of the study site (Figure 3.1), is one of the most important vacation destinations in Vietnam. Provincial and municipal government officials and entrepreneurs view tourism in this area as a key economic development strategy, investing heavily in tourist accommodations and attractions. In three years (2001 - 2003), US$ 35,000,000 was invested in *Promoting the diversification of tourist products* and upgrading the standards of Khanh Hoa Province, especially Nha Trang and surroundings, by increasing public awareness, developing national character, protecting the environment and landscape, and building several 5-star hotels (Khanh Hoa Portal 2005). In 2004, the Khanh Hoa Provincial Government estimated another 10 % increase in visitors in 2005, up to 690,000 visitors (240,000 foreign visitors), with a future goal of attracting 1 million visitors (480,000 foreign visitors) in 2010. This goal was partially met earlier than expected. In 2008 tourist arrivals to Khanh Hoa Province were

1,597,228, of which 315,585 constituted foreign visitors, representing a 12 % increase in comparison to 2007 (Gasparotti & Nguyen 2009). According to the Khanh Hoa Tourist Department there were a total of approximately 400 accommodation facilities, including resorts and budget hotels, offering a total of 9,850 rooms in 2009. Another 882 rooms within four projects are scheduled to open by 2011, while an additional 15 other hotel/resort developments are planned or are in the early construction stage (Gasparotti & Nguyen 2009). Revenue from tourism in this area in 2005 was estimated to contribute to 36 % of the GDP. Total revenues in 2010 are estimated to be VND 500 billion (US$ 30,000,000). In 2004, 2870 people were employed in the tourist sector. Total employed is expected to increase 2.5 fold by 2010 (Khanh Hoa Portal 2005).

3.4 Fisheries

Fishing has a long history in Vietnam. Unlike many other Southeast Asian countries, however, capture fisheries in Vietnam is not easily classified into small scale/artisanal or commercial/large scale fishing. Engine sizes, hull length, distance from shore, depth when fishing, and gear deployed, all contribute to defining the type of fishing (Pomeroy et al. 2009). In government documents they are more commonly classified as nearshore and offshore. Nearshore fishing is classified to <30 m depth from shore for the Tonkin Gulf waters, East and South West waters and Thailand Bay; <50 m depth for the central coast (FIC 2008). Off-shore fishing vessels are defined as those equipped with >90 hp engines, and which are registered for operating offshore. If engine power is less or the vessel is not registered for fishing beyond the 30 or 50 m depth line, they also belong to the nearshore fisheries category (FIC 2008). Around 72 % of total mechanised vessels in Vietnam have less than 45 hp and 84 % have less than 90 hp. In 1990, over 90 % of the country's total catch came from the nearshore area (generally 4-5 nm from shore) (Han 2007; Nguyen Chu Hoi et al. 2006).

3.4.1 Legal framework and property rights

Management policies and development of marine capture fisheries have changed dramatically in the last 60 years, shifting from a small-scale industry to an export, production-oriented industry, which is a major part of the national economy. From 1945-1954, the government's policy was for a small-scale industry to supply local demand for seafood. During the following 20 years, while the country divided, the North developed state fishing enterprises, while, in the South, there was a policy for a more market-based industry through modernisation and mechanisation of the fleet. During the years Vietnam was working on reunification (1975-1985), there was continued collectivisation of the fishing industry and the government invested heavily to increase production and to modernise the fishing fleet through the establishment of fishing cooperatives and fishing companies. This change was, however, inefficient and did not meet planned quotas (FIC 2008; Ha Xuan Thong 1997; Pomeroy et al. 2009). In 1986, the "doi moi" (renewal) policy was adopted, aimed at liberalising trade and moving the country towards a market-oriented economy, changing traditional common property rights to a hybridization of property rights (Adger et al. 2001). The fisheries sector moved away from collective harvesting, processing and marketing to private fishing operations and a decrease in state subsidies. Fishing vessels and gear owned by the cooperatives were sold to private operators. These were allowed to sell fish in the free market, and from 1986 to the beginning of 2000, there was a rapid increase in production and an even larger increase in fishing effort, both inshore and offshore. Fisheries management was however given little attention (FIC 2008; Ha Xuan Thong 1997; Pomeroy et al. 2009).

The legal framework for marine capture fisheries management is a body of legislative texts, which has evolved over the last four decades. The first policy addressing fisheries management after the "doi moi", was written in 1987 – the Regulation on Management and Conservation of Marine Resources, which declared that all marine resources were under the control of the state. It also prohibited certain fishing gear and methods, capture of species of economic value, immature animals, or those ready to spawn (FIC 2008).

In 1989, the government promulgated the ordinance on the Conservation and Management of Living Aquatic Resources, which consisted of 27 articles, and sets out the general principals of conservation, development and management of living resources, and the role of the state therein (e.g. Total Allowable Catch – TAC, quotas to be determined by the MOFI, gear restrictions, mangrove clearing prohibition etc.) (FIC 2008).

In the following years, the government and the MOFI delivered a number of legal normative documents pertaining to the protection and development of fisheries resources, aiming at creating an integrated legal framework for sector management purposes. In 1991, the MOFI declared that any vessel, no matter what size or ownership, must be registered with the Department of Fisheries Resources Conservation. In 1992, lines and regions of fishery production was established, including the in-shore line (<50 m depth) (FIC 2008). In the mid 1990s there were reports of over-exploitation of nearshore resources, leading to a ban on the construction of vessels with less than 20 hp in 1997, with the aim of forcing inshore fishers to build larger vessels and fish offshore. This ban was, however, most often, not upheld (Ha Xuan Thong 1997). Loans were also offered in the late 1990s to fishers to fish offshore and in 1997, a 5-year tax-free period was offered for all offshore vessels. In February 1998, a directive banned illegal fishing methods, while resource protection was promoted (FIC 2008).

During the period 1985-2003, fisheries management activity in nearshore waters was limited, although management structures were in place. There was poorly reported, under-reported, illegal and unregulated catch in nearshore areas because of weak management and enforcement regimes, partly due to budgetary constraints of the provincial governments. The depressed state of the fisheries resources forced fishermen to use mesh sizes under legal limits and other techniques to ensure survival, which has resulted in a reduction of productivity and economic returns from fisheries (Nguyen Long 2003; Pomeroy et al. 2009).

The National Assembly approved the Fisheries Law in November 2003. It was administered by the Minister of Fisheries and is comprised of 10 chapters and 62 articles, including a number of new chapters compared with the 1989 ordinance. There are additionally a number of decisions, directives, regulations, decrees and circulars concerning the fisheries legal status. The Fisheries Resources Conservation Department and a system of 37 sub-departments in localities are responsible for policy promulgation, direct management, inspection and protection of the fisheries resources. Between 1997 and 2001, a range of decisions established Provincial Fisheries Departments in all coastal provinces. They are under the direction of the Provincial People's Committees and under the management of the MOFI (FAO 2008). These implement fisheries law, regulations, licensing and national fisheries policy at the provincial level. The Provincial People's Committee can make resolutions, decisions, standards and quotas on fisheries with the province, but not in conflict with the regulations of the Ministry. The law aims to provide for a stronger, more comprehensive, responsible and sustainable fisheries management base through ecosystem approaches and integrated management (Pomeroy et al. 2009). Fishery rules and regulations are, however, still limited to a modest number of gear size and type restrictions and are unfortunately seldom enforced due to budgetary constraints. Fishermen also have to keep a log of fishing operations, but these are, similarly, seldom maintained or controlled. Fishing licenses are imposed, but many fishermen ignore them (FAO 2008).

Vietnam fisheries is, therefore, nearly uniformly defined by an absence of defined property rights (Han 2007). From the 1990s, property rights have been vested in the state, partly in collective property rights and increasingly, rights have been allocated to individuals (Adger et al. 2001). The move towards effective privatisation of such resources is, however, enhancing the inequality in the distribution of income. This increases the heterogeneity within the resource user group and lessens the likelihood of co-operative management (Adger & Luttrell 2000).

3.4.2 Facts and figures

Seafood is the third major export product of Vietnam after textile-garments and crude oil. In 2004, Vietnam exported fisheries products to 80 different countries and territories. The main export markets for fishery products are: USA (35 %), Japan (26 %), China/Hong Kong (7 %) and Europe (6 %) (FAO 2008). The fisheries sector was estimated to contribute 4 % of the GDP in 2006 and employ approximately 3 million people. Around 10 % of the total population derived their main income directly or indirectly from fisheries. The increase in the population rate in fisheries communities is around 2.6 - 2.8 %, much higher than the national average (1.3 %), with an average fishery household of 6 - 7 people (FAO 2008). The educational level in the fishing communities is low: 68 % do not finish primary school, more than 20 % do not finish secondary school, about 10 % graduate from secondary schools and only 0.65 % have certificates or diplomas from vocational schools or universities (Nguyen Long 2002). The demand for fish and fish products is high in Vietnam. People consume on average 19.4 kg per year, which is more than half of their animal protein intake. Shrimp, squid and mackerel are the most favoured products (FAO 2008). Of the more than 1600 species of crustaceans, 2500 species of shellfish and 2000 species of fish, 130 fish species are commercially important, while the most important commercial species groups are: shrimp, tuna, squid, sea bream, snapper, grouper and small pelagics (FAO 2008).

The number of fishermen nearly doubled in Vietnam between 1990 and 2004, from 270,600 to 550,000, and the domestic fishing fleet capacity increased by a factor of 6.5 (with an average increase of 2300 small vessels (<45 hp) per year) (Lam 2005; Pomeroy et al. 2009). The most common fished areas are nearshore areas (<50 m depth), constituting 82 % of total national marine catch. Results from an assessment of marine fisheries resources in Vietnam shows that the maximum sustainable yield (582,212 tonnes/year) has been exceeded since 1986 (Nguyen Long 2002). Fisheries catch from 2008 was more than 2.1 million tonnes (GSO 2009b), indicating that most nearshore coastal regions of Vietnam are overexploited and fishing pressure is still increasing because of the annual increase of small fishing boats (Pomeroy et al. 2009; Stobutzki et al. 2006). In 1985, the average catch per horsepower was 1.11 tonne/hp but in 2000 it was only 0.45 tonne/hp, or 41 % of the 1985 figure. With a lower percentage of commercial fish, a higher percentage of trash fish in the catch and the smaller size of fish caught, the income per fishing trip is decreasing (Nguyen Long 2002). A number of factors have led to overexploitation of in-shore resources, including mesh sizes under legal limits, high levels of by-catch and incidental catch of small/juvenile fish, harmful fishing gear such as fixed nets, destructive fishing techniques, and trawling, which has damaged the seabed (Pomeroy et al. 2009).

3.4.3 Van Phong Bay fisheries

Four fishing villages are located close to the study site (Whale Island Resort: WIR) in Lach Cua Be Channel, formed by Hon Lon Island and the Dam Mon Peninsula in Van Phong Bay (Figures 3.1). According to Mr. Hung, the Chairman of the People's Committee for Khanh Hoa Province, Dam Mon is the largest village close to the resort, accommodating approximately 300 families (approximately 2000 people). Mr Hung informs that the fishing fleet comprises 50-60 vessels, which are all classed as nearshore fishing vessels, fishing within a maximum depth of 50 m (FIC 2008). Approximately half of these are large enough to fish outside the channel (15 NM distant). The small bamboo basket boats used for fishing close to home were not included in this estimate.

A wide range of fishing techniques are used, including trawling, purse seining, beach seining, hook and line, cast net fishing, trap fishing, as well as illegal and destructive methods such as bright light fishing (>2000 W), blast and cyanide fishing, hose and hook fishing and fishing with high volt electricity. The larger vessels, fishing the deeper waters outside the channel, target larger species, mainly tuna. Some of the fishing families target anchovy or squid at night using bright light fishing, but they all fish within the channel; the remainder are less selective and often use fish mesh sizes under legal limits (IUCN 2003b; Van Nguyen & Phan 2008; van Zwieten et al. 2002).

Observations made at the nearby Hon Mun MPA, show absence or low abundances of many larger target species, e.g. groupers, snappers and emperors, consistent with over-harvesting (Van Nguyen & Phan 2008), suggesting that similar conditions are likely to be found 100 km north of its location, in this similarly over-populated area. Because of a growing population overexploiting the nearshore resources, more and more fishermen are turning to lobster, fish or shrimp aquaculture (FAO 2008; Ministry of Fisheries and World Bank 2005). Aquaculture productions has grown tremendously over the last few years in Vietnam, even surpassing fishery landings in 2007; by the end of 2008 aquaculture production was even 15 % higher than fish catches, providing 4.6 million tonnes seafood (GSO 2009b). Aquaculture activity in Van Phong Bay is becoming particularly important during the winter months when fishing is restricted by weather conditions. The aquaculture families are, however, still relatively poor, so they use trash fish as feed, supplemented with low value shellfish. This increases the risk of transmission of diseases, which is why they add large amounts of antibiotics. This combination increases nutrification significantly, creating further imbalance and harm to the ecosystem (IUCN 2003b).

3.5 Whale Island Resort

Whale Island Resort (WIR) is a Hotel Managed Marine Reserve (HMMR), located on a small island, Hon Ong (approx. 100 ha) in Van Phong Bay, Khanh Hoa Province, south-central Vietnam, 80 km north of Nha Trang (Figures 3.1 and 3.2).

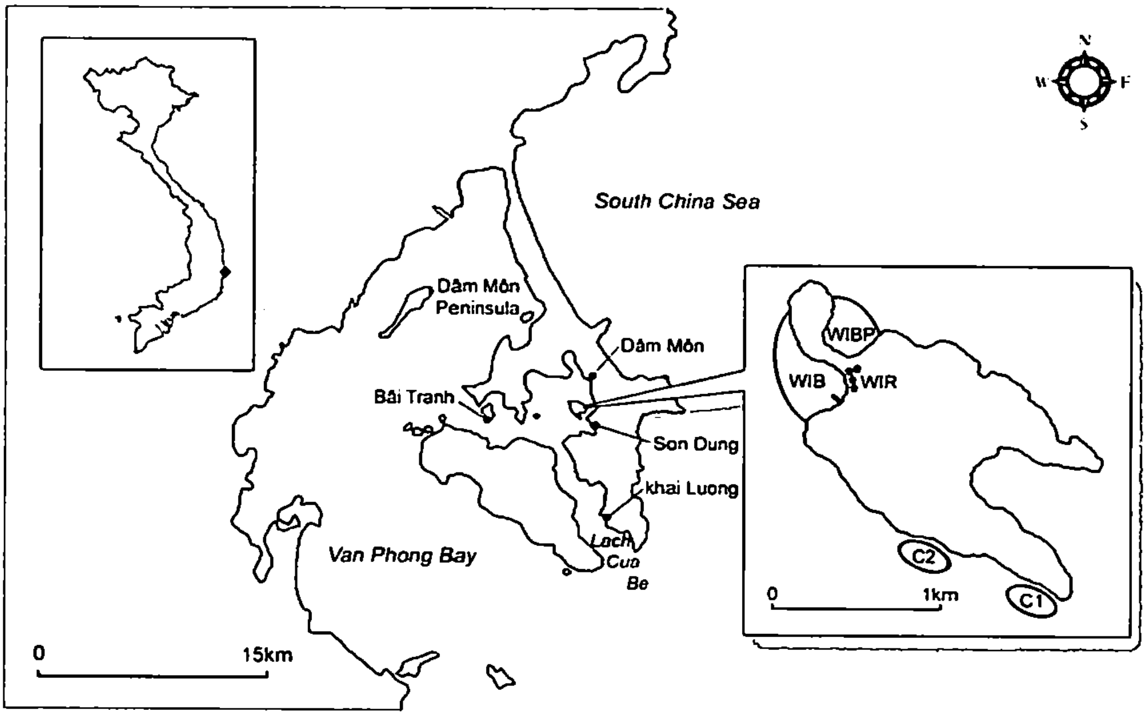

Figure 3.2. Map showing Hon Ong Island, its reserves (Whale Island Bay reserve: WIB & Whale Island Bay Peninsula reserve: WIBP), Control sites (C1 & C2) and surrounding villages, located in Van Phong Bay, Khanh Hoa Province, south-central Vietnam

There are 32 bamboo-built bungalows nested into the island accommodating a maximum of 70 guests (Figure 3.3). The average length of stay is 3 nights and the average yearly occupancy is 60 %. The majority of guests are tourists, who are either travelling independently, or with organised tours; a small percentage are businessmen.

Figure 3.3. Picture of part of Whale Island Resort, including the outer marker buoys for Whale Island Bay reserve (WIB)

3.5.1 Resort eco-friendliness and conservation projects

The resort is eco-friendly albeit not certified; the only pollution it generates is from the ferry, transporting guests and supplies to and from the mainland, in addition to the daily diving and snorkelling boats. Effluent is recycled in a septic tank and used to irrigate local plant species and inorganic waste is collected daily from the beach and rooms and burnt in a specially constructed high-heat furnace. Pamphlets are provided in the bungalows describing proper behaviour towards the local marine and terrestrial environment. A couple of security guards, who double as reserve wardens, provide for safety during the day and fend off poachers during the night. Hiking trails have been hewn into the countryside for guest safety and in order to decrease damage and erosion. Several clusters of artificial reefs, constructed out of clay pots, have been deployed at approximately 4 m depth, to serve as substrate for their coral transplantation project, while creating habitat complexity for fish, increasing fish assemblages. Broken off pieces of coral from the reef damaged locations are placed on these surfaces to facilitate growth. Fish Aggregating Devices (FADs) have also been constructed, made from cut-up strips of netting, bound together, fastened to buoys and anchored to the sea floor at 9 m depth, attracting schools of fish, including larger species, such as Snapper (Lutjanidae), Jacks (Carangidae) and Barracuda (Sphyraenidae) (Appendix 2). The manager ensures that the vast majority of food and drink is purchased from local vendors. The resort employs approximately 45 staff; the majority of whom reside in the nearby village of Dam Mon, or they come from other villages in the vicinity.

3.5.2 HMMR establishment

The resort was established in 1997 when the fishing population of the largest nearby village, Dam Mon, was relatively small. The resort owners became increasingly concerned when they noticed a decline in fish and coral populations. They believed that the decline was mainly caused by overfishing and destructive fishing techniques, such as blast and cyanide fishing, and hose and hook fishing. This was compounded by rubbish dumping and pollution from an increasing number of fishing vessels and people in Dam Mon and nearby villages. The owners, therefore, decided they would try to protect a small area of the coastline. They maintain that they informed their staff and asked them to spread the suggestion to their local fishing families and others. When there were no negative responses, they leased a larger area from the authorities of Khanh Hoa Province, which took the form of a 10-year contract, and included the coastal seas up to 600 m from the resort. The adjacent bay (<600 m) was marked by the local coast guard and enclosed with buoys in 2001 to mark the no-take zone, and the 11 ha HMMR (Whale Island Bay reserve - WIB), was thus created. Since WIB seemed to be increasing fish stocks, the owners decided to enclose another bay on the other side of the peninsula in August 2005, creating a 5 ha marine reserve (Whale Island Bay Peninsula reserve - WIBP) (Figure 3.4). The owners conclude that the yearly costs of maintaining the reserves are relatively low; the marine portion of the lease, the reserve wardens, material, repair and maintenance cost less than US$ 10,000 per year; no reserve user fees are collected.

Figure 3.4. Picture of part of Whale Island Bay Peninsula (WIBP: left) and Whale Island Bay (WIB), Hon Ong Island, south-central Vietnam

3.5.3 HMMR enforcement and poaching

Although the owners report no initial complaints about creating WIB, it became evident that the enclosures were not accepted by the fishermen of Dam Mon for the first couple of years, resulting in frequent poaching. On these occasions, the managers affirm contacting the local coast guard on a regular basis to deliver verbal warnings or to confiscate fishing gear from regular offenders. They maintain that poaching efforts gradually abated and suggest that today, non-compliance is rare at WIB, while the frequency of fishermen "fishing the line" (fishing just outside the marked buoys) during the night is relatively high (2-3 times per week). The owners and managers indicate that poaching is more common in WIBP (approximately every two weeks), where night patrols by the reserve wardens are less frequent. From personally observed occurrences during the night, it seems that when fishing within the reserves, traditional line and hook fishing is generally used, but when "fishing the line", more extractive net fishing is employed.

3.5.4 HMMR future

There are plans to build an international trans-shipment seaport in Van Phong Bay. Although several environmental assessments in favour of building the port have failed, it is foreseen that a 400 ha site will be finalised by 2020. Initial construction was originally set for 25th January 2008, but this was postponed pending further inquiries. Van Phong Bay is relatively close to international sea lanes to Europe, north Asia, Australia, Southeast Asia and north Asia. The average depth (20-22 m) of the 45,000 ha bay and the 6 km wide navigational passage are considered ideal for port accessibility. The port is part of a broader plan to develop Van Phong into an economic zone in central Vietnam, which is suggested to focus on such fields as tourism, services, industry, aquaculture and others. The Economic Zone is estimated to cover an area of 150,000 ha, encompassing several provinces (Ha 2008; Thanhnien News 2008; VietnamBusinessFinance 2008).

Due to these future developing plans, the owners of WIR were only able to lease the Island and surrounding seas for one year in 2008 and 2009 and may well be forced to abandon their hotel in coming years.

3.6 Summary

Whale Island Resort is an excellent choice of study site for this thesis. The owners and staff are environmentally conscious and concerned and it has two reserves. One of these was established only 2 months before the first surveys were carried out, approximating pre-enclosure conditions, ideal to test the potential increase in fish stocks following protection.

Five related research studies have been conducted and are compiled in this thesis. Four of these are specific to the study site of Whale Island Resort, Vietnam; the fifth study has a global dimension to it. The first study is associated with the effectiveness of the two HMMRs (WIB and WIBP) at increasing the diversity, size and density of fish within the reserves (Chapter 4). These parameters are compared with two unprotected Control sites (C1 & C2), which have similar environmental characteristics (Figure 3.2). The second study concentrates on WIB's effectiveness at increasing fish stocks through deployment of 5 Artificial Reefs (ARs) (Chapter 5). The third study focuses on the perceptions of local fishermen from Dam Mon (largest village adjacent to WIR) towards the marine reserves (Chapter 6); the fourth study conducted at WIR explores the tourists'

Willingness to Pay (WTP) extra to stay at HMMRs (Chapter 7). The fifth study reviews the status of existing HMMRs worldwide (Chapter 8)

The studies carried out in Chapters 4 and 5 (biological effectiveness) were conducted with the underwater visual census method. Data for the studies in Chapters 6, 7 and 8 were collected through questionnaires. Details of these studies and descriptions of methods employed are provided in the main analytical chapters that follow.

4. The effectiveness of Whale Island Resort's marine reserves at increasing fish stocks

Contents of this chapter were used to write:

Svensson, P., L. D. Rodwell, and M. J. Attrill. 2009. Privately managed marine reserves as a mechanism for the conservation of coral reef ecosystems: a case study from Vietnam. Ambio **38**:72-78

4.1 Introduction

Coral reef ecosystems are important for the sustainable development of many tropical coastal countries, providing food, minerals and income to local fisheries whilst also offering natural protection against wave erosion (Spalding et al. 2001). These ecosystems are, however, highly threatened today, despite a growing number of Marine Protected Areas (MPAs) established over the last three decades, with proven success at increasing species richness, biomass and biodiversity (Dayton et al. 2000; Russ & Alcala 1998). Bryant et al. (1998) found that the coral reefs of Southeast Asia are the most threatened (80 %), mainly attributable to coastal development and fishing-related pressures.

To address this threat, and to reduce loss of biodiversity, the need for more MPAs has therefore been recognised in recent years. At the World Summit on Sustainable Development (Johannesburg 2002), and later at the World Parks Congress (Durban, September 2003), representatives of protected areas recommended networks of marine reserves covering 20-30 % of habitats by 2012 (IUCN 2003a). Countries have acknowledged the dire consequences of losing coral reef ecosystems and the worldwide response has been to create each year for the last decade approximately 40 MPAs which include coral reefs, thus covering 18.7 % of the world's coral reef habitats (Mora et al. 2006). In 2002, 646 MPAs had been declared in Southeast Asia; however, only 8 % of the countries' reef area is covered (Burke et al. 2002). Unfortunately, a large majority of MPAs in Southeast Asia and worldwide is reported as failing because they have not met their objectives, have been listed as marine reserves but not succeeded in implementing management, have failed, or lie dormant at one of the subsequent development stages (McClanahan 1999). The major barrier to successfully managed reserves has been attributed to the inability to secure adequate long-term funding for management costs (Dharmaratne et al. 2000), resulting in inadequate law-enforcement (Depondt & Green 2006). In a worldwide study of MPAs, only 15.7 % of respondents reported funding levels to be sufficient for effective conservation (Balmford et al. 2004).

The private sector, bolstered by tourism, could offer a major source of revenue allowing MPAs to become self-financing, establishing a truly successful and economically sustainable MPA, especially in developing countries (Davis & Tisdell 1996; Dharmaratne et al. 2000). The Durban Action Plan (from the World Parks Congress 2003) also called on the private sector to "financially support the strategic expansion of the global network of protected areas" and states that tourism can provide economic benefits, opportunities for communities, create awareness and greater knowledge of our natural heritage (IUCN 2003a).

Private parks on land are well-known and have been accepted as conservation areas for over half a century (Langholz & Lassoie 2001), with several large private parks existing in South America and Africa, some covering over 100,000 ha (Langholz et al. 2000). While little is still known about the effectiveness of such private parks at protecting and allowing for growth of plants and animals, they are still expanding rapidly and number in the thousands, protecting several million hectares of biologically important habitat (PRN 2007). Privately managed MPAs, on the other hand, are not well known, despite the private sector's growing involvement, and reported higher influence in protected area decision making, especially in developing countries (Dearden et al. 2005). Privately managed MPAs are still widely undocumented and insufficiently researched, but similar to terrestrial private parks, they are believed to have been initiated because of the same three reasons: government failure to satisfy public demand for nature conservation (both quality and quantity), growing societal interest in biodiversity conservation and the rapidly expanding ecotourism industry (Langholz & Lassoie 2001; Riedmiller 1999).

It is traditionally understood that in private-community ecotourism joint ventures, the private sector provides capital, business, marketing experience and clients; the local communities provide the location and local knowledge, while the local government or Non-Government Organisation (NGO) should mediate between the two, as well as provide basic infrastructure and other necessities (Kiss 2004). It is, however, a general misconception that submerged lands cannot be owned or leased by private enterprises (Beck et al. 2004). In researching the coastal states surrounding the United States of America, Slade et al. (1997) found that nearly one third of submerged lands were owned or leased by the private sector, developing marinas, private docks, fisheries, aquaculture or other ventures. US states, in which ownership of submerged lands is possible, include Florida and Hawaii (Beck et al. 2004) - tropical states which include coral reef systems. Leasing submerged lands as a tool for marine conservation has, however, rarely been applied, even though the costs of leasing such areas are generally orders of magnitude lower than equivalent schemes in the terrestrial environment. It is, for example, possible to lease up to half of California's kelp forests, as well as sponge and soft coral habitats in Florida (Beck et al. 2004).

A growing number of hotels and dive resorts are discovering the leasing potential of adjacent coastal areas with or without external stakeholders. The Navini Island Resort, Fiji, has taken advantage of the customary South Pacific practice of owned, limited access areas of the sea and its resources, so called *tabu* areas, by leasing the sea around the Island up to a depth of 30 m. A monthly fee is paid to the owners, who enforce fishing restrictions, and in return, the hotel agrees to follow the *tabu*, which prohibits any damaging of the coral reef ecosystem or extraction of its resources (Arthur Reed, resort manager, pers. comm.; Tuxson 2005).

In other cases, resorts which have the financial backing, resources and economic incentive, have taken over the day-to-day management of an MPA. These are termed "entrepreneurial MPAs", where the MPA is officially designated, but resources are lacking to effectively manage the reserve (Colwell 1999). Some private no-take zones are also precursors to public protection, which could be viewed as money saved by the government for areas that may otherwise have needed protection (Langholz & Lassoie 2001). The protected zone adjacent to Lankayan Island Dive Resort, Sabah, Malaysia, which turned into Sugud Islands Marine Conservation Area (SIMCA), is such an example (Teh et al. 2007). The number of officially recognised privately managed MPAs is still small, but there are reported successes, such as the Chumbe Island Coral Park (CHICOP), which possibly also represents the first fully functioning MPA in Tanzania (Riedmiller 1999).

There is growing literature showing that MPAs can effectively increase diversity, density and biomass of organisms within protected boundaries, irrespective of the size of the MPA (Halpern 2003), as well as enhancing fishing yields in the surrounding fished areas through the process of 'spillover' of fish from the MPA (McClanahan & Mangi 2000; Mora & Sale 2002; Samoilys et al. 2007). The biological effectiveness of privately or hotel managed MPAs (Hotel Managed Marine Reserves: HMMRs), have, however, not yet been adequately researched.

In light of the high financial costs of establishing and maintaining protected areas, this paper examines an alternative approach to protecting at least a part of the 20-30 % of the world's seas through private management. HMMRs may offer a solution to the increasing need for marine conservation by assuming responsibility for protecting adjacent marine environments, yet also safeguarding the hotels' future through reputation and return guests. The future of local communities may also be sustained, by ensuring direct and indirect jobs from tourism activities and growth, and by providing spillover from increasing the standing fish stocks in the reserves.

In this chapter, the effectiveness of Whale Island Resort's marine reserves are researched, in terms of their capacity to increase coral reef fish density, diversity and size. The findings of this local study are analysed and extrapolated to consider potential global possibilities.

4.2 Study site and methods

A detailed description of the study site can be found in Chapter 3. The surveyed areas include the 11 ha Whale Island Bay reserve (WIB), the 150 m distant 5 ha Whale Island Bay Peninsula reserve (WIBP), and two Control sites (C1 and C2), which have similar exposure, slope and morphologic characteristics, located 800 m along the coast, southeast from WIB and 350 m apart (Figure 4.1). As exact geographical control replicates were not possible, the manta tow technique (English 1997) - effective at assessing a large area relatively quickly, was used to choose control sites, which were as close a fit to conditions of the HMMRs as feasible, with regards to beach slope gradient and benthic structure. As natural differences between locations are likely to exist, this study focused on relative change over time at our four sites, rather than absolute comparisons of fish communities. The first survey was conducted in October 2005, two months after WIBP was enclosed, thus approximating pre-protection conditions for that reserve. The following three surveys were conducted every six months during a 3-week period, each time in April and October, with the last survey conducted in April 2007; two seasons were therefore assessed over two years.

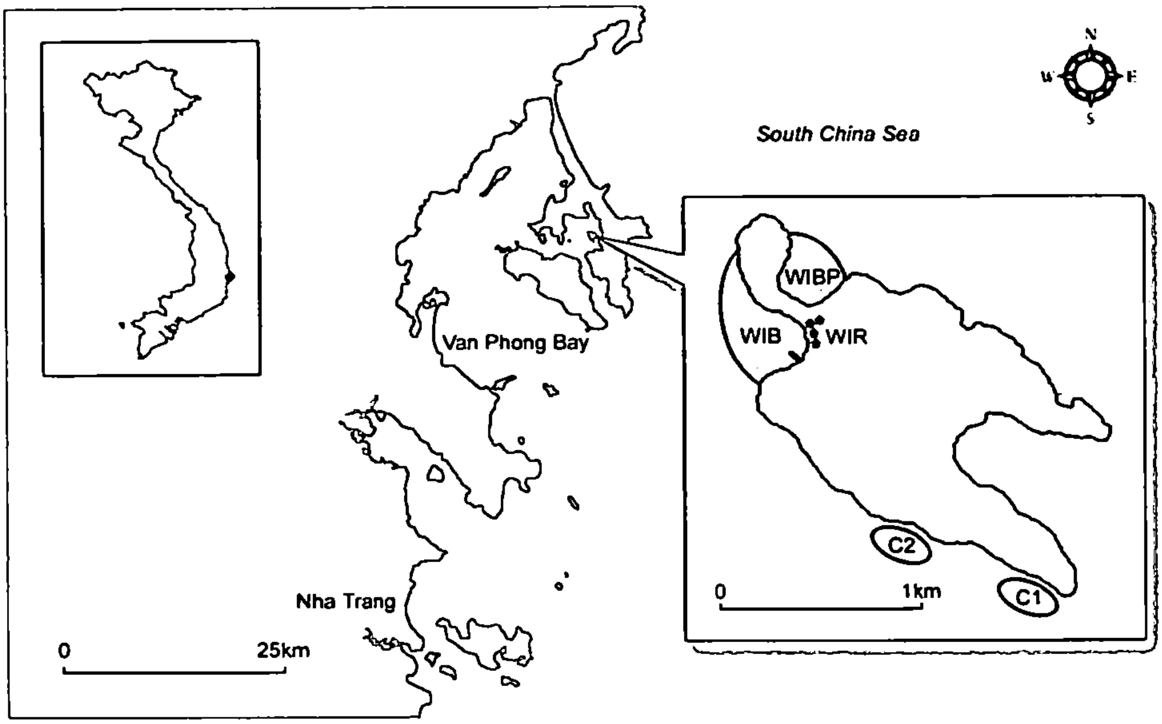

Figure 4.1. Illustration of study area showing Whale Island Resort (WIR), the 11 ha Whale Island Bay reserve (WIB) and the 5 ha Whale Island Bay Peninsula reserve (WIBP), plus the locations of the two Control sites (C1 & C2) on Hon Ong (Whale Island), in Van Phong Bay, Khanh Hoa Province, Vietnam

During all four survey visits (October 2005 – April 2007), replicates of four 50 m transects were surveyed at 3 m and 9 m depth at each of the four survey sites (WIB, WIBP, CI & C2), using the visual fish census method described by English et al. (1997), where the diver swims at a constant speed above the transect and identifies and counts individual fish and records their size and distance from the transect. The same transect line was used to survey the benthos using line intercept transect over 20 m. Here, the benthic habitat and its length is recorded. Instead of only including fish within a set perpendicular boundary to the transects, variable distance counting was used to calculate the area (and thereby density) (Labrosse et al. 2002). The whole fish community was identified to species where possible, but excluded cardinalfish (Apogonidae), lizardfish (Synodontidae) and the bottom-dwelling species such as the gobies (Gobiidae) and blennies (Blenniidae) (Figure 4.2, Appendix 2) because their cryptic lifestyles made accurate enumeration difficult. The number of individual fish per species, their estimated size and distance from the transects was recorded. To increase accuracy in length estimations, I arranged and estimated Polyvinyl Chloride (PVC) fish-models (7 - 49 cm) along a 50 m line, while snorkelling at a constant pace. This exercise was repeated with varying configurations and distance from the observer before each survey visit, until 95 % accuracy was achieved.

I analyzed fish density, species richness, average size of fish and number of fish >15 cm using a 3-way Analysis of Variance (ANOVA) model with site, habitat and time as factors; benthos cover (i.e. composition of benthic habitat) was analyzed with a 2-way ANOVA, for site and time. I checked for ANOVA assumptions using Cochran's test and transformed where necessary; Student-Newman-Keuls tests (SNK) further investigated the significant interactions between factors. All ANOVA analyses were undertaken using GMAV5 for Windows. To explore differences in fish assemblage composition between times and sites, hierarchical agglomerative cluster analysis was conducted to produce a dendogram using PRIMER5 software on a similarity matrix (Bray-Curtis similarity index), calculated from square-root transformed species abundance data (Clarke & Gorley 2001). Significance tests for differences between site and time were performed using Analysis of Similarity (ANOSIM) and the fish families contributing most to dissimilarities were determined by the similarities percentage procedure SIMPER (Clarke 1993).

4.3 Results

Over the four visual census surveys, 242 species of fish from 35 different families were identified; 195 species were observed in WIB reserve, 138 in WIBP reserve, while 107 and 87 species were recorded at C1 and C2 respectively. A full list of identified fish species can be found in Appendix 1. Over all sites and survey periods, average species richness and average size of fish were higher at the 3 m sites compared with the 9 m sites (SNK, $p<0.01$), as were densities of fish and average number of fish >15 cm (SNK, $p<0.05$) (Tables 4.1 & 4.2).

Table 4.1. A biannual breakdown of fish species richness, density (m^{-2}), number of fish >15 cm and average size of fish (cm) (with SE) found at the 3 m rocky habitats for Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP) and Control sites (C1 & C2)

		Species richness	Density (m^{-2})	No. fish >15 cm	Ave. size (cm)
WIB	October 05	35.75 +/- 2.11	1.41 +/- 0.30	60.00 +/- 23.77	9.77 +/- 2.11
	April 06	45.50 +/- 1.89	2.57 +/- 0.44	121.00 +/- 49.31	10.28 +/- 1.52
	October 06	46.00 +/- 2.09	3.17 +/- 0.79	108.75 +/- 32.07	8.95 +/- 0.71
	April 07	54.75 +/- 0.41	2.53 +/- 0.25	195.75 +/- 37.57	10.17 +/- 0.92
	Total	**45.50 +/- 1.60**	**2.42 +/- 0.44**	**121.38 +/- 35.68**	**9.79 +/- 1.31**
WIBP	October 05	18.75 +/- 2.16	0.76 +/- 0.06	3.50 +/- 1.50	6.36 +/- 0.34
	April 06	29.50 +/- 4.62	1.58 +/- 0.28	48.75 +/- 27.85	8.43 +/- 1.07
	October 06	27.25 +/- 2.16	1.59 +/- 0.27	44.50 +/- 20.51	9.17 +/- 0.25
	April 07	24.75 +/- 0.41	1.81 +/- 0.41	61.25 +/- 34.30	8.58 +/- 0.49
	Total	**25.06 +/- 2.34**	**1.44 +/- 0.26**	**39.50 +/- 21.04**	**8.14 +/- 0.54**
C1	October 05	18.25 +/- 2.48	0.54 +/- 0.10	0.00 +/- 0.00	5.08 +/- 0.88
	April 06	27.00 +/- 1.73	0.94 +/- 0.12	11.25 +/- 2.95	7.66 +/- 0.49
	October 06	27.25 +/- 2.16	0.86 +/- 0.10	7.50 +/- 12.42	7.37 +/- 0.24
	April 07	26.75 +/- 2.04	0.76 +/- 0.06	25.25 +/- 30.52	9.64 +/- 0.86
	Total	**23.19 +/- 2.48**	**0.77 +/- 0.10**	**11.00 +/- 11.47**	**7.44 +/- 0.62**
C2	October 05	14.75 +/- 1.85	0.33 +/- 0.10	0.75 +/- 1.30	6.64 +/- 0.40
	April 06	26.25 +/- 2.46	0.96 +/- 0.08	10.50 +/- 8.87	7.79 +/- 0.60
	October 06	14.00 +/- 0.94	0.54 +/- 0.04	3.50 +/- 4.09	7.94 +/- 0.32
	April 07	20.25 +/- 2.65	0.65 +/- 0.15	14.75 +/- 9.78	8.60 +/- 0.93
	Total	**18.81 +/- 1.97**	**0.62 +/- 0.09**	**7.38 +/- 6.01**	**7.75 +/- 0.56**
Total averages		**28.12 +/- 2.10**	**1.31+/- 0.22**	**44.81 +/- 18.55**	**8.28 +/- 0.76**

Table 4.2. A biannual breakdown of fish species richness, density (m^{-2}), number of fish >15 cm and average size of fish (with SE) found at the 9 m sandy habitats for Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP) and Control sites (C1 & C2)

		Species richness	Density (m^{-2}),	No. fish >15 cm	Ave. size (cm)
WIB	October 05	9.75 +/- 2.30	0.16 +/- 0.02	7.00 +/- 5.61	7.77 +/- 1.69
	April 06	13.63 +/- 4.69	0.27 +/- 0.03	22.25 +/- 13.61	13.63 +/- 4.69
	October 06	16.00 +/- 4.62	0.38 +/- 0.10	30.00 +/- 28.96	10.55 +/- 1.82
	April 07	11.00 +/- 2.15	0.69 +/- 0.26	44.24 +/- 46.22	12.69 +/- 3.89
	Total	**12.25 +/- 2.69**	**0.37 +/- 0.10**	**25.88 +/- 23.60**	**11.16 +/- 3.02**
WIBP	October 05	3.75 +/- 0.65	0.08 +/- 0.03	0.25 +/- 0.43	3.94 +/- 0.67
	April 06	3.50 +/- 0.43	0.38 +/- 0.14	0.50 +/- 0.50	2.41 +/- 0.19
	October 06	3.25 +/- 1.14	0.20 +/- 0.10	29.33 +/- 35.69	7.67 +/- 2.41
	April 07	7.25 +/- 1.29	0.81 +/- 0.24	2.00 +/- 1.41	3.20 +/- 0.19
	Total	**4.44 +/- 0.88**	**0.37 +/- 0.13**	**8.02 +/- 9.51**	**4.30 +/- 0.86**
C1	October 05	3.75 +/- 0.74	0.07 +/- 0.02	0.00 +/- 0.00	5.24 +/- 1.82
	April 06	4.25 +/- 0.74	0.27 +/- 0.14	1.00 +/- 0.71	4.58 +/- 0.93
	October 06	10.00 +/- 2.03	0.16 +/- 0.02	2.00 +/- 3.46	8.12 +/- 1.06
	April 07	8.00 +/- 1.22	1.10 +/- 0.14	4.00 +/- 3.32	4.20 +/- 0.59
	Total	**6.50 +/- 1.18**	**0.40 +/- 0.08**	**1.75 +/- 1.87**	**5.54 +/- 1.10**
C2	October 05	0.75 +/- 0.22	0.01 +/- 0.00	0.00 +/- 0.00	2.67 +/- 0.79
	April 06	4.25 +/- 0.74	0.10 +/- 0.02	0.00 +/- 0.00	2.93 +/- 0.34
	October 06	2.50 +/- 0.56	0.15 +/- 0.03	1.00 +/- 0.71	4.26 +/- 0.81
	April 07	4.25 +/- 0.41	0.62 +/- 0.20	1.00 +/- 1.22	2.63 +/- 0.12
	Total	**2.38 +/- 0.45**	**0.22 +/- 0.07**	**0.50 +/- 0.48**	**3.12 +/- 0.52**
Total averages		**6.39 +/- 1.30**	**0.34 +/- 0.09**	**9.04 +/- 8.87**	**6.03 +/- 1.38**

At 3 m, the sea floor is scattered with a higher rocky substratum cover ($F=29.05$, $p=0.013$) relative to surveys conducted at 9 m, where substratum consisted mainly of sand (average 98.1 %), but no significant differences in overall benthic structure were found between WIB, WIBP, C1 or C2 ($F=1.10$, $p=0.368$). Coral cover, on the other hand, was significantly higher at WIB compared with the Control sites and WIBP (SNK, $p<0.01$), though no significant differences were evident between the controls and WIBP. Live coral cover is, however, comparatively poor at each location, equalling 7 % at WIB rocky habitat and less than 1 % at the other three rocky locations, as well as at all surveys conducted at 9 m (Table 4.3).

Table 4.3. A breakdown of coral and rock cover (with SE) across the surveyed locations: Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP) and Control sites (C1 & C2) at the 3 m Rocky (R) habitats and 9 m Sandy (S) habitats

	Coral cover (%)	SE	Rocky cover (%)	SE
WIB R	7.00	0.56	6.86	0.79
WIB S	0.34	0.07	0.78	0.27
WIBP R	0.08	0.02	4.05	0.87
WIBP S	0.56	0.08	0.41	0.14
C1 R	0.98	0.16	14.84	1.90
C1 S	0.07	0.02	1.09	0.22
C2 R	0.26	0.04	10.27	0.96
C2 S	0.16	0.05	0.00	0.00

ANOSIM tests confirmed that the fish assemblages between the 9 m sandy habitats and the 3 m rocky habitats were significantly different (Global R=0.745, Global P=0.001). The families contributing most to the dissimilarity between habitats were the Pomacentridae, Nemipteridae and Labridae (Table 4.4, Appendix 2). The dendogram (Figure 4.2) illustrates these findings and additionally shows a higher level of similarity between rocky sites. For both the sandy and rocky habitats, closest similarities were observed between the two Control sites and WIBP (approximately 70 % for rocky habitats and 55 % for sandy habitats). Although 35 families were observed, the vast majority of fish found at all sites belong to the damselfish family (Pomacentridae, 56-68 %), followed by bream (Nemipteridae, 12-17 %) and wrasse (Labridae, 6-12 %). The larger predator species, jacks (Carangidae), barracuda (Sphyraenidae) and milkfish (Chanidae) (Appendix 2) were, however, exclusively found in WIB and WIBP.

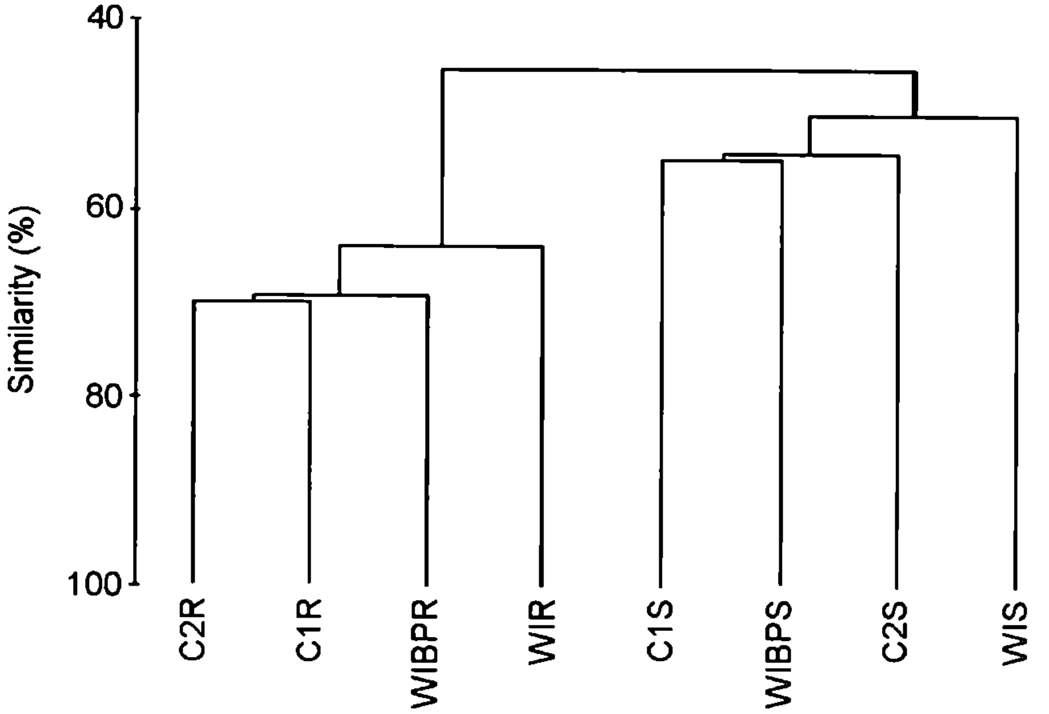

Figure 4.2. Dendogram illustrating similarities in fish assemblages between Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP), and two Control sites (C1 & C2), for surveys conducted biannually between October 2005 and April 2007 at Whale Island Resort, Hon Ong, Vietnam. Habitats: Rock (R) and Sand (S)

A more detailed account of the similarities in fish assemblages within each habitat are shown in Figures 4.3 & 4.4. These again highlight the stronger similarity of fish assemblages at the rocky habitats, but also the tightly separated grouping for fish communities found in WIB. After the first survey in October 2005, where WIBP fish assemblages were very similar to those found at C1 and also, but to a lesser degree, C2, the fish assemblages developed to create their own separate community. The fish communities of C1 and C2 seem to be more interlinked. A near to comparable compact cluster was also found at the sandy habitats for WIB, while another similarity group was formed by the three remaining sites. The 9 m surveys conducted in October 2005 at C2 revealed only one species with low densities (*Amblypomacentrus clarus*), explaining this site's high dissimilarity with other sites.

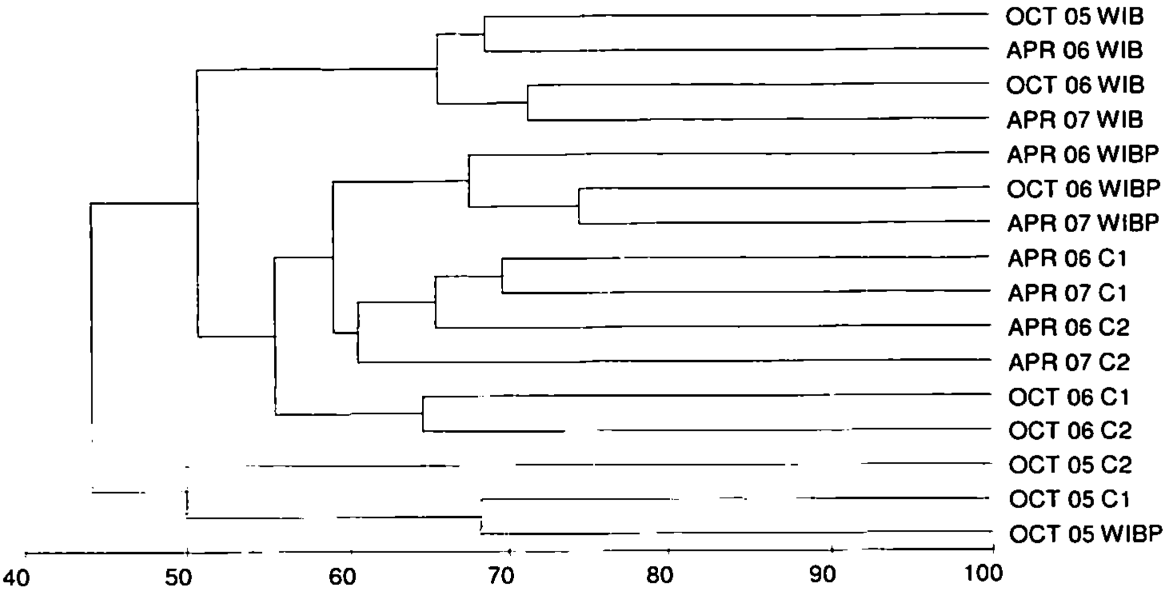

Figure 4.3. Dendogram illustrating similarities (%) in fish assemblages for 3 m rocky habitats between Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP), and two Control sites (C1 & C2), for surveys conducted biannually between October 2005 and April 2007 at Whale Island Resort, Hon Ong, Vietnam

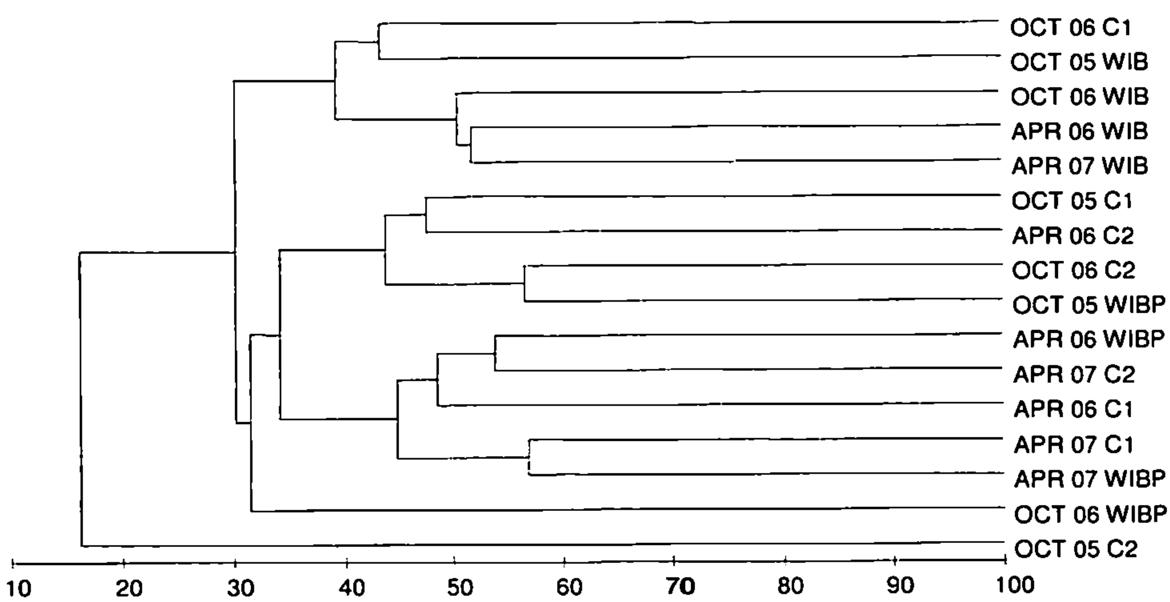

Figure 4.4. Dendogram illustrating similarities (%) in fish assemblages for 9 m sandy habitats between Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP), and two Control sites (C1 & C2), for surveys conducted biannually between October 2005 and April 2007 at Whale Island Resort, Hon Ong, Vietnam

The differences in fish assemblages between sites across all survey periods can be visualised from the Multidimensional Scaling Ordination (MDS), whereby the nearer the points are to each other, the more similar are the assemblages at those sites and times (Figure 4.5). A strongly clustered and a slightly less clustered group can be observed, although without any obvious pattern, suggesting similar fish assemblages can be found at each location when the different habitats are not considered individually at each site.

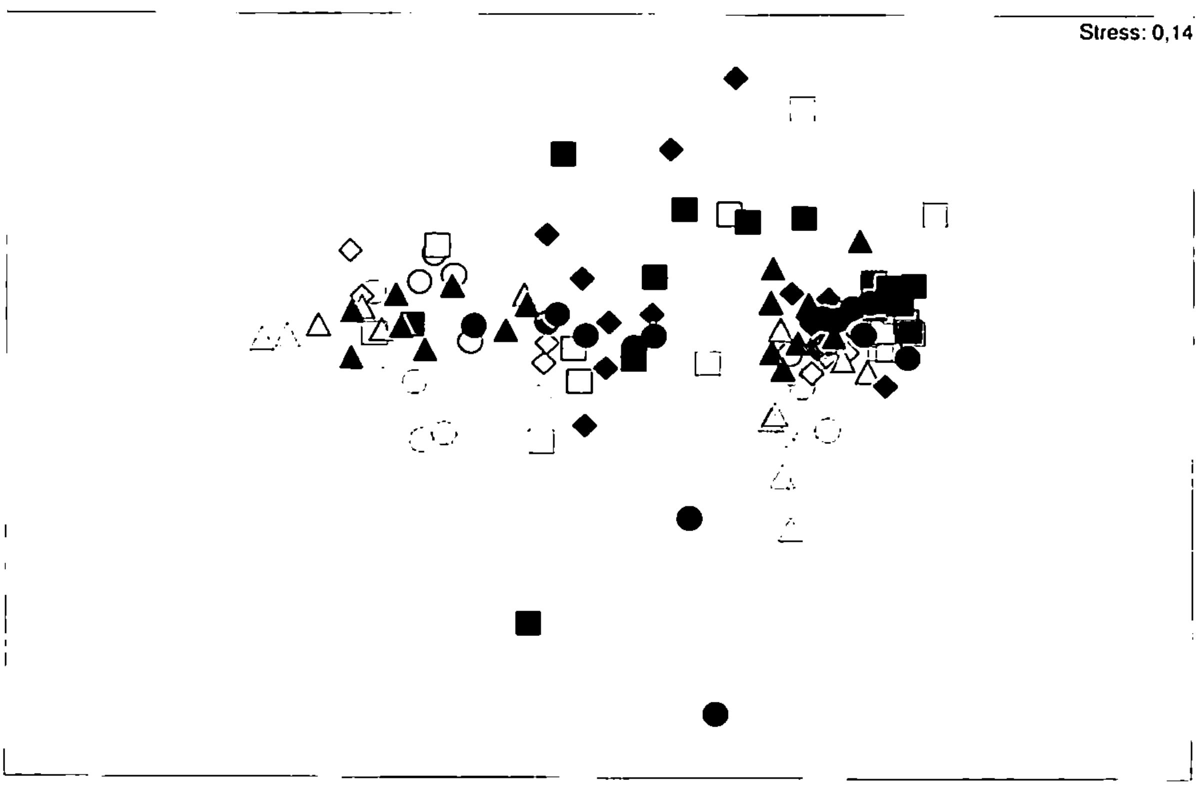

Figure 4.5. A Multidimensional Scaling Ordination (MDS) showing the similarities in fish assemblages (square root transformed) between WIB (squares), WIBP (circles), C1 (diamonds) and C2 (pyramids) for surveys conducted biannually between October 2005 and April 2007 (white to black shading) at Whale Island Bay, Hon Ong, Vietnam

WIB contained significantly higher species richness, density, average size of fish and number of fish >15 cm (SNK, $p<0.01$), compared with C1, C2 and WIBP over all survey visits (Tables 4.1 & 4.2, Figure 4.7). The abundance of butterflyfish (Chaetodontidae), which has been used as an indicator species for healthy reefs (Dickson 2006), were also significantly higher at WIB (one-factor ANOVA, $F=15.404$, $p<0.001$) (Figure 4.6).

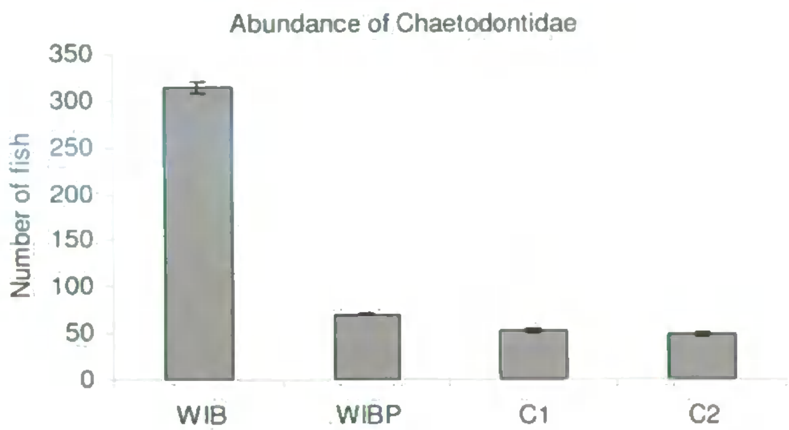

Figure 4.6. The abundance of butterflyfish (Chaetodontidae) found over all survey periods at Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP) and the two Control sites (C1 & C2) (with SE)

While there were no significant differences between survey periods for species richness and average size, significantly higher values were found in the latter two surveys compared with October 2005 for density (SNK, $p<0.01$) and number of fish >15 cm (SNK, $p<0.05$), as well as density for April 2006 relative to October 2005 (SNK, $p<0.05$). Figure 4.7 displays a separation of the findings from the two different habitats, clearly showing higher values at the rocky habitat, and giving some indication of the significances over different time periods.

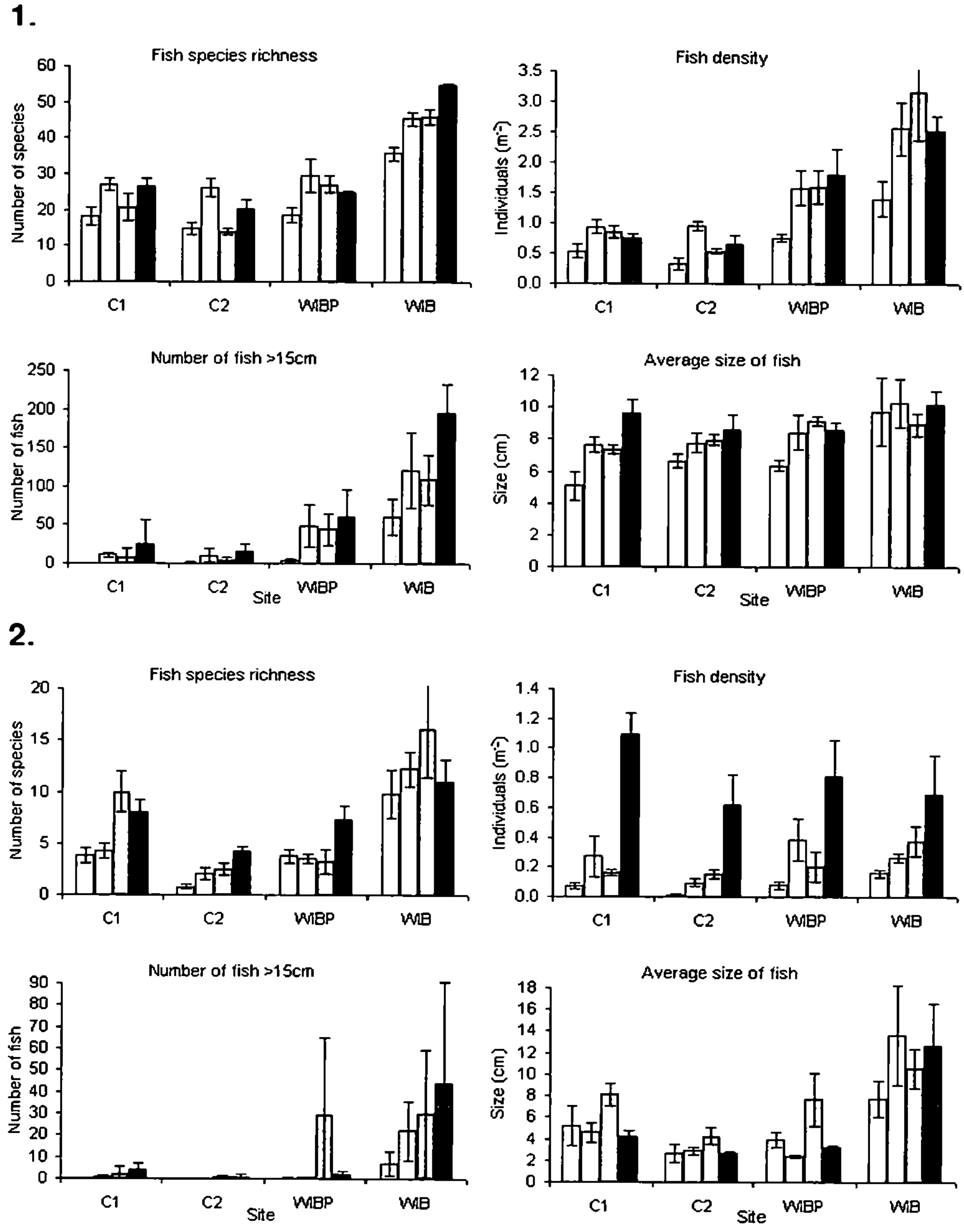

Figure 4.7. Visual censuses comparing fish species richness, density, number of fish >15 cm & average size of fish (SE) at the 3 m rocky habitats (1) and the 9 m sandy habitats (2) for Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP) and two Control sites (C1 & C2), for surveys conducted from October 2005 to April 2007 (light to dark grey shading) at Whale Island Resort, Hon Ong, Vietnam.

WIBP reserve, established as a no-take zone two months prior to the first survey, showed no significant differences to controls at baseline for all parameters, except higher species richness relative to C2 (SNK, $p<0.01$) (Figure 4.7). Following enclosure, WIBP increased its fish stock and average size, resulting in higher overall densities of fish and numbers of fish >15 cm (SNK, $p<0.01$) compared with controls and a higher species richness than C2 (SNK, $p<0.01$). No significant differences were recorded for average size compared with controls, or species richness compared with C1. Fish density and fish >15 cm increased significantly within WIBP (SNK, $p<0.01$) from the first survey period to the next, but remained relatively constant thereafter (Figure 4.7), with no significant differences between the latter three sampling periods; each, however, was significantly different (SNK, $p<0.01$) from October 2005 (approximating pre-enclosure). No significant differences were evident for species richness or size. The families mainly responsible for the increase, and thus resulting dissimilarity, between the two survey periods at WIBP were the Pomacentridae, Nemipteridae, Gerreidae and Scaridae (Table 4.4, Appendix 2). The SIMPER analysis also highlights the increased average abundances of several fish families in the last three survey periods at WIBP, approximating averages attained at WIB during the first survey; averages were surpassed for Nemipteridae, Labridae and Caesionidae.

Table 4.4. Fish families contributing most (90 % cut off) to the dissimilarity between sites: Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP), time: (October 2005 (1), 3 biannual survey periods: April 2006 – April 2007 (2-4)), seasonal dissimilarity across sites (including Controls C1 & C2) and habitat dissimilarity across all sites: 3 m rock and 9 m sand (SIMPER, not transformed data, Diss/SD, dissimilarity/standard deviation, Cum.%, Cumulative % contribution)

Families	Ave. abundances		Diss/SD	Cum.%
	Rocks	Sand		
Pomacentridae	229.42	55.38	1.90	53.28
Nemipteridae	55.64	3.81	1.67	70.40
Labridae	35.88	0.79	1.50	83.87
Caesionidae	7.45	3.62	0.49	87.37
Gerreidae	7.08	0.52	0.67	89.35
Chaetodontidae	5.23	0.30	1.16	90.99
	October	April		
Pomacentridae	191.27	261.94	1.53	56.13
Nemipteridae	37.24	72.94	1.28	72.27
Labridae	38.79	31.75	1.16	80.10
Caesionidae	4.12	10.66	0.59	84.14
Gerreidae	6.15	7.81	0.85	87.18
Siganidae	1.03	6.06	0.27	89.37
Scaridae	3.67	3.72	0.68	91.16
	1WIBP	2WIBP		
Pomacentridae	96.75	295.25	3.30	61.96
Nemipteridae	25.75	76.5	1.18	77.18
Gerreidae	0.50	16.25	0.97	82.04
Scaridae	0.75	14.75	1.24	86.35
Labridae	34.75	33.00	1.28	90.33
	1WIBP	1WIB		
Pomacentridae	96.75	299.75	2.16	60.11
Nemipteridae	25.75	60.00	2.65	71.96
Labridae	34.75	30.75	1.01	77.47
Gerreidae	0.50	14.25	1.74	81.99
Scaridae	0.75	7.25	0.58	85.65
Caesionidae	9.75	2.00	0.73	89.05
Chaetodontidae	1.50	8.25	1.06	91.55
	2-4WIBP	2-4WIB		
Pomacentridae	289.67	525.67	1.53	58.04
Nemipteridae	73.58	101.25	1.39	69.41
Labridae	42.92	48.67	1.31	75.60
Gerreidae	7.58	19.50	1.01	80.04
Caesionidae	2.42	17.33	0.84	84.42
Scaridae	6.58	5.83	0.91	86.36
Mugilidae	2.08	8.08	0.81	88.28
Lutjanidae	1.92	8.17	0.94	90.11

The overall composition of fish assemblages were significantly different across all sites (ANOSIM, Global R=0.567, Global p=0.001), between sites (all R=0.292-0.943, p≤0.002), across all periods (ANOSIM, Global R=0.502, Global p=0.001) and between periods (all R=0.323-0.753, p≤0.003). Diversity was significantly higher in April 2007 (SNK, p<0.01) compared with the three previous visits across all sites. For average fish size, there were no significant differences across sites and times, in part due to the high percent of small damselfish (Pomacentridae) (64.5 %). There is an apparent seasonal trend for density and fish >15 cm (Figure 4.8): values recorded in April 2006 were significantly higher than October 2005 and April 2007 values significantly higher than October 2006 (SNK, p<0.01). The families mostly responsible for the dissimilarity between April and October surveys were the Pomacentridae and Nemipteridae (Table 4.4).

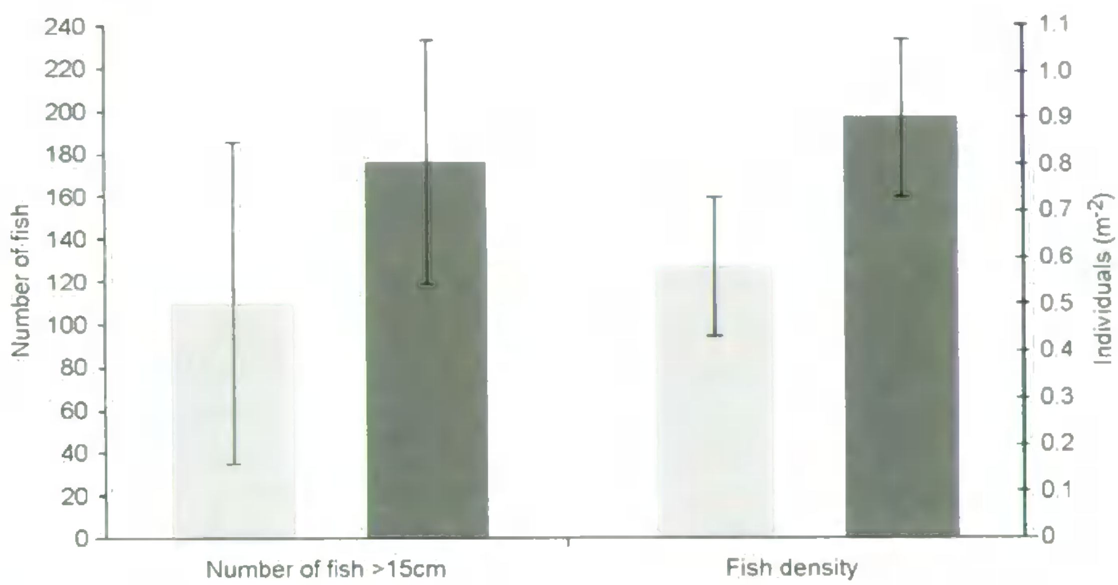

Figure 4.8. Seasonality of averaged density and number of fish >15 cm surveyed at both depths (3 m & 9 m) during time intervals October (2005 & 2006 – light grey) and April (2006 & 2007 – dark grey) at Whale Island Bay reserve (WIB), Whale Island Bay Peninsula reserve (WIBP) and two Control sites (C1 & C2) (with SE)

4.4 Discussion

The objectives of this study were to determine the effectiveness of HMMRs in terms of increasing the number, size and diversity of fish, and to assess how rapidly a previously-exploited area can increase fish stocks, once protected from fishing. The results indicated that these measures of the fish community at WIB clearly surpassed those of the unprotected Control sites (Tables 4.1 & 4.2, Figure 4.7). Equivalent results have been observed at a number of similar-sized MPAs (Halpern 2003). Roberts and Hawkins (1997) reported that the small marine reserve of Anse Chastanet, St. Lucia (2.6 ha), initially established as a protected zone for snorkellers of the hotel, managed to double the biomass of commercially important predatory fish species such as the snapper. In the Philippines, the Sumilon Island Reserve (12.5 ha, 9 year protection) had approximately 1.8 times higher density than the Control sites and 1.2 times the number of species than the unprotected Sumilon sites (overall WIB density: 2.9; number of species: 2.6 compared with averaged controls). Apo Island Reserve, Philippines, (11 ha, 1 year protection), reported approximately 1.4 times higher density and 1.15 times higher number of species than the unprotected Apo sites (WIBP density: 1.8; number of species: 1.2) (Russ & Alcala 1989). This comparison between the officially recognised Philippine reserves and the reserves in Vietnam demonstrates at least equal effectiveness for these HMMRs. Similarly, the size of fish at WIB were overall 1.5 times higher than the Control sites (WIBP, 1.3 times) and the number of fish >15 cm, 22 times higher (WIBP, 4 times, Tables 4.1 & 4.2, Figure 4.7). These are considerable increases for WIBP in particular, bearing in mind there were minimal differences between this site and the two Control sites in October 2005.

This supports the evidence that small HMMRs can, in only a short time, increase fish populations significantly following protection. Analogous results were produced by Halpern and Warner (2002), who found that marine reserves can significantly increase average levels of density, biomass, and diversity within 1-3 years, independent of the size of the reserve, based on a review of 80 reserves.

Without effective protection, such small reserves can, however, be quite vulnerable. At the Anse Chastanet reserve, St. Lucia, fish biomass dropped by 20 % following a period of ineffective protection; however, biomass recovered to double the initial value within 2 years of re-instatement (Roberts & Hawkins 1997). The increase in biomass was primarily credited to an increase in fish size, much like WIBP, where the total number of fish >15 cm increased 13 times from baseline to April 2006 and by 17 times from baseline to April 2007. This clearly highlights both the benefits and downfalls of small marine reserves. If small reserves are fully protected, they can increase the size and density of fish rapidly; however, if poaching does take place, the detrimental effects can be seen immediately. The magnitude of damage will depend on the intensity of fishing, the fishing gear/techniques used and the standing stock prior to the event. If HMMRs become lax in maintaining effective protection, their image as an eco-friendly resort, where you can dive and snorkel off the beach, could become compromised. This could possibly result in lower occupancy rates and decreased profit: why private reserves in particular have an added incentive to uphold protection.

While WIB is effectively protected, poaching still takes place at WIBP; unlike pre-protection, however, less extractive fishing methods are used. In Van Phong Bay, one fishing method, which does not target specific species, involves dragging nets from within a small bay onto the beach (beach seining), not only causing serious damage to living coral, but also extracting a far higher number of fish than post-protection, where generally hook and line fishing is used. This may explain the rapid increase in density and number of fish >15 cm from the first survey to the next, and also why the number and size of fish did not increase further over the following year (Tables 4.1 & 4.2, Figure 4.7). Unfortunately, the WIBP site is also currently restricted to tourists, which lessens the incentive for protection.

Beach seining may also account for the low coral cover at WIBP, C1 and C2 (<1 %), though coral cover at WIB rocky habitat is also rated low with 7 % (Table 4.3). While there is evidence of more numerous and diverse fish assemblages associated with coral reef habitats (Roberts & Ormond 1987; Spalding et al. 2001), it is questionable whether such low levels would add significant value, although there were significantly more corallivorous butterflyfish (Chaetodontidae) observed in WIB (6 x Control sites & 4.5 x WIBP) (Figure 4.6, Appendix 2). This family has been positively correlated with coral cover and marked as indicator species for healthy reefs (Bell & Galzin 1984; Khalaf & Crosby 2005). A more likely scenario, perhaps, for the significantly higher number of butterflyfish and other species, as well as individual fish size in WIB compared with C1, C2 and WIBP, is the 6-year protection period and the cessation of large-scale fish netting. This would also account for the observed differences in fish assemblages for sandy and rocky habitats of WIB compared with the other sites (Figure 4.2) and the shift to an individual community after half a year at the WIBP rocky habitat (Figure 4.3).

Rocky habitats (3 m) evidently have a richer fish assemblage than sandy habitats (9 m), mainly attributed to higher numbers of Pomacentridae, Nemipteridae and Labridae (Table 4.4, Appendix 2). This is expected for sites with higher structural complexity (Roberts & Ormond 1987; Spalding et al. 2001), but both are highly depauperate in terms of commercially valuable groups of large food fishes: Serranidae (e.g. *Epinephelus, Cephalopholis* spp.), Lethrinidae (*Lethrinus* spp.) and Lutjanidae (*Lutjanus* spp.), especially at C1, C2 and WIBP (Appendix 2). Even though the abundance of such species was notably higher at WIB, grouper, emperor bream and snapper only accounted for a small percentage of the fish population (0.46 %, 1.86 % & 0.94 % respectively). Unlike many small coastal demersal fishes, which are relatively sedentary, having a home range of <1 km^2, the size and living spaces of such species tend to be larger, consequently requiring a larger area of protection (Kramer & Chapman 1999).

The number of these species did not increase dramatically once WIBP was protected, but measures of the fish assemblage increased between October 2005 and April 2006, especially for the number of fish >15 cm, which increased from 2-9.4 % of the population; number of species and average density also increased. A 3-fold increase in Pomacentridae accounted mostly for the latter, while Nemipteridae, and to a lesser degree Gerreidae and Scaridae (Appendix 2), were mainly responsible for an influx of larger fish (Table 4.4). This is consistent with previous findings, where predatory fish (Nemipteridae) responded strongly to well-enforced reserves in the Philippines (Samoilys et al. 2007). While this could be seen as a sign of spillover from WIB, there was no indication of simply a relocation of WIB stock (Table 4.4, Figure 4.7). While the average abundances increased over the following three survey periods for WIB and WIBP, the average contribution to the dissimilarities for the three major families (Pomacentridae, Nemipteridae, and Labridae) remained similar to the first survey period (Table 4.4). The average dissimilarity decreased, however, from 55.53 % to 36.59 %, indicating that some movement between reserves may be taking place.

The number, size and diversity of fish also increased at C1 and C2 between the first and second survey, but not as dramatically as at WIBP reserve, the difference probably related to the absence of larger-scale extractive fishing methods in the reserve. A seasonal trend is evident for density and number of fish >15 cm across all sites (Figure 4.8), with higher values reported in April. The main contributors were species of the Pomacentridae family, followed by a much smaller contribution from the larger Nemipteridae, Caesionidae, Gerreidae and Siganidae families (Table 4.4, Appendix 2). The difference could be due to lower fishing intensity over the northeast monsoon season (October to February), when fishing is restricted by weather conditions. The higher fish densities could, however, also be related to seasonal recruitment patterns. Higher peak settlement of several damselfish species has been recorded during the wet season at San Blas, Panama, believed to be caused by the strong onshore winds (Robertson 1990). Srinivasan and Jones (2006), however, found that recruitment densities for Pomacentridae were highest after the wet season (December–February), in April/May, and again in October/November, in Kimbe Bay, Papua New Guinea. Pomacentridae was also the main contributor to the dissimilarities between the two seasons at (Whale Island Resort's (WIR) reserves (Table 4.4). Without further research into temporal dynamics of fish recruitment and fish landings in Van Phong Bay throughout the year, it is not possible to unequivocally determine the cause of temporal differences.

Although there was an initial significant increase in fish stock at WIBP, the level plateaued, showing only minimal temporal differences thereafter (Figure 4.7). Fish stock and sizes are, however, still increasing 6 years after protection at WIB, and since the surveys were only conducted during two years, further replenishment is perhaps still possible at WIBP, but more effective protection will then also be needed. Fishing the line is observed regularly at WIB, which is a good indicator that fishermen perceive the reserve to be increasing its fish stock and possibly producing spillover. Spillover was not researched outside WIB for this study, but several fishermen confirm that fish stocks have improved adjacent to the reserve (Chapter 6). The long-term goal of all HMMRs located near fishing villages should be to compensate or increase their fishing yields to alleviate poverty, increase standards of living and to repay the debt of compliance to the hotels' no-take zones.

At WIR, fishermen have also been seen fishing extensively between WIB and WIBP with nets, potentially hindering the replenishment of WIBP fish stocks to its full capacity from WIB. Whilst this may be a good short-term solution enabling increasing yields, arguably it may not be a good long-term strategy to allow build-up of fish stocks. A better solution to improve the marine reserve potential would be to expand both reserves to encompass the peninsula, creating one larger no-take reserve and to increase protection efforts. This would increase the capability to self-sustain a larger fish stock, including larger economically important species with greater fecundity, allowing for greater larval dispersal and adult movement across boundaries, which could better compensate, or indeed enhance, adjacent fisheries (Hilborn et al. 2004; Kramer & Chapman 1999; Sale et al. 2005). A buffer zone adjacent to the reserve, where less extractive fishing methods are allowed, would further enhance coastal resources (White et al. 2005). Such unilateral protection by WIR and elsewhere (Christie 2005) may, however, increase tension with some local fishermen, who already perceive WIR as a reason for their reduced catches over the last few years; the reserve protects two beaches inhibiting their more extractive beach seining method (Chapter 6). In a survey conducted with fishermen from the nearby fishing village, Dam Mon, the majority of fishermen would, however, welcome more protected areas, but some suggest the hotel or government could help compensate for their loss of fishing grounds by providing support to develop lobster aquaculture (Chapter 6)

4.5 Conclusion

This research provides good evidence that, with effective protection, small HMMRs can increase fish stocks rapidly, matching, or in some cases surpassing, officially established MPAs of a similar size. This study does not offer conclusive evidence for the effectiveness of all HMMRs, or whether such small HMMRs can compensate for the loss of fishing area set aside for the reserve. There is, however, evidence of spillover from the similar sized Apo Island reserve in the Philippines (Russ & Alcala 1996) and fishermen statements in this study suggest spillover from WIB (Chapter 6). Certainly, results show the promise of such schemes. One HMMR may only make a difference very locally, but many hundreds to thousands of HMMRs lining coastal countries across the tropics could create a network of marine reserves which, some argue (Dawson et al. 2006; Roberts et al. 2001), can have a cumulative positive effect on fish and coral growth by providing refugia at various distances for adult, larval and propagule dispersal and settlement. Furthermore, hotels have the incentive, and often the resources, to lease and maintain adjacent coastal areas, to sustain or enhance the environment for their benefit and that of their guests.

5. Can Hotel Managed Marine Reserves enhance fish stocks by deploying artificial reefs?

5.1 Introduction

It is widely known that the coral reef ecosystem is one of the most diverse systems on our planet, housing vast numbers of fish species, which rely on coral reefs for food, shelter and living space (Spalding et al. 2001). Coral reefs are, however, declining at an alarming rate worldwide due to natural (e.g. coral bleaching, crown-of-thorns starfish) and anthropogenic disturbances (e.g. pollution, overfishing and destructive fishing practices, sedimentation) (Pandolfi et al. 2003). Marine reserves have been designated worldwide to attempt to help preserve coral reef habitats and to enhance fish stocks, but a variety of other methods are also available to further boost fish populations (Claudet & Pelletier 2004).

Marine structures have the potential to attract, concentrate and enhance fish stocks, be they man-made or natural (Bohnsack & Sutherland 1985; Jensen et al. 1994). Artificial Reefs (ARs), defined as "submerged structures placed on the seafloor deliberately, to mimic some characteristics of a natural reef" (OSPAR Commission 1999), have been suggested as a potential fisheries enhancement tool (Pickering & Whitmarsh 1997). The use of ARs can, however, fill a number of roles beyond this; for example, as tools for restoration and rehabilitation of coastal ecosystems (e.g. providing a suitable substrate for coral growth) (Clark & Edwards 1994; Pickering et al. 1998), nature conservation, aquaculture/marine ranching (Seaman 2007) or as an attraction to dive and snorkelling tourists, who can simultaneously be educated to understand the need for environmental conservation, while relieving pressure on Natural Reefs (NRs) (Van Treeck & Schuhmacher 1998).

In terms of increasing productivity, the deployment of artificial reefs relies on the assumption that they provide additional critical habitat, which increases the environmental carrying capacity and, thereby, the abundance and biomass of reef biota (Bortone et al. 1994; Pickering & Whitmarsh 1997). The AR potentially provides a suitable substratum for benthic fauna, and, thereby, additional food, increasing feeding efficiency, shelter from predation and currents and a suitable habitat for the recruitment of organisms, which would otherwise be lost from the population (Demartini et al. 1994; Jan et al. 2003; Lan et al. 2004; Leitao et al. 2008).

The materials used to create ARs vary across the globe. Many countries use materials of opportunity, such as discarded tyres (Branden et al. 1994) or derelict vessels (Jan et al. 2003), but can also deploy specially designed ARs, such as steel reefs (Kim et al. 2008), including BIOROCk^{TM}, which uses an electrochemical process to draw calcium carbonate from the water column (Goreau & Hilbertz 2005). Pulverized fuel ash (Lam 2003) or concrete is favoured in many countries, including Japan and Taiwan (Pickering et al. 1998), where several thousand units have been deployed over the decades (Jan et al. 2003; Kim et al. 2008).

The effectiveness of artificial reefs in increasing productivity depends very much on the design of the reef structure, specifically if they can then mimic the target species' natural habitat (Spanier 1994). Rugosity, or topographic complexity of ARs (i.e. the presence and variety of crevices (Anderson et al. 1989), sand cavities, hole sizes, and secondary biogenic complexity created after algae and sessile invertebrate growth), has been shown to contribute significantly to species composition and biological productivity for certain species (Aseltine-Neilson et al. 1999; Ferreira et al. 2001). There is significant evidence to suggest that fish species prefer hole sizes which are near to their body sizes (Hixon & Beets 1989; Robertson & Sheldon 1979; Shulman 1984), suggesting that if larger commercial species are being targeted, the hole sizes should be equally large. This was also duly demonstrated by Hixon and Beets (1989). Similarly, a greater number of small holes increases the capacity of the reef to provide shelter from predation for small fish, thus decreasing recruitment and post-settlement mortality of juveniles (Gladfelter & Johnson 1983; Hixon & Beets 1989). Many ARs have been designed in Korea and Japan using different materials (mainly steel and concrete), offering a range of designs to attract species. Korea has focused on a box reef style, which was designed to meet the biological requirements of both the Korean rockfish (*Sebastes schlegeli*) and madai (*Pagrus major*). These ARs attract more of these species than do natural reefs (Kim et al. 2008). Japan has developed taller reefs, which have in some cases also shown to attract a larger number of transient fish and species, which respond to this visual stimulant and spatial reference (Anderson et al. 1989; Rilov & Benayahu 1998, 2000).

Apart from the structure of artificial reefs, strong correlations have also been reported between fish assemblages and the physical location of the artificial reef, in terms of distance from the shore and depth (Brokovich et al. 2006; Jan et al. 2003), temperature, visibility, currents and size of the reef (Jan et al. 2003; Sanders et al. 1985). In a study off the coast of southeast Florida, the influence of depth was investigated: fish diversity, biomass and number of larger fish (>5 cm) were found to be significantly greater at 21 m than at 7 m (Sherman et al. 1999).

The optimal size of an AR for increasing abundance is an ongoing debate, but Jan et al. (2003) suggest that while larger areas of reef support a higher fish biomass, they hold fewer individuals. Ogawa et al. (1977) established a direct relationship between production increase and reef volume up to 4000 m^3 and Ambrose and Swarbrick (1989) suggested that smaller reefs may attract more fish from a proportionally larger area, due to the higher perimeter-to-area ratio.

ARs, as well as Marine Protected Areas (MPAs), are increasingly regarded as valuable methods for ecosystem conservation and fish and habitat restoration and rehabilitation (White et al. 1990). In this study, the effectiveness of variously sized, but still relatively small, artificial reefs within the Hotel Managed Marine Reserve (HMMR) of Whale Island Resort (WIR), are considered, comparing fish stocks with natural reefs.

5.2 Study site

A detailed description of the study site can be found in Chapter 3. There are 5 ARs in Whale Island Bay reserve (WIB), made from glazed clay pots (partially broken), heaped into relatively round clusters at 4 m depth, which were deployed in 2003 (Figure 5.1).

Figure 5.1. Picture of an artificial reef (AR1), made from clay pots, with long-spine urchins (*Diadema* spp.) found amongst transplanted corals, and showing a school of brown demoiselle (*Neopomacentrus filamentosus*) and scissortail sergeants (*Abudefduf sexfasciatus*) in Whale Island Bay reserve (WIB), Hon Ong, Vietnam

The ARs vary in sizes, from approximately 4–15 m^2, each containing pots of different sizes and diameters (roughly 25–70 cm). AR1 (6.2 m^2) is found in the southern side of the bay, 70 m from the beach, situated next to a large boulder. A cluster of 3 ARs (AR2: 4.2 m^2, AR3: 7.5 m^2, AR4: 14.9 m^2) are located 80 m north of AR1, parallel to the beach, approximately 7–10 m apart. AR5 (6.5 m^2) is adjacent to the northern coastline, 100 m from the beach (Figure 5.2).

Two Fish Aggregating Devices (FADs), made from bound-together strips of netting, which are fastened to surface buoys and anchored to the seafloor at 9 m depth, are located approximately 75 m from AR1 and AR5.

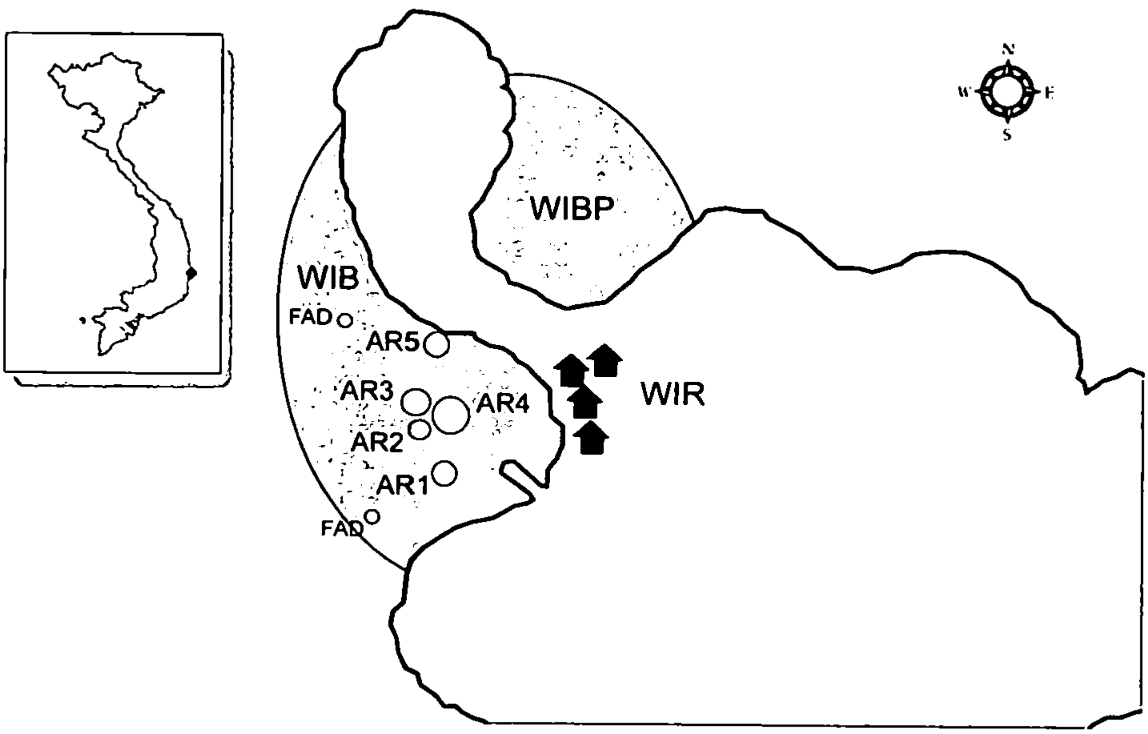

Figure 5.2. Illustration of the locations of 5 Artificial Reefs (ARs) and 2 Fish Aggregating Devices (FADs) found in Whale Island Bay reserve (WIB), Whale Island Resort (WIR), Hon Ong, Vietnam

The ARs were all placed on a sandy substratum within 10 m of existing larger boulders. Broken coral fragments found at a nearby snorkelling site, which is often visited by many tourists from local Van Phong Bay tourist companies, have been transported back to WIB and placed on the pots in the hope they would re-attach and survive, which several have (Figure 5.1). Many juvenile branching corals of the species *Stylophora pistillata* have also colonised pot surfaces.

5.3 Methods

Four replicate visual reef fish census surveys (English 1997) were conducted biannually during the four research trips (October 2005 – April 2007). Surveys were conducted using SCUBA at high tide, recording the fish species, their size and the number of larger fish (>15 cm) from a distance of 5 m (only counting species found within 2 m of the AR), before gradually approaching the AR to survey the small resident and cryptic fish. Survey replicates of the natural reef (mostly rocky with patches of coral: 7 % cover), were similarly conducted during these visits at approximately 3–4 m depth, using a 50 m line transect (Chapter 4; Svensson et al. 2009). All species were recorded to species level, but to standardise with the surveys conducted on the natural reefs, cardinalfish (Apogonidae), and the bottom-dwelling species such as the gobies (Gobiidae), blennies (Blenniidae) and lizardfish (Synodontidae), were excluded (Chapter 4, Appendix 2).

To allow comparison of fish stocks between the ARs and the NRs, only fish found within 2 m of the line transect were included and results from the two reef types were standardised for area. Species richness, average size of fish and number of fish >15 cm were analyzed using a 2-way analysis of variance (ANOVA) model with reef type and time as factors. ANOVA assumptions were checked using Cochran's test and transformed where necessary. All ANOVA analyses were undertaken using GMAV5 for Windows. A proxy of biomass was attained by multiplying the average size of fish by abundance for each reef type. To explore differences in fish assemblage composition between times and reef types, a non-metric Multidimensional Scaling Ordination (MDS) was performed using PRIMER5 software on a similarity matrix (Bray-Curtis similarity index) calculated from fourth square-root transformed species abundance data (Clarke & Gorley 2001). Significance tests for differences between reef types and time were performed using Analysis of Similarities (ANOSIM) and the fish families contributing most to dissimilarities were determined by the similarities percentage procedure SIMPER (Clarke 1993). Regression analysis was performed to test for any relationship between surveyed parameters and AR area. The data for abundance of fish and the number of fish >15 cm were found to be significantly non-normal (Cochran's test), so these data were log-transformed to fulfil regression assumptions.

5.4 Results

A total of 20,630 fish was recorded over the 4 survey periods (October 2005 – April 2007) at the 5 ARs (71 %) and 5 NRs (29 %), which comprised 138 species, belonging to 28 families. The majority of families (96 %) and most species (88 %) were found on the NRs, while only 85 species (23 families) were present at the ARs. A few species were only found on the ARs (12), across 9 families, but these were in relatively low abundances, accounting for 0.52 % of the population.

Significant differences between individual ARs were found for average size, species richness and number of fish >15 cm (ANOVA All Df = 4, $p<0.05$) over the four survey periods, but with no obvious consistent pattern. A significant positive trend in species richness, abundance and number of fish >15 cm was, however, found with increasing size of the AR (Regression analysis: All Df = 2, $p<0.001$, $p<0.05$, $p<0.001$), but not for average fish size (Figure 5.3).

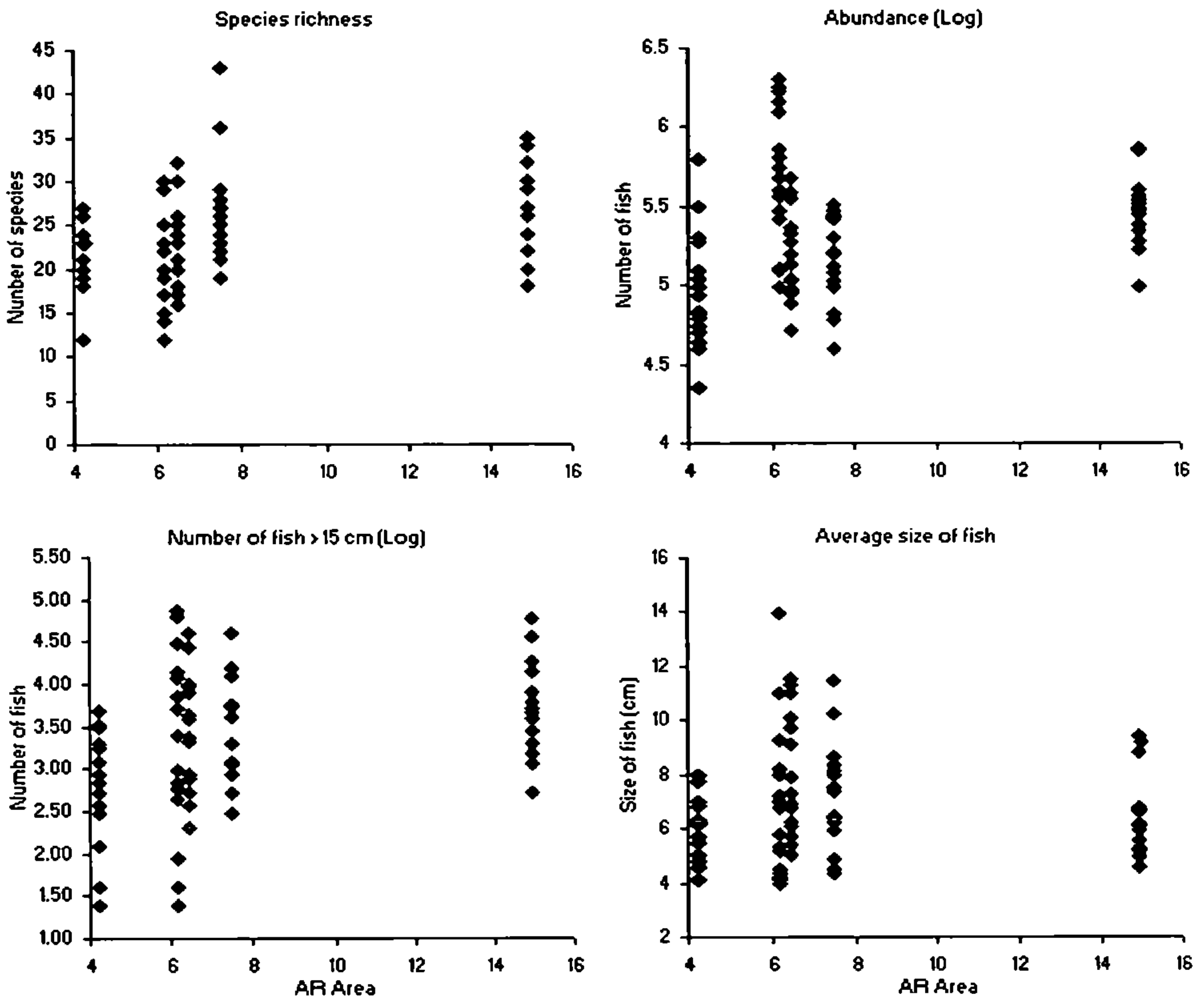

Figure 5.3. A trend analysis of fish stocks for five artificial reefs (ARs) with varying sizes at Whale Island Bay, Hon Ong, Vietnam

Fish assemblage composition also varied significantly between ARs (ANOSIM R Global = 0,387, $P<0.001$). The three central ARs (2-4) exhibited no significant differences however, as opposed to fish assemblages found on AR1 & 5 compared with AR2-4 and between AR1 and AR5 ($R = 0.438 - 0.823$, $p<0.05$). A comparison of AR fish assemblages are displayed in Figure 5.4.

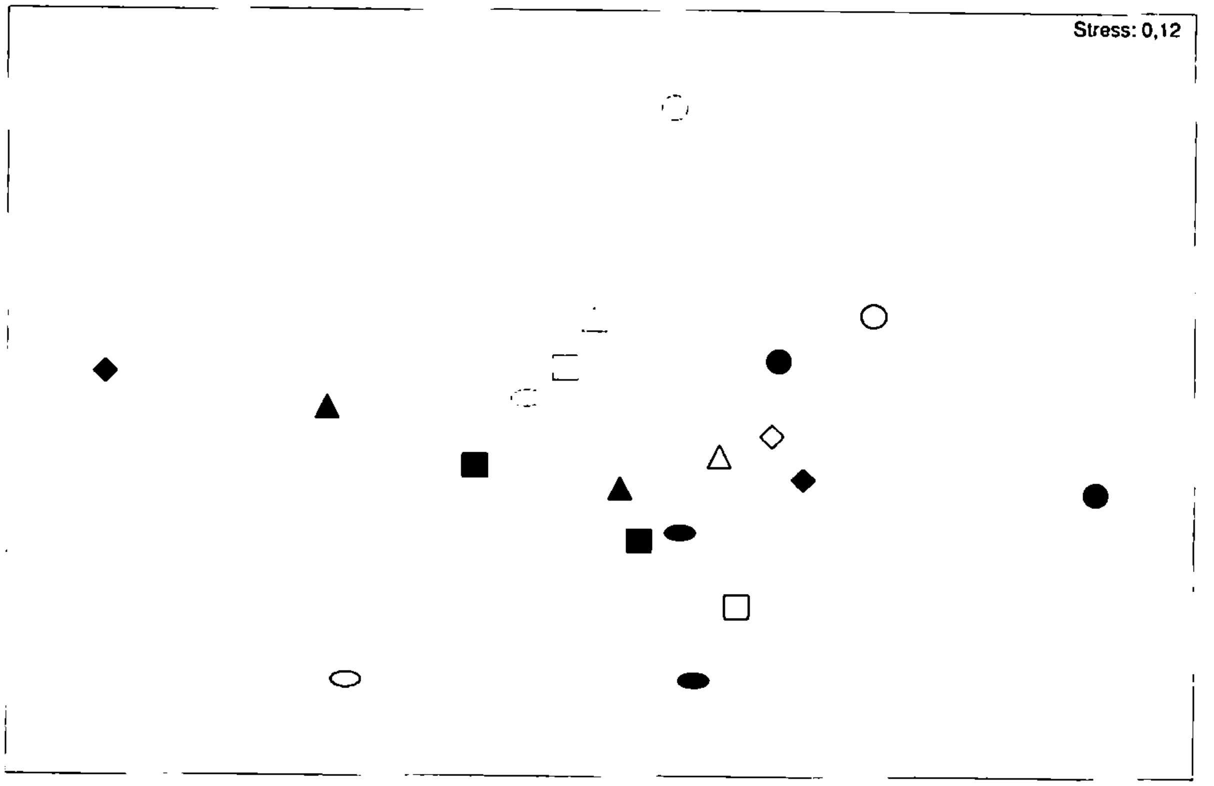

Figure 5.4. A Multidimensional Scaling Ordination (MDS) showing the similarities in fish assemblages between 5 artificial reefs (AR1: circle, AR2: diamond, AR3: pyramid, AR4: square, AR5: oval) and 4 time periods (October 2005 – April 2007: white to black shading) at Whale Island Bay, Hon Ong, Vietnam

When data are standardised for area, species richness, density and number of fish >15 cm were significantly higher on ARs than NRs, while the average size of fish was not significantly different (Table 5.1, Figure 5.5). Only the number of fish >15 cm showed significant change over time.

Table 5.1. ANOVA results of a comparison of fish stocks between artificial reefs and natural reefs for surveys conducted biannually between October 2005 and April 2007, in Whale Island Bay, Hon Ong, Vietnam

	Reef type			Time		
Species richness	Df = 2	f = 423.22	p < 0.001	Df = 4	f = 1.46	p = 0.248
Density	Df = 2	f = 400.81	p < 0.001	Df = 4	f = 0.79	p = 0.509
Number of fish >15 cm	Df = 2	f = 456.55	p < 0.001	Df = 4	f = 6.38	p < 0.01
Average size	Df = 2	f = 0.39	p = 0.537	Df = 4	f = 0.89	p = 0.459

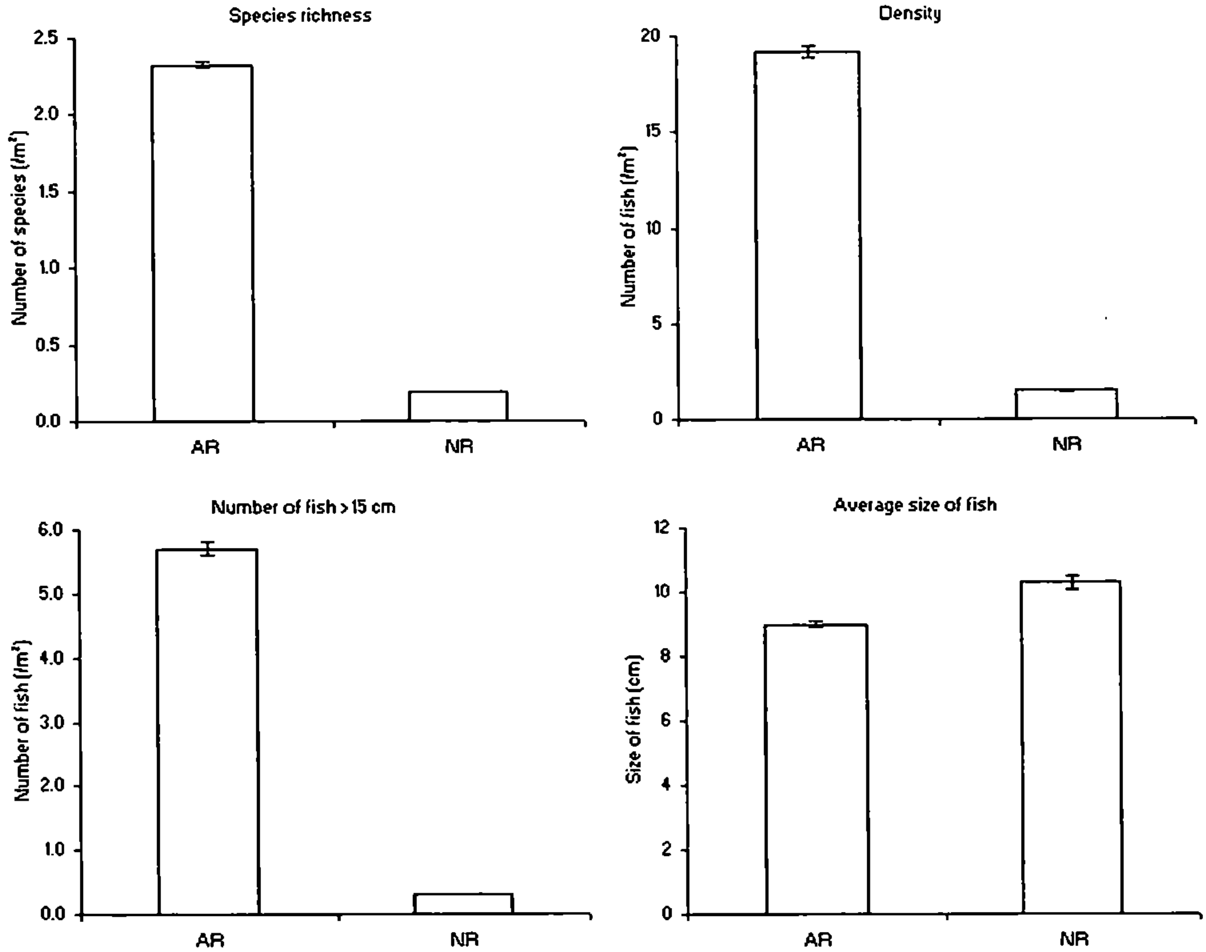

Figure 5.5. A comparison of fish stocks (standardized for area) between Natural Reefs (NRs) and Artificial Reefs (ARs) across all survey periods (October 2005 – April 2007) with SE, at Whale Island Bay, Hon Ong, Vietnam

A complete summary of fish stocks for each reef type over time can be found in Table 5.2, which again highlights the consistently higher values for AR compared with NRs for species richness, density and the number of fish >15 cm.

Table 5.2. Fish stocks (standardized for area) found at Artificial Reefs (ARs) and Natural Reefs (NRs) over 4 survey visits at Whale Island Bay, Hon Ong, Vietnam

Reef type	Spp. richness	SE	Density	SE	No. fish >15 cm	SE	Ave. size of fish	SE
AR Oct. 05	2.46	0.11	18.81	0.99	5.32	0.61	9.29	0.24
NR Oct. 05	0.18	0.01	0.88	0.11	0.20	0.04	11.93	1.26
AR Apr. 06	2.59	0.07	20.48	1.31	7.67	0.76	10.23	0.48
NR Apr. 06	0.22	0.02	1.56	0.18	0.25	0.04	10.79	0.84
AR Oct. 06	2.16	0.09	15.55	0.57	3.45	0.39	8.37	0.32
NR Oct. 06	0.23	0.01	2.23	0.23	0.40	0.07	10.08	0.75
AR Apr. 07	2.10	0.07	21.96	0.99	6.38	0.33	8.01	0.24
NR Apr. 07	0.14	0.01	1.35	0.05	0.36	0.04	8.33	0.32

ANOSIM analysis revealed significant differences in fish assemblages between the two reef types (Global $R = 0.739$, Global $P < 0.001$) as well as between survey periods (Global $R = 0.256$, Global $P < 0.001$), a difference only detectable for fish >15cm in univariate analyses. The damselfish *Neopomacentrus filamentosus* contributed most to the dissimilarity between reef types (Table 5.3), and pomacentrids, as a family, accounted for over 25.4 % of the dissimilarities. The average dissimilarity between the natural and artificial reefs was 75.2 %.

Table 5.3. SIMPER analysis (fourth root transformed) of fish contributing most (75 % cut off) to the dissimilarity between reef types: Natural Reefs (NRs) and Artificial Reefs (ARs) (Diss/SD, dissimilarity/standard deviation, Cum.%, Cumulative % contribution, *, Pomacentridae) at Whale Island Bay, Hon Ong, Vietnam

Species	Ave. abundances		Diss/SD	Cum.%
	AR	NR		
Neopomacentrus filamentosus *	51.51	0.47	2.92	6.86
Abudefduf sexfasciatus *	8.08	0.04	2.44	11.60
Scolopsis ciliatus	11.22	0.14	2.90	16.07
Scolopsis margaritifer	4.19	0.04	2.75	19.08
Abudefduf vaigiensis *	2.52	0.01	1.77	23.19
Halichoeres chloropterus	3.50	0.07	2.54	26.43
Pomacentrus simsiang *	3.77	0.06	1.51	29.57
Pomacentrus cuneatus *	2.44	0.04	1.60	32.69
Choerodon anchorago	1.12	0.00	3.10	35.70
Cephalopholis boenak	0.90	0.01	3.52	38.35
Chaetodon auriga	0.78	0.01	2.60	40.68
Caesio teres	1.71	0.04	1.01	42.80
Pomacentrus proteus *	1.08	0.05	1.69	44.92
Scolopsis affinis	0.40	0.00	1.46	46.98
Abudefduf bengalensis *	0.35	0.00	1.67	48.99
Cheilinus chlorourus	0.44	0.01	1.75	50.95

The differences in fish assemblages between reefs can be visualised from the MDS (Figure 5.6). This displays a tight cluster for AR fish assemblages (circles), with a separate, more loosely clustered, group for NRs (squares). There are three significant NR outliers from the first survey period (white) and second period (light grey), which differ in fish assemblages compared with the other surveys (same time period). This seems to be explained by low average abundances of the damselfish *Neopomacentrus filamentosus* and *Abudefduf sexfasciatus*, or a high average of the fusilier, *Caesio teres*, perhaps reflecting temporal population variability (Appendix 2).

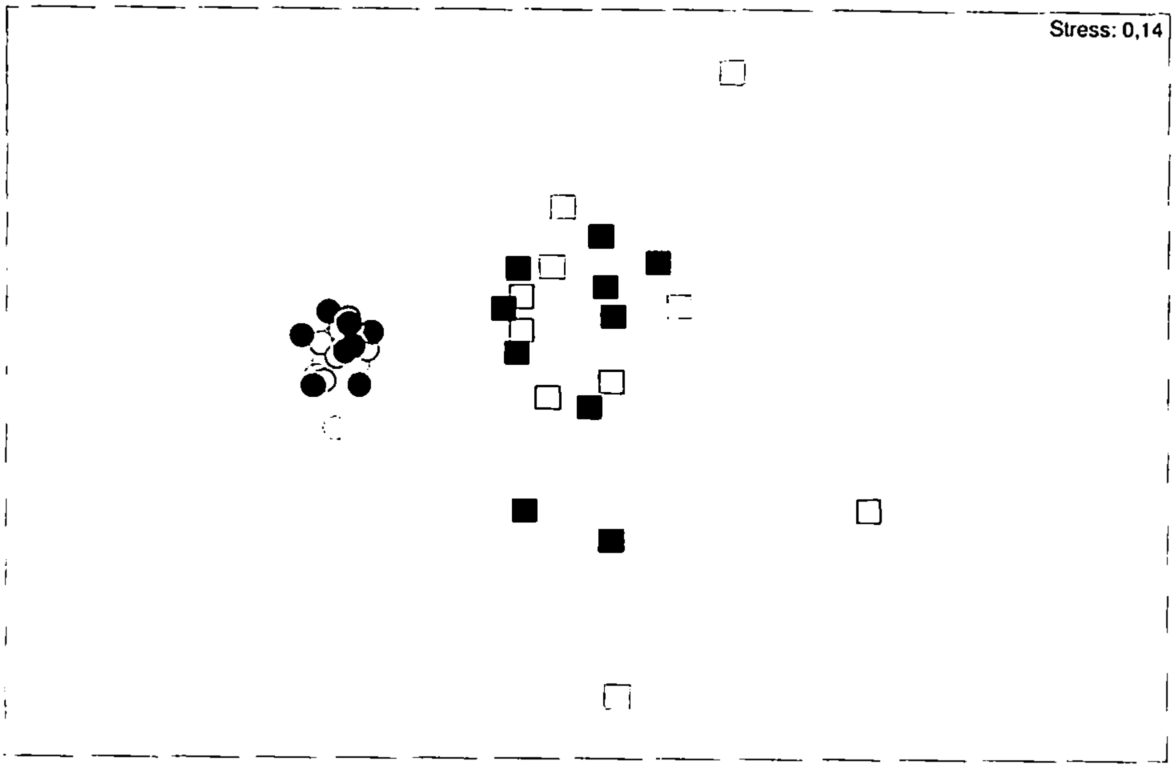

Figure 5.6. A Multidimensional Scaling Ordination (MDS) showing the similarities in fish assemblages (fourth root transformed) between artificial reefs (circles) and natural reefs (squares) for surveys conducted biannually between October 2005 and April 2007 (white to black shading) at Whale Island Bay, Hon Ong, Vietnam

5.5 Discussion

The results suggest higher fish densities, species richness and number of fish >15 cm on the ARs within WIB, compared with adjacent area-equivalent NRs (Tables 5.1, 5.2, Figure 5.5) and overall 11.15 times greater biomass. Similar examples of higher productivity on ARs have been recorded elsewhere. ARs deployed in the Virgin Islands were found to have 11 times greater biomass compared with NRs and biomass on an AR off the Marquesas Islands, French Polynesia, showed 8 times higher biomass than that of a nearby NR (Dean 1983). The average size of fish, conversely, was larger on NRs, which could be explained by the higher density of small fish on the ARs (Figure 5.5). There were for example, 67.1 times more pomacentrids found on the ARs than on NRs, the vast majority on both reef types being the brown demoiselle (*Neopomacentrus filamentosus*) (47.4 % and 31.4 %). The scissortail sergeant (*Abudefduf sexfasciatus*) and the whitestreak monocle bream (*Scolopsis ciliatus)* were also found in higher abundances on the ARs (206.6 and 72.3 times higher). These species contributed most to the dissimilarities between the reef types (Table 5.3).

The very high density of damselfish on the ARs may be explained by the isolation of the ARs from other suitable habitats, compounded by the rugosity created by the clay pots. The partly smashed pots create a greater number of holes than the rocky reef with its superposition of boulders, offering more refugia from predation and physical stress for these small, territorial, low-trophic level fish species (Allen et al. 2003; Ferreira et al. 2001). The broken coral reef fragments also add to the complexity and attractiveness of the habitat, even though many of these do not survive very long. Although coral cover was not estimated, because dead, algae-infested coral are often replaced with newly-found broken live fragments, it was apparent that the average coral cover on ARs (dead or alive, Figure 5.1) is higher than the average 7 % coral cover found on NRs (Chapter 4). A nesting substratum on the ARs is also present for these species, which spawn demersal eggs; it is seldom observed that these species migrate once they have settled (Jan et al. 2003; Jan & Ormond 1992). The ARs are however relatively small so, while they attract very high numbers of fish locally, fish assemblages on NRs are much greater overall due to their much larger area.

It has been suggested that ARs, when in close proximity to the shore, may become an extension of the existing habitat, providing potential benefits for fish recruitment (Danner et al. 1994). This is certainly the case for AR5, which is situated adjacent to the natural reef (Figure 5.2). None of the other reefs is, however, very far from the coastline and all are adjacent to one or a few large boulders, which often have small patches of smaller, layered rocks, increasing complexity and providing a suitable habitat for small fish. ARs placed near NRs have been found to first attract fish from their original habitat but, similar to results from this study, the fish assemblages changed and developed a structure of their own (Dean 1983). Furthermore, ARs deployed 25 m from an existing coral reef have also been shown to have the potential to increase recruitment without reducing the population size of the reef (Stone et al. 1979).

The size of the AR seems to play a significant role in recruiting fish. The larger the area of the AR, the higher the abundance, species richness and number of fish >15 cm (Figure 5.3), although there is considerable variance around these trends. These results confirm that of other authors (Ambrose & Swarbrick 1989; Jan et al. 2003; Ogawa et al. 1977). A range of optimal sizes has been proposed for fishery enhancement, including suggestions from 400 m^3 as a minimum effective size, to 2000-5700 m^3 to ensure peak fish harvests (Bohnsack & Sutherland 1985; Sato 1985). Jan et al. (2003), on the other hand, calculated the most effective AR size for resident fish to 4-10 reef units (2 m^3 hollow concrete cubes), which is closer to the size of the largest AR in WIB. To include transient fish, however, 15 units were recommended. So, although relatively small reef sizes have been suggested to be more effective at increasing biomass, the smallest sizes are still larger than the ARs at the HMMR in WIB. These reefs in WIB were, however, not designed specifically to enhance fisheries, but to add substrate for coral re-attachment and growth and provide visual stimulus, thereby attracting snorkellers and relieving pressure from NRs. The number of commercially important fish species (Serranidae, Lutjanidae, Lethrinidae and Siganidae) are consequently low (460 specimens found across all AR and time periods, representing 3 % of the population).

To increase the number of commercially valuable larger fish, another design would be required: constructing ARs with a greater surface area, while still supporting a high level of complexity. These would need to include a great number of larger holes to accommodate larger species and which have to be deployed at greater depths (at least 20 m) (Rilov & Benayahu 2000; Robertson & Sheldon 1979; Sherman et al. 1999; Shulman 1984). The larger WIB reefs do support larger fish assemblages, though, again, mainly due to increased abundances of

Neopomacentrus filamentosus, Abudefduf sexfasciatus, Abudefduf vaigiensis and *Scolopsis ciliatus* (Appendix 2).

The fish assemblages varied between the different artificial reefs. AR1 for example, attracted comparatively more fusiliers, possibly drawn to the AR by the 75 m distant FAD (Figure 5.2). This FAD has on occasion been found to attract larger schools of fish e.g. fusiliers (Caesionidae), jack's (Carangidae) and emperors (Lethrinidae) while, during the first two survey periods, schools of barracuda (Sphyraenidae) (Appendix 2), were found on the northern FAD, but these were not attracted by AR5. The three central ARs (2-4), on the other hand, exhibit no significant differences in fish assemblages (Figures 5.2, 5.4), These centrally located, closely clustered ARs therefore appear to be working as one unit. This potentially increases the total area of AR, but still does not increase the number of larger species of interest to fisheries. Therefore, the size of the reef does not seem to be the sole limiting factor (if the aim of ARs is as a fisheries enhancement tool), but rather the design, and perhaps the physical location.

The HMMR's artificial reefs seem to contribute significantly to increasing local fish populations within WIB. They are perhaps not enhancing fisheries (although 97 % of fishermen did suggest spillover from the reserve; Chapter 6), but they are providing habitats for thousands of fish, providing a substratum for coral growth, and increasing the total productivity of the area, while visually enhancing the otherwise largely featureless sandy seascape. These attract snorkelling tourists, who subsequently ask questions about the hotel's AR project, adding to conservation awareness building and insight into the need for marine resource restoration and protection. Svensson et al. (2008) for instance, showed that environmentally conscious tourists are significantly more inclined to pay extra to stay at HMMRs (Chapter 7). SCUBA beginners can also be trained in this bay and around the ARs, which, while providing visual stimulus, relieves pressure from natural reefs.

6. The perceptions of local fishermen towards a Hotel Managed Marine Reserve in Vietnam

Contents of this chapter were used to write:

Svensson, P., L. D. Rodwell, and M. J. Attrill. 2010. The perceptions of local fishermen towards a hotel managed marine reserve in Vietnam. Ocean & Coastal Management **53**:114-122

6.1 Introduction

Marine Protected Areas (MPAs) have been receiving increasing attention over the last decades, as an effective management strategy for conservation and fisheries management (Bohnsack 1998; Roberts et al. 2005; Russ et al. 2003). They have the ability to significantly increase species richness, biomass and density of fish relatively quickly (1-3 years), independent of their size (Chapter 4; Halpern & Warner 2002), and protect coral reef ecosystems from over-exploitation (Boersma & Parrish 1999), if sufficiently funded and effectively managed (Davis & Tisdell 1996). From a fisheries point of view, it is suggested that MPAs can protect a greater spawning stock and sedentary species, allowing fish to grow larger and live longer, greatly enhancing their fecundity. This increased fecundity can in turn provide new recruits to outside fishing areas and increase the density gradient of adult species from the reserve, allowing spillover to adjacent fishing grounds (Hilborn et al. 2004; Russ & Alcala 1996; Russ et al. 2004).

For local fishermen to benefit from the spillover of MPAs, the size and spacing of MPAs have to be carefully designed and there needs to be compliance with the no-fishing rule. Several studies of tropical fish species provide evidence of relatively short larval dispersal distances, indicating that reserves can be relatively small but should have neighbouring reserves relatively close by, to allow for protected resettlement (Jones et al. 2005; Jones 2005; Kritzer 2004). Small reserves are, however, more vulnerable to poaching, so, in order for MPAs to effectively protect the coastal ecosystem and benefit fisheries, committed cooperation and support from local populations is essential (Kritzer 2004; Wells & McShane 2004).

In order to gain commitment and to prevent non-compliance from the local communities, the best method is to provide intensive education programs and involve local fishermen already at the planning stages of the MPA, to ensure that their inherent cultural precepts and socioeconomic needs are considered carefully. This will give them decision power, which will help convince them that reserve objectives are not only developed for conservation purposes, but also for long-term fishermen benefits (Aswani et al. 2007; White & Vogt 2000). This is not to say that patrolling and enforcement of reserve boundaries are not necessary. If the reserve is successful at significantly increasing abundance, this will provide strong incentives for poachers (Sethi & Hilborn 2008). Many poaching incidences may, however, not be of criminal intent, but rather a misconception of where the boundary lies (McClanahan 1999), but for regular misdemeanours, it is necessary that the punishment for poaching outweighs the possible gains brought on by the fishing activity (Beddington et al. 2007).

Community-based MPAs are, therefore, widely considered the most effective reef management strategy in the tropics (White & Vogt 2000). Indigenous knowledge of ecological processes can help identify interconnectivity between habitats and find potential reserve sites that incorporate biodiversity and include the presence of vulnerable and exploitable species (Roberts et al. 2003) - these potential sites would be discussed and a balance is found which would benefit the environment and local stakeholders. Other parties involved in community-based MPAs may include the local government, Non-Government Organisations (NGOs) and the private sector. In these situations, the private sector, often represented by diving operations or hotels and resorts, are meant to supply funding and bring business to the area (Kiss 2004).

There has been an increase in the reported cases of hotels, in particular resorts offering diving holidays, which have taken the initiative to establish marine reserves with varying degrees of participation from other stakeholders (Chapter 8; Svensson et al. 2008; Svensson et al. 2009). Similar to privately managed parks on land, many of the privately managed MPAs, termed Hotel Managed Marine Reserves (HMMRs), have been established because of the government's inability to satisfy the public's and ecotourists' demands for nature conservation in both quantity and quality (only 14 % effectively managed in a review of 285 MPAs in Southeast Asia) (Burke et al. 2002), in addition to creating a potentially profitable market niche for their business (Gössling et al. 2006; Langholz & Lassoie 2001; Svensson et al. 2008; Svensson et al. 2009). In these cases, HMMRs generally pay a lease or tax to the owning authority and close the area to fishing, generally by buoy markers. For example, the owner of Wakatobi Dive Resort, South-eastern Sulawesi, Indonesia, pays a leasing fee to the chiefs of affected communities for a strip of coastline covering 200 ha, designated a no-take sanctuary, as well as a 500 ha adjacent area reserved for traditional fishing practices. Representatives of the communities patrol the reserve with boats sponsored by the resort and ensure compliance with agreed extractive bans. If no poaching takes place, the full amount of the agreed lease is paid out and the money is used to develop local infrastructure and build schools and other public buildings, in addition to providing for fishermen whose fishing grounds have been lost (Wakatobi Dive Resort 2008; Lorenz Maeder, resort owner, pers. comm.).

In this chapter, the perceptions of local fishermen living adjacent to an HMMR in Vietnam have been obtained and assessed. These are the people most affected by established marine reserves. Their perceptions are therefore extremely important to gauge the effectiveness of the protection in meeting its ecological, economic and social objectives.

6.2 Study site and community surveys

A detailed description of the study site can be found in Chapter 3. Figure 6.1 illustrates the location of the fishing village, where the fishermen perceptions surveys were conducted (Dam Mon), as well as other nearby villages of Whale Island Resort (WIR) and its 11 and 5 ha reserves (Whale Island Bay: WIB & Whale Island Bay Peninsula: WIBP) in Lach Cua Be channel.

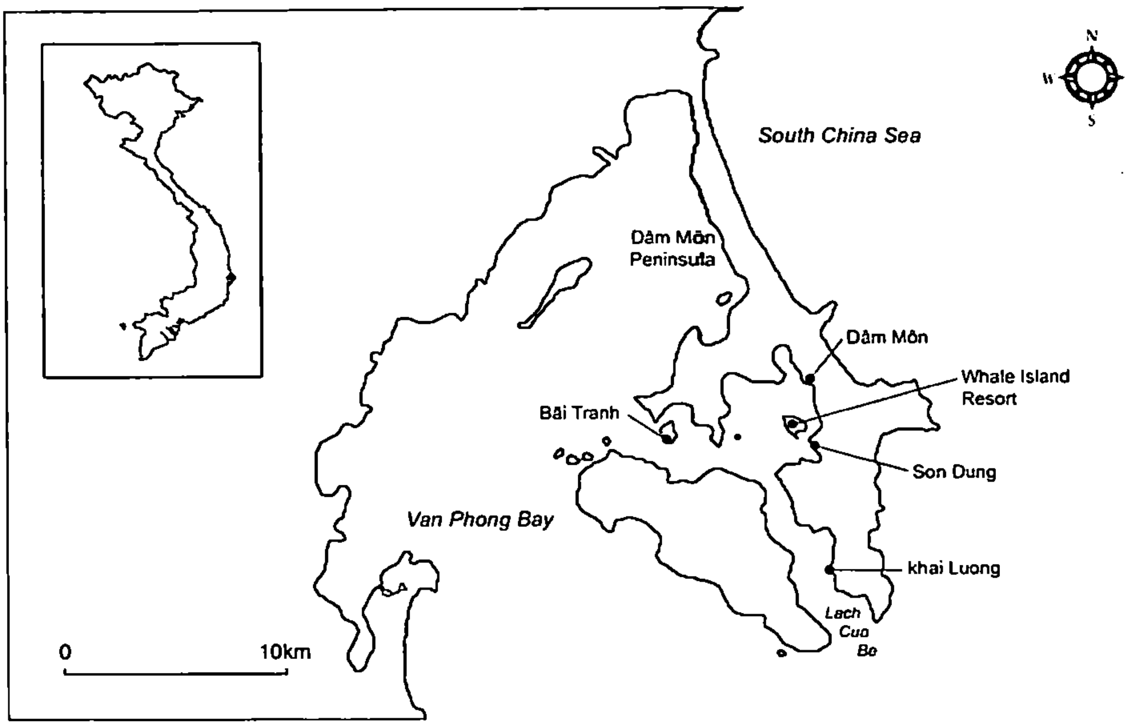

Figure 6.1. Illustration of Whale Island (Hon Ong) showing: Whale Island Resort, Dam Mon and the nearby fishing villages in Lach Cua Be Channel formed by Dam Mon Peninsula and Hon Lon Island, in Van Phong Bay, Khanh Hoa Province, Vietnam

Two sets of qualitative and quantitative, open and close-ended anonymous questionnaires were completed by the fishermen of Dam Mon in October 2006 and April 2007. In October 2006, 40 questionnaires (translated into Vietnamese) were given to the Chairman of the People's Committee to distribute to the local fishermen. When these questionnaires were returned, it was evident that several sets had been completed in unison with the family, providing near duplicate results. A relatively one-sided positive viewpoint pertaining to the benefit of increasing the local number of protected areas was also apparent. A follow-up, identical, interview-based survey was, therefore, conducted with the aid of two local marine biologists from the Institute of Oceanography in Nha Trang, who acted as translators. The idea was to check the authenticity of the results from the first survey and to examine data from a different angle to improve the legitimacy of the outcomes of the investigation. The interviews were conducted with another set of fishermen in April 2007, but singling out individuals in the village was near impossible, so instead, 10 random fishing families were interviewed at their homes while they were repairing their nets. 40-50 individuals were involved in this survey. Complication with singling out individuals is not surprising, considering the traditional Vietnamese social structure, which can be broadly characterised by a closely knitted patriarchal extended family system, where family unity is extremely important (Adger et al. 2001).

Only fishermen from Dam Mon were surveyed since their village is one of the closest to WIR (1 NM), would be most affected by loss of fishing grounds and would therefore be able to give the most accurate interpretation of the ecology and management of the reserves. Fishermen from the other nearby fishing village (Son Dung; Figure 6.1) predominantly fish within the Lach Cua Be channel, which is why these fishermen were not surveyed. Overall, the opinions of approximately 5 % of the fishing village (approx. 2000 people) were represented.

In these semi-structured surveys, fishermen were requested to complete a demographics section detailing their age, sex and average yearly income; give their opinion of whether they consider the amount of fish to have increased, decreased, or stayed approximately the same in the last 10 years; identify the top 5 reasons why the think fish stocks have decreased, if so specified (11 options were suggested, others could be transcribed); state whether they think the coral reefs and fish need protection, while given the opportunity to suggest how; state which fishing techniques they use (11 methods suggested) and which species they target. They were then asked to explain why they think WIR had closed off the bay with buoys and to state whether WIR had had an overall positive, negative or inconsequential impact on their lives. Subsequently, they were asked whether the enclosures had had an impact on their lives financially (responding on a 5-point likert scale from 1 '>20 % increase/year' to 5 '>20 % decrease/year'). Next, they were requested to comment on potential fishing gains incurred from the protection, by stating whether they consider the number of fish, size and diversity of fish to be from, 1 'much higher/bigger to 5 'much lower/small, to within 200 m of the reserve boundary, and to specify if an increase in a particular species had been noticed. The final set of questions enquired whether they themselves, or relatives, ever fish in the reserves (3-point likert scale from 1 'Yes, often' to 3 'No, never') and, if so, why they fish there; how the number and diversity of fish, number of invertebrates and coral cover in the reserves compare to unprotected areas (responding on a 5-point likert scale from 1 'much higher' to 5 'much lower'), and if they think it would be a 'good idea' or 'bad idea' if the hotel or government were to close off more coastal areas around Whale Island.

Since two different survey techniques were used, each with a small sample size, and comprising some near duplicate results, detailed statistical analysis was not possible. Instead, qualitative and descriptive analysis is provided, which give some indication of reserve effectiveness and management performance. These data are, however, exceptionally valuable in providing an insight into local communities' attitudes to MPAs and, in particular, to HMMRs, as such information is rare, or the first of its kind.

6.3 Results

The 40 respondents of the first survey represented a balanced mix of genders aged >18 to <65, the majority ranging from 18 to 35 (Table 6.1). The average fisherman's income totalled VND 9,990,000 per year, or approximately US$ 640 (Apr. 2007 exchange rate: US$ 1 = VND 15,600). Most of the lowest income earners were the older generations >55 and the one boy under 18, earning <VND 5 million per annum. The lowest income recorded was VND 2.5 million (US$ 160/year). The highest earners (max VND 60 million, or US$ 3846 per annum) were between 18 and 25, who target tuna in deeper waters outside the channel. The large group of middle-ranged income earners use a wide range of fishing techniques from hose and hook fishing and trap fishing to trawling. They target shrimps and little lobsters for use in aquaculture, anchovy, squid and Carangidae spp. inside and outside the channel, or indiscriminately any kind of fish, often through cast-net fishing or beach seining (Figure 6.2).

Table 6.1. Breakdown of Dam Mon fishermen's responses to the first questionnaire distributed by the Chairman of the People's Committee (%) and second interview-based questionnaire, expressed in number of families

	Fishermen (%)	No. families
Sex	(n=40)	
Female	52.5	
Male	47.5	
Age	(n=37)	
<18	2.7	
18-25	27.0	
26-35	29.7	
36-45	18.9	
46-55	10.8	
56-65	5.4	
>65	5.4	
Yearly Income	(n=35)	
≤5,000,000	19.0	2
>5,000,000 ≤7,500,000	26.2	1
>7,500,000 ≤10,000,000	16.7	2
>10,000,000 ≤15,000,000	14.3	1
>15,000,000	7.1	1
No. fish in last decade?	(n=40)	
Decreased	95.0	9
No Change	5.0	1
Do corals need protection?	(n=40)	
Yes	100.0	6
No		3
Why WIR enclosed bay?	(n=38)	
Protect ecosystem	94.7	4
Prevent fishing, Increase fish species	86.8	2
Attract tourists	29.0	7
WIR changed life?	(n=39)	
No change	61.5	
Overall positive	38.5	1
Overall negative		9
Yearly income changed?	(n=39)	
No change	53.9	
>20% Increase	35.9	
>10% Increase	5.1	
>20% Decrease	5.1	8
>10% Decrease		1
Fish within 200m?	(n=40)	
Yes	80.0	2
No	20.0	

	Fishermen (%)	No. families
Number of fish within 200m?	(n=30)	
Much Higher	40.0	1
Higher	60.0	
No change		1
Size of fish within 200m?	(n=30)	
Much Bigger	46.7	
Bigger	46.7	
No Change	4.7	1
Spp. richness within 200m?	(n=29)	
Much Higher	24.1	
Higher	75.9	
No change		1
Increase in spp. within 200m?	(n=30)	
Coral reef fish	70.0	
Mugilidae	36.7	
Serranidae	30.0	
Nemipteridae	23.3	
Carangidae	16.7	
Squid or Anchovy	13.3	
Invertebrates	6.7	
Fish inside bay?	(n=36)	
No, never	97.8	10
Yes, sometimes	2.2	
Been inside buoys?	(n=40)	
Yes	67.5	
No	32.5	10
Species richness in HMMR?	(n=20)	
Much higher	25.0	
Higher	75.0	
Number of fish in HMMR?	(n=26)	
Much higher	15.4	
Higher	84.6	
Number of Invertebrates in HMMR?	(n=25)	
Much Higher	12.0	
Higher	88.0	
Coral cover in HMMR?	(n=25)	
Much Higher	12.0	
Higher	88.0	
Make more MPAs?	(n=37)	
Good Idea	100.0	2
Bad Idea		8

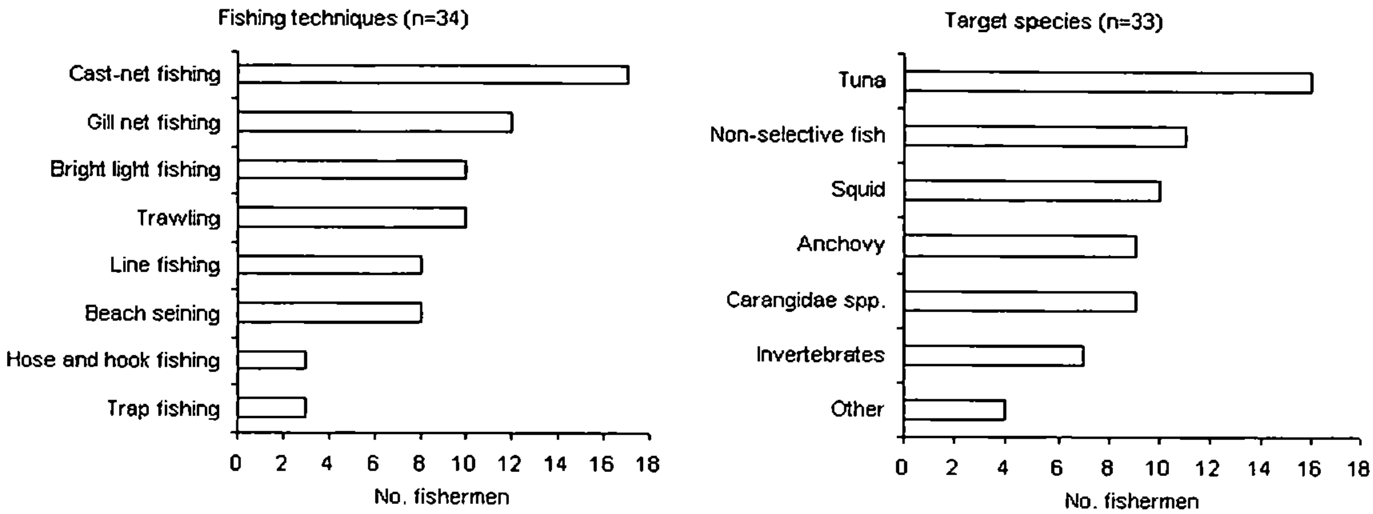

Figure 6.2. The fishing techniques and target species of Dam Mon fishermen

The vast majority (95 %) had noticed a decrease in the number of fish in the ocean in the last decade, the main reason being attributed to better fishing techniques. Blast fishing was accredited a close second, and overfishing, third place (Figure 6.3). These findings coincide with the resort owners' conclusions as to why fish and coral populations had declined, and why they decided to protect their adjacent coastline.

All fishermen suggested coral reef ecosystems should be protected, specifically to protect from blast fishing and to increase the standing stock. They thought that protected zones should be strictly enforced and the local communities educated to understand the value of MPAs (Figure 6.3). When asked why they thought WIR had enclosed the bays with buoys, all but two mentioned marine protection; instead these indicated that it was only to attract tourists. In fact, 29 % of all fishermen from the first survey also suspected the reason was to attract more tourists (Table 6.1).

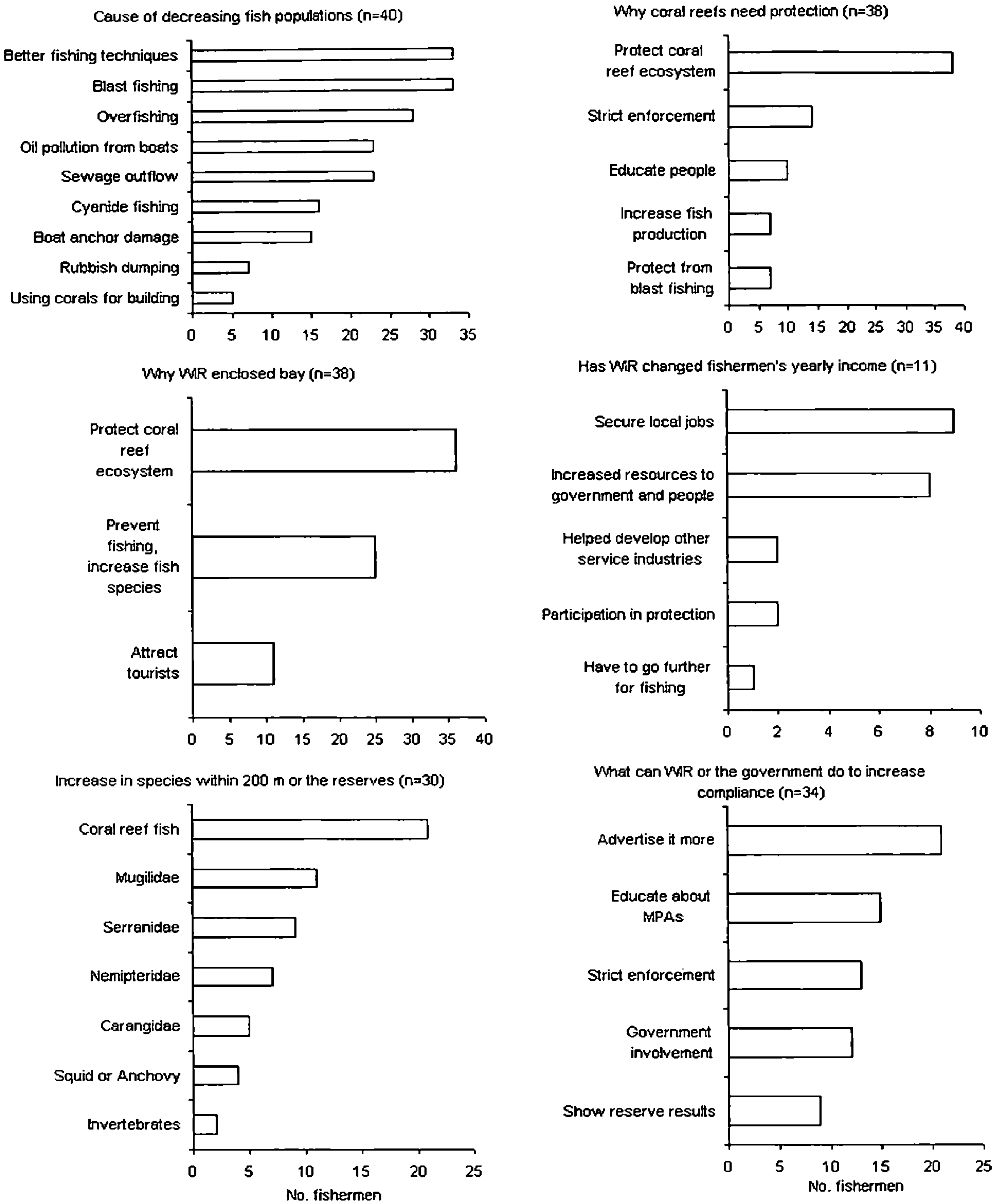

Figure 6.3. Dam Mon fishermen's opinions on the cause of decreasing fish populations (a.), why coral reefs need protection (b.), why Whale Island Resort (WIR) enclosed the bay (c.), reasons for a change in yearly income brought on by the establishment of the HMMRs (d.), their perceptions of the fish species attributing to spillover (<200 m) (e.) and suggestions what WIR and/or government could do to increase compliance (f.)

The responses from the fishermen showed an overall positive attitude towards WIR, with 41 % boasting an increase in their yearly income (Table 6.1). Those giving a reason for this suggested that they had secure jobs or could develop other projects related to tourism since the protection (Figure 6.3). These fishermen are included in the 80 % who fish within 200 m of the reserve and who have noticed an increase in the number, size and species richness of fish within this area, regardless of their fishing techniques. While the majority suggested that coral reef fish in general had increased within 200 m of the reserve, several fishermen also declared an increase in commercially valuable groups of large food fishes, e.g. Serranidae and Carangidae (Table 6.1).

Two fishermen declared a decrease in their yearly income, one of whom admitted to sometimes fishing inside the reserve (the only one to do so), but did not comment on which fishing techniques he uses or the state of the reserve compared with unprotected areas. The second fisherman thought that the size of fish and the species richness was greater within 200 m of the reserve, but explained that the fishermen now have to go further for fishing and expenses are increasing (Figure 6.3).

Although only one fisherman admitted to fishing inside the reserves, 68 % had an opinion on the number of fish and invertebrates, coral cover and species richness within the reserves compared with unprotected areas. All fishermen who commented on these attributes rated reserve species as being higher or much higher (Table 6.1). The fishermen were asked what could be done to improve compliance. Their suggestions varied from education and advertising the reserve, by announcements and showing reserve results, to stricter enforcements and more government involvement (Figure 6.3). All but three, who did not offer an opinion, thought that more reserves around the island would be better (Table 6.1); eight respondents even suggested protecting a coastal area fringing the whole island. Interestingly, the two who indicated a decrease in yearly salary also recommended more protection.

These eight respondents, however, belong to one of two larger sets of fishermen surveys, whose results were mostly identical, minus the demographics section, suggesting they could have completed the questionnaires in unison with the whole family. These eight have at least one boat large enough to go outside the channel to fish for tuna. Seven of them indicated that their income had increased by >20 % because of the reserve, six of them suggesting it was because they had secure jobs. They all thought that coral reef fish abundances had increased within 200 m of the reserve and considered the reserve biota to be higher than unprotected areas, understanding the value of the protected zone. The other group of 7 with similar results, all replied identically to the question: what could the hotel or government do to increase compliance. All suggested more government involvement and for the hotel to announce reserve achievements. They fish for squid, anchovy and little lobsters and consider the reserve to be effectively increasing fish assemblages in and within 200 m of the reserves. Six of them thought it would be a good idea to increase the number of reserves around Whale Island and one had noticed a financial increase.

The responses of the interviewed families of fishermen differed greatly from those of the other fishermen. Their average yearly income, calculated from the total amount earned by the fishermen of the family, divided by the number of family fishermen, equalled VND 7,400,000 or US$ 470 (73.4 % of the average income from the first survey). Most of these fishermen had noticed a decline in the number of fish, attributed to better fishing techniques and overfishing, but only 6 families thought that the coral reef ecosystem needed protection (Table 6.1). These fishermen, living on the outskirts of Dam Mon, fish with bright lights targeting anchovy (6 families) and squid (4 families), and 8 families also fish by beach seining, which is non-selective.

Six families concluded that WIR had erected the fishing boundaries to protect the coral reef ecosystem or to increase fish stocks, but seven families figured it was also or only to attract tourists. Only one family thought the efforts of WIR had had a positive impact on them, and all who commented, stated a financial loss since the reserves were established (Table 6.1). They implied that they had to go further for fishing, which cuts into their profit margin.

Only 2 families fish within 200 m of the reserves, one reporting an increase in stocks; the other had not noticed any significant changes since the protection. All, however, clearly indicated that they do not fish inside the reserve because they are afraid of potential repercussions in the form of fines or gear/vessel confiscations. Several of these fishermen had bitter feelings towards the owners and the reserves and one fisherman thought that the owners had only restricted fishing in order to be able to catch fish for themselves and guests. Only 2 families thought that more protected areas around Whale Island would be a good idea (Table 6.1).

6.4 Discussion

It has been the strategy of some governments to relocate whole communities following the establishment of an MPA, to reduce pressure on resources and to increase income potential (Wells & McShane 2004). Many countries do not have the capital or resources for such actions, however, and the ethical justification is questionable. Community managed MPAs, where local communities can have a voice in reserve location and objectives, is in this sense fairer. When established hotels wish to enclose an area for the sake of conservation, and possibly to attract more tourists, the location is already generally decided: adjacent to the hotel. Therefore, community involvement and acquiescence is extremely important, especially when foreign ownership is concerned (Langholz & Lassoie 2001).

The owners of WIR asked the local staff to confer with their families, and feedback to them if they would have any objections for the bay adjacent to the hotel to be enclosed, and fishing to be prohibited. While all the respondents from the first survey and 6 fishing families from the second survey now agree that coral reefs need protection, and 100 % from the first survey and 2 families from the second, would welcome more protected areas around Whale Island (Table 6.1), it took a few years upon establishment of the HMMR to increase compliance to the no-fishing rule to a level of perceived acceptable loss, where only occasionally, hook and line fishermen using bamboo basket boats, did not comply (Michel Galey, resort owner, pers. comm.). 42 % of the fishermen from the first survey suggested that education programs should be established to make people better understand the value of marine reserves (Figure 6.3).

Although 95 % of fishermen from the first survey thought that WIR had established the reserves to protect the coral reef ecosystem or increase fish stocks, only 6 families from the second survey believed this, and 4 families thought it was purely for tourists' benefit. One family additionally commented that there had been no announcements from the hotel. In a survey conducted with owners of private reserves on land in Costa Rica, it was determined that a sense of conservation ethic was the most powerful motivating force to establishing private reserves, followed by profit (Langholz et al. 2000). The main concern for the owners of WIR, when the reserves were established was, and is, protecting the coral reef ecosystem, highlighted by the fact that they have not advertised the reserves to tourists. It seems, however, that a more widespread and direct announcement by the hotel when planning the reserves would have been preferred by local fishermen, in order to give them a feeling of involvement and to manifest their position as stakeholders, where their opinions and concerns are taken into consideration. More government involvement and education awareness programs concerning the benefits of marine reserves, as well as regular updates on reserve progress, would also have been appreciated after the reserves were established (Figure 6.4). Such regular communications with the adjacent communities would have informed fishermen of the conservation efforts the hotel is undertaking, and provide the opportunity for open debate on how the hotel and local communities could work together to achieve mutual goals.

Fishers' lack of education and knowledge of marine reserves as a method of sustaining habitats and nearshore fisheries in the long-term has been recognised in areas of the Philippines (White & Vogt 2000). Once an MPA has been designated, providing more information about regulations and scientific results has shown to increase local stakeholders' feeling of participation, significantly increasing compliance (Viteri & Chavez 2007). In a compliance analysis with fishermen in the Galapagos Marine Reserve, boat owners' perception of the legitimacy of regulations was a major influence for compliance (Viteri & Chavez 2007), suggesting that the adherence to no-poaching regulations for an HMMR would be better accepted with a more notable presence of a respected body, such as the local government. Strict and well-controlled reserve boundaries were also recognised by several fishermen as a necessary action to increase compliance. Aswani et al. (2007) interviewed fishermen from communities adjacent to reserves in the Solomon Islands and found that while good enforcement equalled less poaching, the perceptions of MPA effectiveness was also directly correlated with the level of enforcement. The costs of enforcement must, however, be lower than gains attributed to yields from unprotected areas due to spillover (Sethi & Hilborn 2008).

Today, poaching at WIB is very rare. This has led to reduced enforcement. There has not been a need to contact the coast guard in several years, so enforcement is now solely controlled by the security officers/night-time reserve wardens. It is generally sufficient to shine a bright light on fishing boats encroaching on reserve boundaries to deter them from any fishing activities. Sometimes, the quieter and more concealed bamboo basket boats may slip by, but then less extractive hook and line fishing is used. While these occurrences are relatively seldom, and the amount of fish caught is limited by their fishing technique, continued non-compliance could be quite harmful and should not be underestimated. Van Zweiten et al. (2002) estimated that basket boat fishing could contribute to one quarter of the total catch of the inshore fishery in Nam Dinh province, Vietnam. However, biological surveys conducted from 2005-2007, researching the size of fish, fish density and species richness, still confirm significantly higher fish assemblages within the reserves compared to unprotected areas (Chapter 4). Spillover was not researched during these biological surveys, but according to the majority of the fishermen from both surveys who fish within 200 m of the reserve boundaries, the HMMRs are increasing the number, size or species richness of fish and providing spillover of, amongst others, large food fishes (e.g. Serranidae and Carangidae; Figure 6.3).

When asked whether they had ever been inside the reserves, 68 % of fishermen from the first survey indicated that they had, and suggested that the number of fish and invertebrates, species richness and coral cover, was higher in the reserves compared to adjacent unprotected areas. Fishermen from the second survey strongly refuted that they ever cross reserve boundaries, being concerned of potential repercussions (Table 6.1). Although, enforcement is now relatively weak, strong enforcement in the past by the local coast guard has ingrained in them knowledge that the expected loss from detection outweighs possible gains from poaching. This has been described as efficient enforcement (Beddington et al. 2007). While these fishing families therefore no longer fish within the reserves, a feeling of animosity towards the hotel has grown, which could perhaps have been avoided, had the hotel owners communicated better, described to the fishing community the potential long-term benefits of MPAs and involved local representatives in the decision making process from the start.

Only one fisherman from the first survey actually admitted to sometimes fishing in the reserves, which prompts the question how all the other 26 fishermen from the first survey can maintain that fish and coral assemblages are higher in the reserve compared with unprotected areas. Eight of these fishermen noted that they now have secure jobs but it is not known whether these secured jobs are positions within WIR. The remainder did not comment, so it is unclear whether all the fishermen had a legitimate reason for knowing the status of coral and fish assemblages in the reserves, if they were just trying to be helpful by answering the question, rather than saying "don't know", or if they were not completely truthful when maintaining they do not fish there. It is understandable that even in anonymous surveys, people do not wish to implicate themselves or family in illegal activities. A more truthful and accurate answer may have been attained by changing the wording of the compliance question to, "whether they know of *other* people who fish within the reserves", as was done by Cinner et al. (2005) to assess the compliance of a closure at Ahus Island, Papua New Guinea.

Quite a large number of fishermen from the first survey stated that their yearly income had increased thanks to the hotel (41 %) and over half of these suggested that it was because of secured jobs or other related service industries (Figure 6.3). Members of these fishing families could have positions with the hotel, they could be delivering resources to the hotel, or they could have established other services thanks to the increasing reputation of the hotel and the resulting tourism growth. They could also simply be better off now, due to a constant supply of spillover of fish from the reserves. Unfortunately, without more detailed comments, this is not possible to determine. All fishermen from the second survey claimed a decrease in income since reserve inauguration (Table 6.1). Half the fishing families commented, and these blame the hotel for their decreased catches, suggesting that the number of available fishing grounds have been stripped away from them. One family argued that, where they once had 5 beaches to fish by beach seining, they now only have 3. Since their fishing vessels are not large, their possible fishing grounds are limited in distance.

It has been suggested that larger marine reserves may be better for biological reasons, bat that smaller no-take areas are generally better accepted by local communities as they do not significantly affect their socioeconomic welfare (Unsworth et al. 2007). While theoretically true, local fishing techniques must be taken into account when establishing HMMRs. The loss of two beaches out of 5 seriously impinges on their ability to secure resources for survival.

Several families suggested that the hotel or government could give financial support to invest in lobster aquaculture, or better boats and equipment, in order for them to be able to extend their fishing area. At least six families out of both surveys partake in lobster farming. The hotel or government could provide financial aid to support lobster aquaculture, but consequences could be dire if additionally funds are not invested in quality feed. Most fishermen currently provide trash fish, mixed with low value crustaceans, increasing the likelihood of infection. This results in copious amounts of antibiotics being used which, in combination, could seriously increase nutrification and harm the environment, especially in areas of low water circulation (IUCN 2003b).

Open access fishing has been depicted as a last resort for survival in times of economic crisis (Bene & Tewfik 2003), but when overfishing has been the constant for a long time, even fishing may not be enough for survival. The bionomic equilibrium is reached when a sustainable human population is surpassed, inducing overfishing, and fishing efforts have reduced the fish population to a level at which catch rates are barely sufficient to cover the costs of fishing (Beddington et al. 2007). It seems that this equilibrium could be near, since 23 % of the fishermen from the first survey and 2 fishing families earn less than the international poverty line of US$ 1 (VND 15,600) per day (IUCN 2003c; Table 6.1). Half of these are, however, the very old or the very young, who will be taken care of in their large, closely knitted, extended families.

Unlike many developed countries, the families of developing countries are often quite large, often including the extended family that live and work together to support all members. For this reason, it was difficult to get individual fishermen responses to the surveys conducted and why it is quite probable that 15 responses from the first survey can be traced back to two families. For the second survey, it proved extremely difficult to interview one fisherman at a time, since everyone wanted to listen and hear what the white foreigner wanted in their small village. This is why the collective opinions of all members of the family (40-50 individuals) were taken into account. A possible method to improve the accuracy of the results of this study would involve questionnaires being distributed to each fisherman as they were returning with their catch, with translators on hand to aid those who were not literate. This may have increased the number of individual responses and avoided respected family elders influencing younger family members' responses. In Vietnam, ancestor worship highly influences the culture and mentality of the people. Children are taught from a young age that they owe everything to their parents and ancestors (Vietnam-culture.com). As a result, younger generations have profound respect for their parents and elders, suggesting they may be more likely swayed by their opinions in their presence. This inevitably biases such family group results.

While 9 out of 10 families implied that WIR had had an overall negative effect on their lives, 39 % from the first survey thought the opposite (Table 6.1). The reasons for these differences could be manifold. The beach seining fishing technique also used by several of the families interviewed decreases their potential to catch enough fish, since two of five beaches have been occupied by WIR. Also, as a result of this non-selective catch method, the hotel does not buy fish from them for guests. The opposite may also be true for fishermen from the first survey, since more of them have larger boats, enabling them to fish in deeper waters to catch tuna and other larger predatory fish, which the hotel will more readily purchase (Figure 6.2). These fishermen may consequently not be as dependent on nearshore fishing as the poorer fishermen from the second survey, suggesting they may not have had any difficulties with the local coast guard in the first years after the reserve was established, unlike some of the fishing families, who may therefore be harbouring ill feelings towards the hotel owners.

More positive and supporting responses from the fishermen of the first survey with regards to the HMMR and the question whether they would welcome more reserves to the area may also have been influenced by the Chairman of the People's Committee. He may have distributed the questionnaires to friends or families he knew, perhaps even to people who work for, or who supply the hotel with their catch (potentially explaining the comments from some fishermen, explaining they have secure jobs: Figure 6.4), or who may well be 'wealthier' families, owning larger vessels and who, are therefore, less nearshore dependent. He will perhaps also have told them what he knows about the hotel, its reserves and the research being conducted, which would greatly influence these fishermen's attitudes and responses.

In account of such uncertainty, it is important to bear in mind possible biases to certain responses from the first surveyed fishermen and/or to consider a misrepresentation of the opinions of the larger community. Albeit, the results do suggest positive attitudes towards the HMMRs and towards establishing more protected areas in a subgroup of the community, but without verifying the perceptions of a larger population, it may be too soon to confirm the effectiveness of HMMRs from a socio-economic point of view.

6.5 Conclusion

The majority of the local fishermen have noticed a decrease in fish populations over the last decade. They recognise the need to protect coral reef ecosystems, especially in today's situation where better fishing techniques are available; population growth has led to overfishing, and where a remaining destructive minority still use blast fishing. A large proportion of fishermen have detected spillover of fish from the reserve, including commercially valuable groups of large food fishes; and the previous biological surveys confirm significantly higher fish stocks within the protection (Chapter 4). Moreover, in the tourist survey (Chapter 7), results indicated that 97.5 % support HMMRs and 86.3 % would be willing to pay extra to stay at such hotels. These findings suggest that this HMMR has achieved its ecological objectives and has the guests' support. A follow-up study to confirm fishers' perceptions of spillover, however, would be prudent, since currently, the social and economic benefits to local fishermen are ambivalent, and depend mainly on the target fishery. More direct and widespread communication, involvement, education and financial support from the hotel could make this HMMR more effectively managed. By paying greater attention to developing and maintaining a mutualistic relationship with affected communities, HMMRs could realise a great potential as an added alternative to traditionally managed MPAs, especially if the government would show a greater presence by aiding in surveillance, monitoring and developing appropriate management and policy frameworks, thereby confirming the legitimacy of the HMMRs and substantiating its support for them as an important marine conservation tool. A network of hundreds to thousands of such

HMMRs lining coastal tropical countries could have a cumulative positive effect on fish stocks to nearshore areas (Dawson et al. 2006; Roberts et al. 2001).

These community surveys provide first indications of the strengths and weaknesses of the management of an HMMR. However, an individual, singular, interview-based survey design, involving a larger sample size would give an improved understanding of the management effectiveness of the HMMR. Future studies of this kind could be used to help gauge management performance and reserve effectiveness for a vast number of community and government managed MPAs worldwide.

7. Hotel Managed Marine Reserves: A Willingness to Pay survey

Contents of this chapter were used to write:

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7.1 Introduction

The bottom–up approach of community-managed marine reserves is widely considered key to effective reef management in the tropics (White & Vogt 2000). Local fishermen's knowledge of the surrounding seas can help provide information of possible locations for the marine reserve and without local community cooperation and participation, reserves may quickly be confronted with protest and rejection, resulting in poaching. Community-managed marine reserves are, however, not generally managed by local communities alone but rather as a joint venture with other stakeholders – the local government, a Non-Government Organisation (NGO) or the private sector (Kiss 2004).

In several circumstances, private enterprises such as hotels and resorts have taken over the day-to-day management of a protected area and, in some cases, full responsibility for the reserve (Colwell 1999). In other instances, hotels have been the initiator and subsequent manager of the reserve (Hotel Managed Marine Reserve: HMMR), with varying degrees of participation from the local governments and/or communities. While private parks may be covering a substantial area on land and growing rapidly, they are only recently becoming more popular at sea. Private parks on land, like those at sea, are still widely undocumented and insufficiently researched, but both are believed to have been initiated because of the same reasons. Firstly, the government's inability to satisfy public demand for nature conservation, in quality and quantity alike (Langholz & Lassoie 2001; Riedmiller 1999), which has led to inefficiently managed parks "paper parks" and damaged ecosystems. In the Caribbean and Southeast Asia, it was found that only

6 and 14 %, respectively, of 285 Marine Protected Areas (MPAs) reviewed were effectively managed (Burke & Maidens 2004; Burke et al. 2002). Some countries have even become indebted, having to rely on international support (Dearden et al. 2005). In a report on a change in governance of protected area systems between 1992 and 2002 in 41 countries, Dearden et al. (2005) found increasingly more countries, therefore, relying on a broader range of funding sources; the medium and less developed countries relying significantly more on funds from foreign governments, donations and concessions paid by the private sector (25 % compared with 14 % of total funding). There is seemingly a trend leading away from solely government-managed protected areas, towards increased participation of stakeholders, with the private sector, local communities and NGOs having a large influence on protected area decision-making (Dearden et al. 2005).

A second reason for the increasing number of private reserves is a growing societal interest in biodiversity conservation (Langholz & Lassoie 2001), peaking with the World Summit on Sustainable Development (Johannesburg 2002) and, later, the World Parks Congress (Durban, September 2003), where representatives of protected areas recommended networks of marine reserves covering 20–30 % of habitats by 2012.

The rapidly growing ecotourism industry is another reason why the private sector is pushing for HMMRs, where they can establish a market niche. Ecotourism has been praised as one of the most promising approaches to sustainable development and protection of important environmental resources in lesser developed nations (Gossling 1999). With ecotourism, it is expected that the impact from tourism on the environment is kept to a bare minimum and that tourism benefits also profit local communities, either by employment or by contributing to community projects (Kiss 2004).

Today, the vast majority of HMMRs are not recognised as MPAs by The World Conservation Union (IUCN). Chumbe Island Coral Park (CHICOP) is one exception, possibly also representing the first fully functioning MPA in Tanzania (Riedmiller 1999). Several others have, however, been initiated privately, before public protection was established (Langholz & Lassoie 2001) and recently, a large number of reported cases of HMMRs lining coastal tropical countries can be found (Chapter 8). In these situations, it was the resort managers' sense of responsibility to their surroundings, which was the initial driving force for their conservation efforts.

These hotels have succeeded in establishing effectively protected marine reserves since they have successfully incorporated the local communities into their hotel and conservation projects. Like many dive resorts they also have boats, personnel and other equipment needed to manage local protected areas and the financial backing and incentive to protect their assets (Colwell 1999), but depending on the extent of their conservation projects, a little financial backing from guests in the form of HMMR user fees can go a long way. Tongson and Dygico (2004) found that tourists can appreciate user fees as they are a direct means to contribute to conserving the natural resources they will enjoy. Several studies actually suggest that tourists and divers are willing to pay substantial user fees to enter MPAs, which can financially supplement or even completely cover conservation costs

(Ahmed et al. 2007; Depondt & Green 2006; Tongson & Dygico 2004). It is suggested that MPAs only start to become successfully managed when funding is secured through self-financing (Davis & Tisdell 1996). The constant supply of funding from user fees could, therefore, be a solution to financing and thereby effectively managing protected areas (Arin & Kramer 2002).

Projects, which may require financial assistance, include monitoring coral reefs, mangroves or other marine life, including sharks, dolphins or turtles, and maintaining turtle hatcheries. Projects may also involve creating artificial reefs out of concrete domes or using mineral accreting technology owned by Biorock™ to transplant coral. Other HMMRs have developed education or awareness programs for tourists, staff and local communities (Chapter 8).

In addition to project costs, associated resources and salary costs, HMMRs generally also need to pay for the area covered by the marine reserve. This can take the form of a lease or tax to be paid to the local government (Colwell 1999). In some instances a portion of user fees are delivered to local communities to build schools, hospitals or to improve infrastructure, or given to fishermen to compensate for any fishing grounds lost (Langholz & Lassoie 2001). The costs accrued to manage HMMRs will ultimately dependent on the conservation projects they are involved in, their management set-up, location and size.

A Willingness to Pay (WTP) survey was conducted at an HMMR in Vietnam in order to gauge tourists' knowledge and interest in marine conservation, the importance of various factors in choosing and locating hotels, their opinion of

HMMRs, and whether tourists would be willing to pay a user fee to support HMMRs. The consumer surplus (CS) was also calculated with the intent of establishing the elasticity of demand for HMMRs, resulting in the optimal user fee.

7.2 Study site and tourists' willingness to pay

A total of 211 questionnaires was completed by tourists visiting the HMMR, Whale Island Resort (WIR) (Figure 7.1) during the four research visits between Autumn 2005 and Spring 2007 (detailed accounts of the study site can be found in Chapter 3). These qualitative and quantitative, open and close-ended questionnaires were placed on the reception desk, so the hotel guests could complete them at will, but usually they were completed during check-out. These questionnaires draw on a convenience sample restricted to the sample group of the hotel guests, providing a great range in age, income, environmental knowledge and level of education of travelling tourists. However, when considering the sample representation for nationalities of visiting tourists to Vietnam, the representation is more balanced to European visitors in the sample; a more accurate, larger Asian proportion in the sample may have been achieved had I conducted surveys with random tourists at several locations.

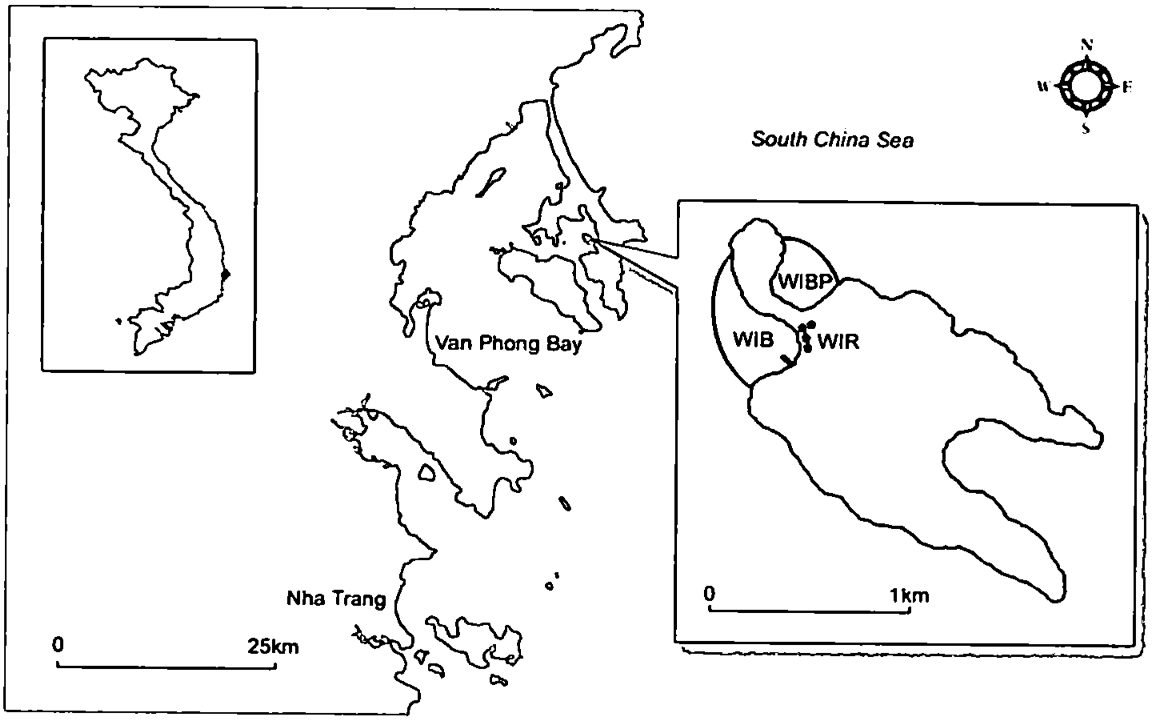


Figure 7.1. Illustration of Whale Island (Hon Ong) showing the Whale Island Resort (WIR), the 11 ha Whale Island Bay reserve (WIB) and the 5 ha Whale Island Bay Peninsula reserve (WIBP) in Van Phong Bay, Khanh Hoa Province, Vietnam.

In this anonymous questionnaire, guests were asked to complete a demographic and personal questions section; a set of behavioural choice questions relating to the methods and reasons for choosing hotels; questions related to their environmental awareness and interests; their opinion of the biophysical state of the HMMR compared to unprotected areas; their thoughts on hotels or resorts acting as caretakers and mangers of marine reserves and how this should be advertised; and lastly, if they would be willing to pay extra for HMMRs, and if so, how much.

For the final WTP questions, a hypothetical scenario was laid out. The respondents were requested to decide if they would be willing to pay more to stay at a hotel which is managing a marine reserve, compared to an adjacent hotel, which is not, all else being equal. The follow-up question asked them to specify how much more they would be willing to pay per night in either US$ or as percent of the room rate. The additional choice to provide a WTP amount as percent of the room rate was added to the fixed US$ option because during the initial interview-based pilot surveys, the majority of tourists requested this possibility on their own accord. To convert the percentage value into monetary terms, the room rate of WIR was used as a model. The average length of stay of three nights was determined as the actual room rate (US$ 96) since the room rate decreases with the number of nights stayed. All percentage responses could thereby be converted to US$ and the median and average WTP calculated for the sample population.

An open-ended WTP Contingent Valuation Method (CVM) question, where respondents specify the amount themselves, was chosen over a dichotomous choice question because this is the first survey of its kind and I did not wish to assume on the distribution of WTP and encourage biased responses by providing pre-defined ranges (O'Conor et al. 1999). Open-ended questionnaires are also understood to give a lower WTP (Bateman et al. 1995). This was preferred, since it is suggested that when people are faced with hypothetical scenarios involving payment, they are often over-generous (White et al. 2001). While they may hypothetically agree to pay a certain amount, they would commonly only agree to half in reality (Loomis et al. 1996).

A stated preference, CVM, was also chosen over other stated preference models (e.g. Choice Modelling - CM), or a revealed preference model (e.g. Travel-Cost Method - TCM), because they are both suspected of giving higher valuation estimates than CVM, which follows my continued goal of trying to produce the most conservative results possible. In a series of experiments involving over 2000 subjects, Boyle et al. (2004) demonstrated that CVM tended to produce much lower valuation estimates than CM. Similarly, Carson et al. (1996) compared stated and revealed preference estimates from 83 studies between 1966 and 1994, and found that CVM estimates were lower (approximately 30 %) than their revealed preference counterpart, TCM (Whitehead 2006).

In order to determine statistical significance between variables and WTP amounts, non-parametric tests were employed (Mann–Whitney U and Kruskal–Wallis H) to test the null-hypothesis that two or more samples were drawn from a single population. The Chi-square cross-tabulations test was used to reveal significance between reasons provided for WTP. Tests excluded tourists who did not wish to comment on their WTP and ignored the final question. One additional sample was removed from the populations because the WTP was deemed far too high to be considered serious (200 % of room rate per night).

The CS was calculated based on the amount guests were willing to pay and calculated the total revenue the resort could make, depending on various user fees the resort could implement per room for nights stayed.

7.3 Results

The European community prevailed in this study, the more numerous being the British, Dutch and then French. While the majority of the visitors resided in their home countries, one-tenth of the visitors had taken up Vietnamese residency (included in 'Other', which also includes the rest of Asia, South and Central America – Table 7.1). University educated visitors dominated and 69 % of the population were between 26-45 years old. A larger percentage of the sample comprised women and the income level was split throughout the spectrum.

There were no significant relationships between these variables and WTP. Although there was a trend in certain categories for higher WTP, such as visitors aged 36-45 and those with PhD level education (Kruskal–Wallis p=0.273, Df=4; p= 0.168, Df=3), the amount visitors were willing to pay varied widely, resulting in high variance (Table 7.1).

Table 7.1. Breakdown of tourists' demographic and personal data and their Willingness to Pay (WTP) (US$) extra to stay at an HMMR with Standard Errors (SE)

	Visitors (%)	WTP ($)	SE
Nationality			
European	69.46	12.55	1.01
Oceanian	16.75	14.88	3.97
North American	8.87	11.37	2.43
Other	4.93	15.49	2.63
Country of Residence			
Europe	62.07	12.58	1.11
Oceania	15.27	15.66	4.23
North America	6.40	11.60	3.36
Other	16.26	12.53	1.26
Gender			
Female	56.31	12.46	1.08
Male	43.69	13.44	1.68
Age			
<26	10.10	9.30	1.74
26-35	44.23	11.73	1.22
36-45	25.00	16.63	2.73
46-55	10.10	12.40	2.44
>55	10.58	12.14	1.51
Education			
Secondary school	9.52	13.47	2.63
College	21.43	14.76	3.32
University	62.38	11.63	0.89
PhD	6.67	17.80	2.92
Gross Income/year ($)			
No Income	5.05	11.33	2.77
<15000	4.04	10.71	1.95
15000-30000	15.66	14.01	3.33
30000-45000	18.18	15.31	2.54
45000-60000	20.71	13.78	2.68
60000-75000	14.65	11.84	1.71
75000-90000	9.60	9.76	1.47
>90000	12.12	12.42	1.80

The sample comprises the available data from 211 surveyed guests minus 24 unusable samples. The WTP is the average, converted from % room rate where necessary, based on US$96/room/night.

In the next section, tourists were confronted with behavioural choice questions: top three methods they use to locate hotels; how they located WIR; the importance of various factors for choosing hotels and the top three reasons for choosing WIR.

The method most commonly used to find tourist's choice of hotel was the internet followed by word of mouth and travel guides (Figure 7.2). This was also the order demonstrated by guests choosing WIR. It seems word of mouth differed the most, with 5.4 % more tourists attracted to the hotel by recommendation, suggesting positive experiences by previous guests. The method least chosen for locating hotels was environmental hotel award sites, which is not so surprising since only 10.95 % of the population said they knew where to look for environmentally friendly hotels (Table 7.2) and of these, approximately half the tourists' responses were vague, writing only 'internet'.

On a likert scale from one to five, tourists were asked to rate certain hotel attributes in order of importance. Location was the most important attribute when choosing a hotel, followed by price, facilities, service and lastly, environmental awards (Figure 7.3). The importance of 'location' also became apparent when asked why they chose WIR, the top two reasons being, 'away from mass tourism' and 'island setting' followed by facilities: SCUBA diving and snorkelling. Eco-friendliness came in forth place ahead of service and safety (Figure 7.3).

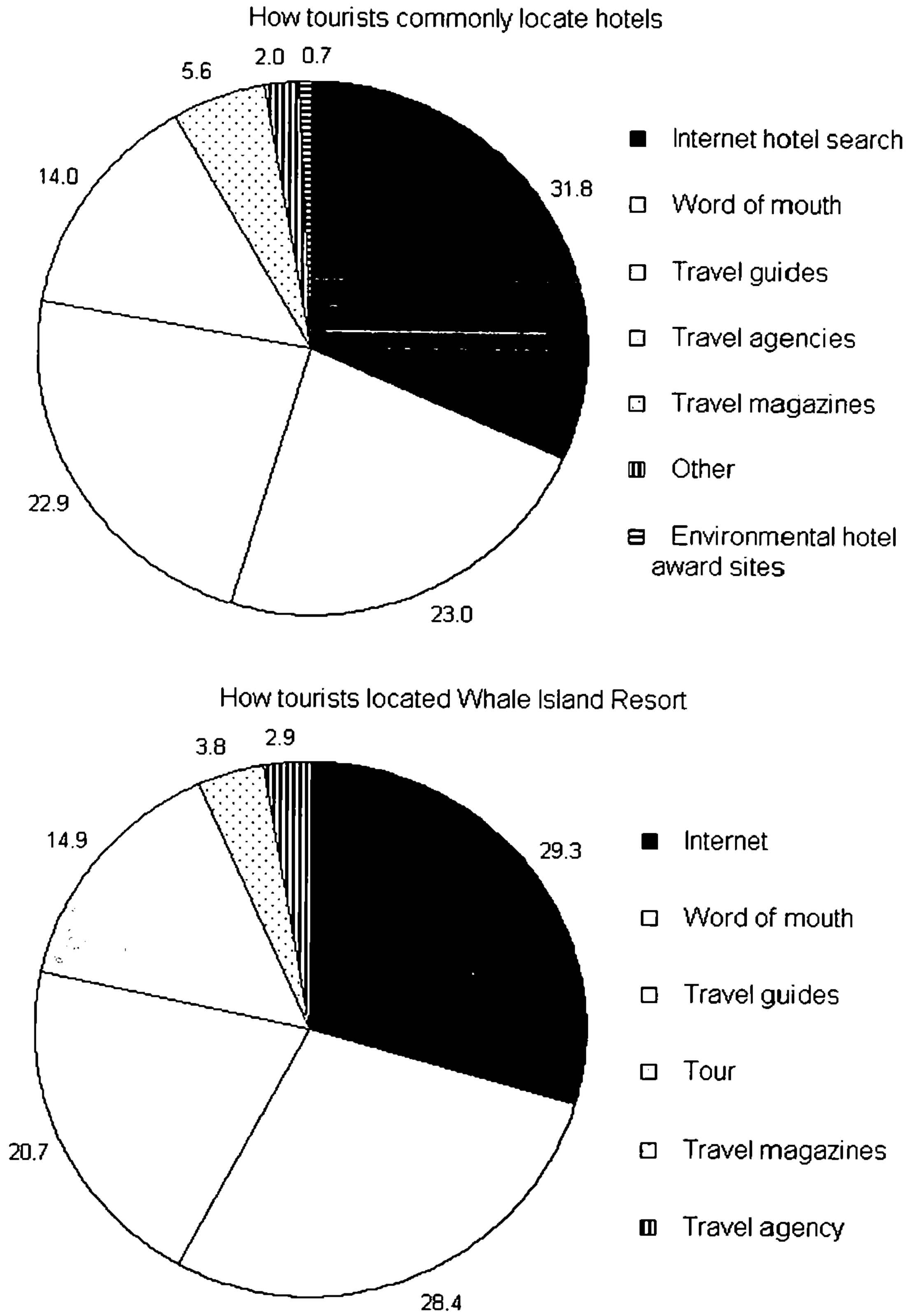
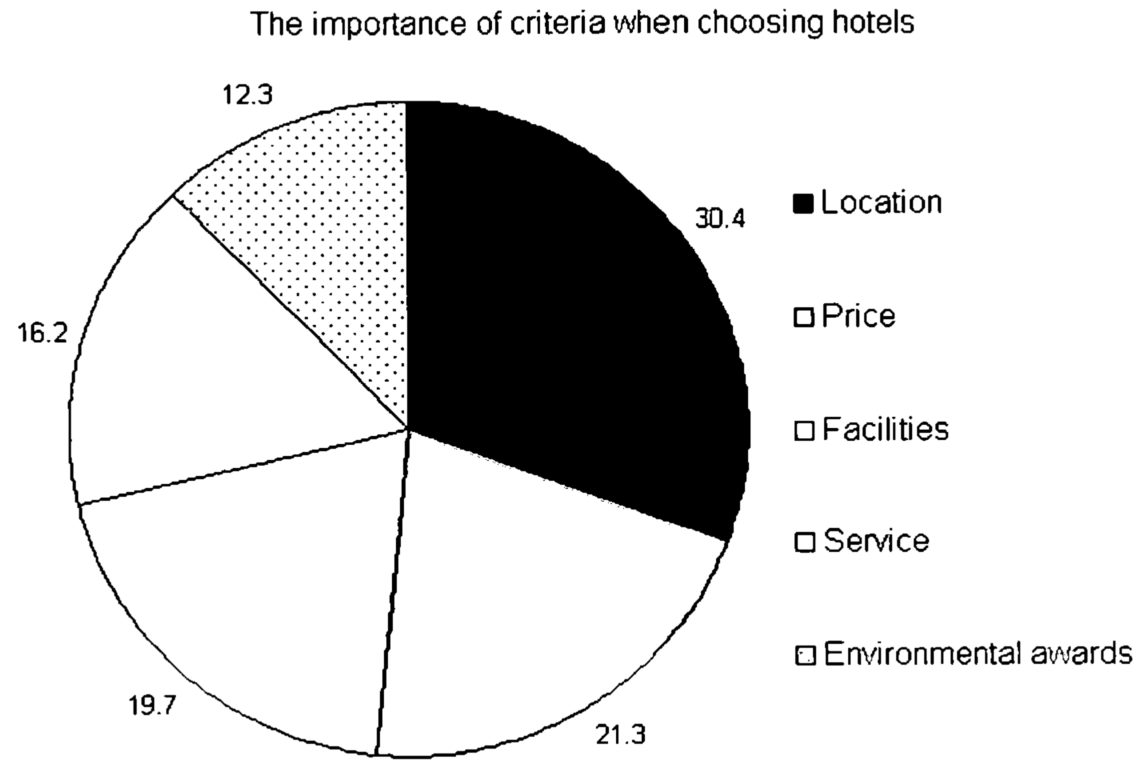


Figure 7.2. Tourists' responses (%) to methods they usually employ to locate and choose hotels and how they found or heard about Whale Island Resort



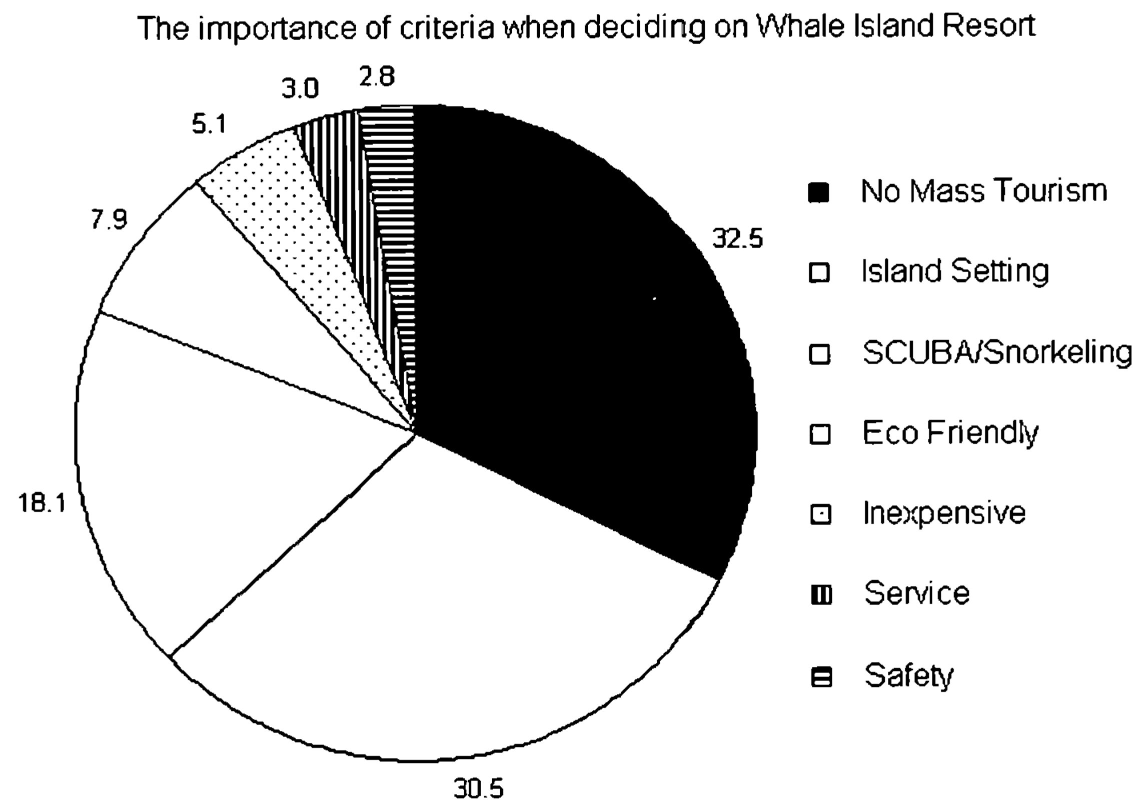


Figure 7.3. The importance of various criteria to guests when choosing hotels and choosing Whale Island Resort (%)

In the following section dedicated to tourists' environmental awareness, interests and knowledge, a larger percentage already knew that WIR was an eco-friendly resort before arriving on the island, while the majority of visitors also knew what MPAs are and would like to have access to hotels' environmental policies before staying at a hotel (Table 7.2). The latter two were the only significant indicators of WTP found from this survey. While having access to hotels' environmental policies when agreeing to pay to stay at an HMMR was highly significant (Chi-square=11.0; p<0.001), whether the respondent knew what an MPA was, affected significantly the WTP amount to stay at an HMMR (Mann–Whitney U= 2391.0; p= 0.047).

Table 7.2. Breakdown of tourists' environmental awareness, knowledge and their Willingness to Pay (WTP) (US$) extra to stay at an HMMR (SE)

	Visitors (%)	WTP ($)	SE
Know what MPAs are?			
Yes *	78.10	13.69	1.15
No	21.90	9.89	1.41
Know how to find eco-friendly hotels?			
Yes	10.95	10.77	1.56
No	89.05	13.09	1.40
Would like to see hotel's environmental policy?			
Yes **	76.19	13.35	1.02
No	23.81	11.27	2.34
Know WIR is eco- friendly?			
Yes	58.57	13.41	1.41
No	41.43	12.47	1.29
Support HMMRs?			
Yes	97.51	14.31	1.41
No	2.49	4.32	2.58
Willing to pay?			
Yes	86.27	13.81	1.34
No	13.73	0	

The sample comprises the available data from 211 surveyed guests minus 24 unusable samples. The WTP is the average, converted from % room rate where necessary, based on US$96/room/night. Nonparametric Mann-Whitney U test *p<0.05, Chi-square test **p<0.001

Guests were thereupon asked to compare the general state of the marine environment, the fish diversity, number of fish, number of invertebrates, size of fish and coral cover within the reserve, with outside fished areas. Only 40.95 % of the guests had also dived or snorkelled outside the enclosed bay, either on a dive or snorkelling trip, or if they had rented a canoe or hobby-cat and snorkelled at other areas around the Island.

I graded tourists' responses, giving '-1' if the tourists thought the conditions were poorer in the reserve, '0' for the same and '+1' for better conditions. All variables apart from coral cover averaged positively for the reserve.

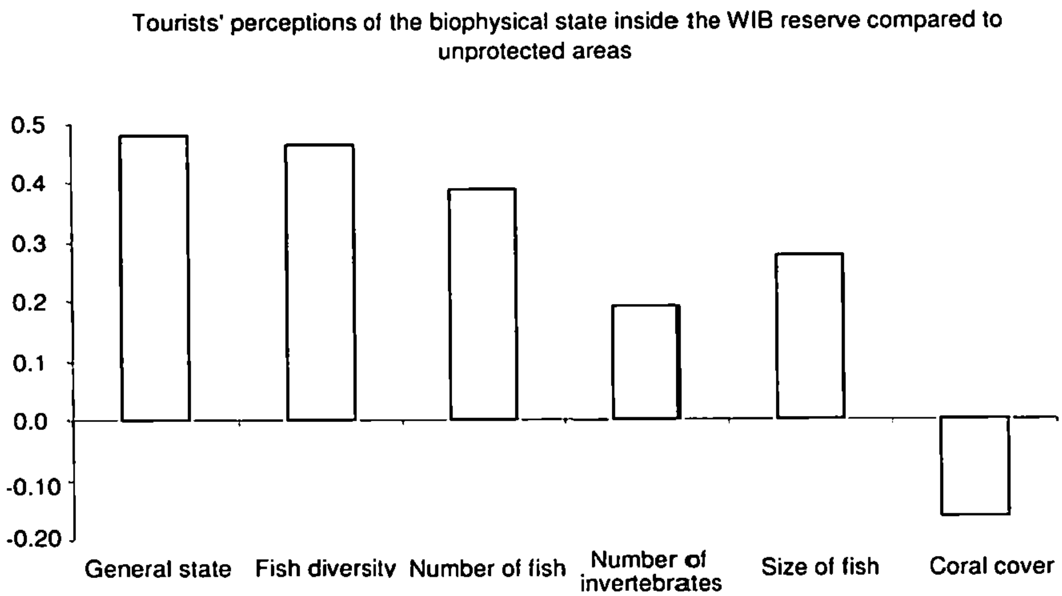


Figure 7.4. Tourists' graded averages of the biophysical conditions inside Whale Island Bay reserve (WIB) compared with unprotected areas (n = 86)

In the succeeding questions, tourists were asked if they support the idea of hotels acting as caretakers and managers of protected areas: 97.51 % did support HMMRs. Of the rest, nine did not have an opinion, five didn't support the concept, one of which expressing concern that the hotel would misuse the idea and profit from it; another was concerned about private ownership of public space becoming exclusionary. The remainder reserved comment since they did not have enough details.

In the follow-up, open-ended question, tourists commented on the reason and conditions for their support of HMMRs. The majority (96.32 %) reasoned HMMRs would better serve the environment, 13.50 % thought private management would be better that government management, while some were more reserved in their opinions, agreeing with HMMRs only if they were supervised and connected to an environmental agency (12.88 %), or had an agreement with local communities (3.68 %). A summary of all comments can be found in Figure 7.5.

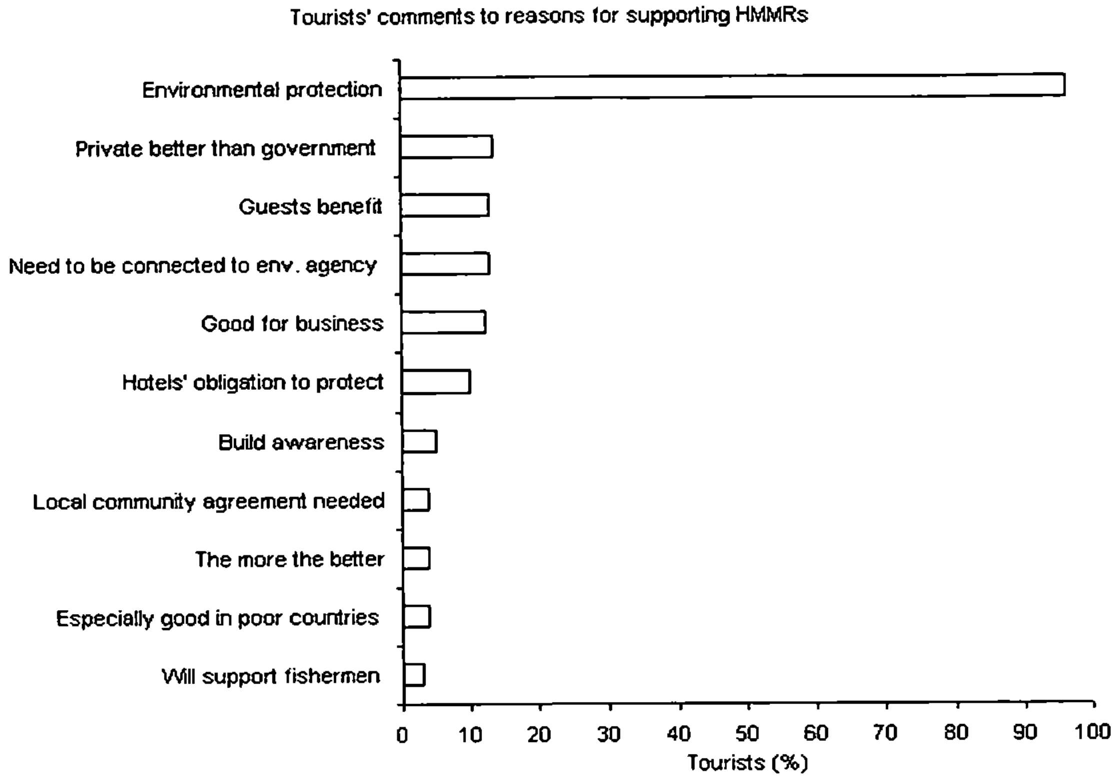


Figure 7.5. Tourists' reasons for supporting Hotel Managed Marine Reserves (HMMRs) (n = 163)

Most guests agreed that HMMR information should best be available to them over the internet and on hotels' homepages (92.22 %). A smaller contingent (17.22 %) suggested that all hotels protecting marine reserves should have a website of their own, where you could browse per country for example, or that they were linked to either country environmental agency websites or dive operation websites. Another faction (15 %) had the same suggestions but would like the HMMRs to be incorporated into some kind of environmental standard or award system, overseen by an environmental agency. A full list of suggestion can be found in Figure 7.6.

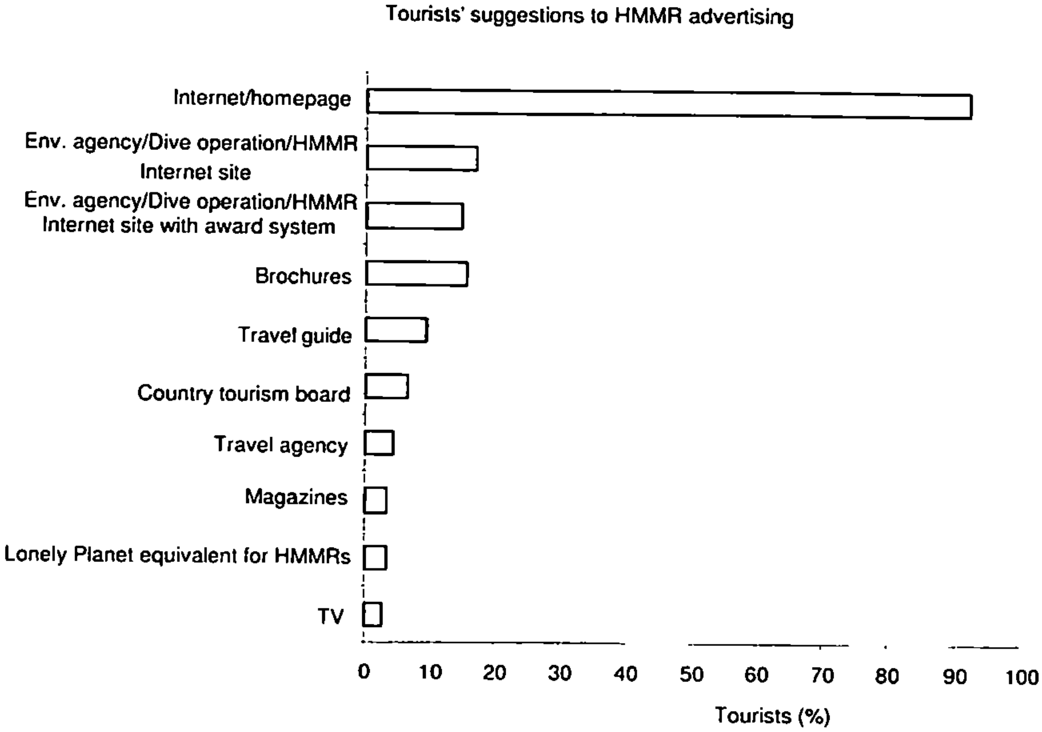
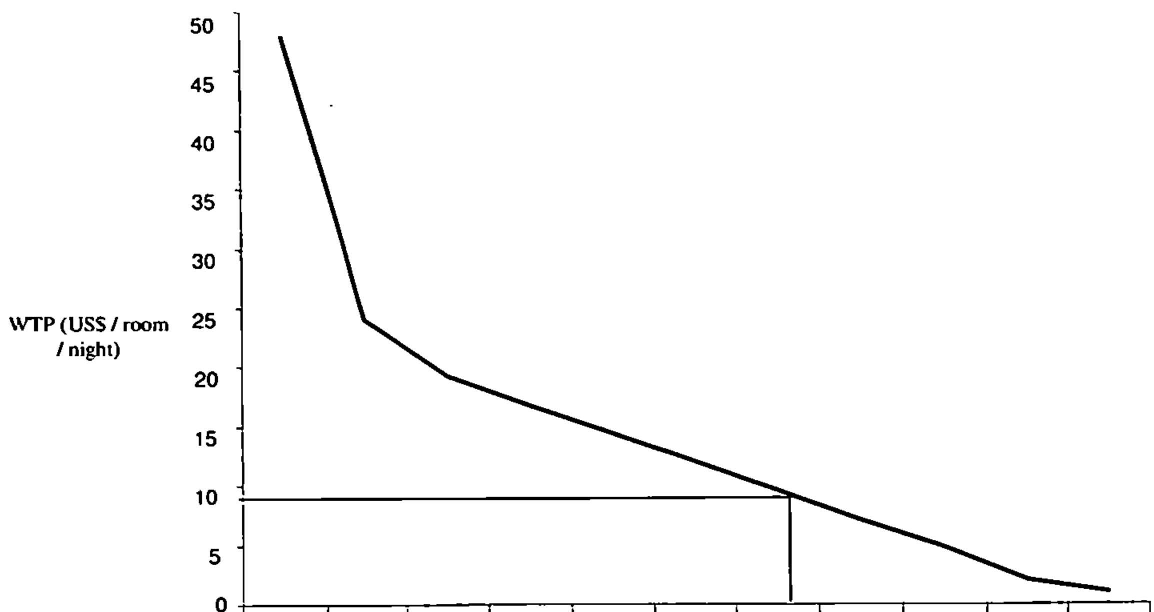


Figure 7.6. Tourists' suggestions on Hotel Managed Marine Reserve (HMMR) advertising and information dissemination (n = 140)

In the final WTP question, most tourists agreed they would be willing to pay more per night to stay at the HMMR (86.27 %), the average being US$ 12.86 extra per room and night stayed, and the median: US$ 9.6. Of the 159 tourists willing to pay at least something, 84.28 % decided to give a percent figure of the room rate. The difference between the averages given in percent (US$ 14.31) and in dollars (US$ 19.46) was significant (Two-Sample Kolmogorov–Smirnov Z=1.403; p=0.039).

The revenue and CS resulting from a user fee system has been calculated based on the WTP results from all tourists, willing to pay or not alike, except those who did not complete the WTP questions (11 %). The results show that 85 % of visitors were willing to pay at least 1 % of the room rate, equivalent to US$ 0.96/room/night.

Extrapolating this 85 % to the number of rooms willing to pay per annum (9931), the hotel would make US$ 9534/year (Figure 7.7) at 100 % occupancy, US$ 5719 at 60 % and US$ 6672 at 70 % occupancy. If all guests were to pay 1 % per room per night, given an average yearly occupancy rate of 60 % (7008 rooms) the resort would make US$ 6728 per year. If yearly occupancy increased to 70 % due to HMMR marketing, the total revenue would equal US$ 7849. Similarly, 83.4 % were willing to pay 5 % of the room rate (US$ 4.8) and 70.1 % were willing to pay 10 % (US$ 9.6), which would amount to US$ 33,638 and US$ 67,277 per year, respectively, at 60 % occupancy if all tourists paid (US$ 28,054 and US$ 47,161 if only willing to pay tourists paid).



	312	1187	3123	3310	4372	5122	8182	8869	9744	9806	9931
WTP ($)	48	24	19.2	16.8	14.4	12	9.6	7	4.8	2	0.96
WTP (%)	2.7	10.2	26.7	28.3	37.4	43.9	70.1	75.9	83.4	84.0	85.0
Revenue ($)	14,990	28,482	59,961	55,614	62,960	61,461	78,550	62,085	46,770	19,612	9534
T. Rev. ($) @ 60 % Occ.	336,384	168,192	134,554	117,734	100,915	84,096	67,277	49,056	33,638	14,016	6728
T. Rev. ($) @ 70 % Occ.	392,448	196,224	156,979	137,357	117,734	98,112	78,490	57,232	39,245	16,352	7849

Number of guest rooms

Figure 7.7. The percentage of guest rooms willing to pay (US$) extra to stay at an HMMR, resulting in revenue per year (US$) at 100 % occupancy. Also, the total revenue per year (US$) based on 60 & 70 % occupancy if all tourists paid the specified WTP amounts, plus showing the median WTP (US$ 9.6/room/night).

The WTP and total revenue drops dramatically beyond 10 %. Only 37.4 % were willing to pay 15 % (US$ 14.4) and 26.7 % were willing to pay 20 % (US$ 19.2) of the room rate. Therefore, at 10 % of the room rate and below, the demand for the HMMR is relatively inelastic and beyond 10 %, the demand becomes relatively elastic and the revenue starts to decrease (Figure 7.7). The CS, defined as the difference between what people are willing to pay for a good or service and what they actually pay, has been calculated based on tourists' total WTP. The total CS tourists are willing to pay beyond the normal room rate to enhance their snorkelling/diving experience and to contribute to coastal conservation has been estimated to US$ 162,437, based on WIR's room rate.

7.4 Discussion

Interestingly, the most common factors influencing WTP for other protected areas: age, education level and income (Lindberg 1991), were insignificant when it came to WTP for an HMMR or deciding the amount, although there was some inclination towards higher WTP for tourists educated to PhD level, and those aged 26–35. The only significant variables affecting WTP were connected to a person's environmental knowledge and interest. While wishing to have access to hotels' environmental policies before staying at a hotel triggered tourists' WTP, knowing what MPAs are influenced the amount. Similar result were elicited by Dharmaratne et al. (2000), who found that people willing to become members and/or were already members of an NGO, established to manage Montego Bay Marine Park and Barbados National Park, were willing to pay more than non-members and those who showed no interest.

The average and median amounts tourists were willing to pay (US$ 12.86 & US$ 9.6) to stay at an HMMR were higher than the average and median amounts charged to divers to enter MPAs in Southeast Asia (both US$ 5) (Depondt & Green 2006) but also lower than some WTP surveys. Divers were willing to pay on average US$ 27.4 to dive at the Bonaire Marine Park (Scura & van't Hof 1993) and US$ 41 to dive at the Tubbataha Reefs Natural Marine Park (Tongson & Dygico 2004). Most commonly, MPA access is levied to individual divers, rather than dive operators, and although user fees may be charged either per dive, per day, per boat or per entry to the park, the timescale is usually per day (Depondt & Green 2006). The user fee system proposed for HMMRs is similar in terms of access to the HMMR per day, but it would not be per diver, but rather, per room, which is more likely to accommodate at least two people, and since guests are paying per night, it may potentially include an extra day, depending on arrival and departure times. Based on a median WTP of US$ 9.6, each tourist would then more likely be paying fees equivalent to US$ 4.8 per day, comparable to the average and median registered in Southeast Asia (US$ 5) (Depondt & Green 2006).

Interestingly, 84 % of respondents preferred to give a WTP value represented as percent of the room rate. The average room rate at WIR for an average length of stay of three nights amounted to US$ 96 (2006 rate), including meals and transportation, which could be considered on the lower end of beach resort accommodations, unless you are back-packing. The median, equivalent to 10 % of the room rate per room (US$ 9.6) or quasi equivalent to US$ 4.8 per person per night could, therefore, be considered conservative, although you do have to consider that guests possibly kept WIR's room rates in mind when considering their WTP. The amount guests were willing to pay in dollars was, however, significantly higher than those who gave a WTP in percent, possibly indicating a higher believed room rate. This is likely to be influenced, however, by responses of an Australian woman and Englishman with average incomes (US$ <45,000 & US$ <60,000), who gave an exceptionally high WTP (US$ 75 & US$ 100). They were either very generous, or had misunderstood the question, possibly thinking it was for the length of their stay. When guests were asked why they preferred to give a WTP amount as percent of room rate, rather than a fixed dollar amount, many tourists reasoned that larger, more expensive resorts would require higher managing costs, but would ultimately also be capable of protecting a larger and 'better' reserve, compared with reserves managed by small, inexpensive resorts and the user fee should be weighted accordingly.

When tourists are actually faced with paying a user fee, they may no longer be willing to pay as much as when faced with the theoretical question of WTP. This over-estimated generous opinion of oneself has been calculated to approximately double the actual WTP (White et al. 2001). There may, however, be a means to minimize this discrepancy. Research suggests that the longer tourists spend on recreational activities by the reef, the more willing they are to pay for improvements in reef quality, especially if their visit and diving/snorkelling experience meets or exceeds their expectations (Ahmed et al. 2007; Lindberg 1991; Ross & Wall 1999).

The average guest stays three nights at WIR, which is three to four days guests can use and benefit from the reserve. At other resorts the average length of stay may well be one week or longer, especially at dive resorts. When asked, over 90 % of guests would choose to return to the resort, which suggests that their stay has met, or exceeded their expectations. Furthermore, when asked how they would compare the marine environment inside the reserve to areas they had seen when diving/snorkelling outside the reserve, except for coral cover, the responses were in favour of the marine reserve for general state of the environment, fish diversity, size and number of invertebrates (Figure 7.4). These questions have their limitations, however, because tourists are not marine biologists using unbiased monitoring methods, but rather base their answers on subjective opinions. Nevertheless, the overall tourist impression was that the hotel was effectively protecting the marine environment and increasing diversity and biomass, which obviously also increases guests' satisfaction and makes them more willing to pay for HMMRs.

The fact that tourists could utilize the reserve for several days and seemed satisfied with both the resort and the effectiveness of the reserve probably influenced the extremely high support tourists gave HMMRs (97.5 %). This, however, just demonstrates that if HMMRs are managed effectively, and results are visible, at least tourists are in favour of HMMRs and are willing to pay for privately managed conservation efforts. A number of tourists (13.5 %) even suggested that private management would be better or more effective than government management of marine reserves, especially in developing countries, where funding is scarce (Figure 7.5). While the vast majority stated that HMMRs would better serve the environment, several also concluded that it would be in the best interest for tourists and for the hotel alike. The majority did not object to the possibility that the hotel could profit from marketing the HMMR and increasing occupancy, as well as protecting the environment, as long as local communities weren't disturbed, but some expressed the desire for proof, i.e. when marketing the HMMR, the marine ecosystem should then also be in a "guaranteed" better condition than unprotected areas through some kind of "official stamp". It was proposed that a suitable environmental agency verify and certify that the resort is in fact dedicated to ecotourism and marine conservation and results are favourable (Figure 7.5).

Tourists concluded that HMMRs could help build awareness for protecting coral reef ecosystems on a local and international level. Since the majority of tourists choose their hotels over the internet (Figure 7.2), most recommended that HMMRs be advertised at an easily findable website either on a country's tourism site, at a website of their own, listing all HMMRs per country, or be incorporated in an existing environmental agency website confirming hotels' advertising (Figure 7.6). Word of mouth was the second highest choice for choosing hotels (Figure 7.2), so the more HMMRs there are providing information through brochures and/or lectures on the need for protection and the hotel's conservation efforts, the more environmental awareness will spread. This would be jointly beneficial to HMMRs, enabling them to maintain a suitable WTP and to increase occupancy and prestige, delivering them into a market niche. The third most important resource for choosing hotels was travel guides (Figure 7.2). In the Lonely Planet guide, there is a caption mentioning WIR and how, through their environmental protection efforts, including transplantation of coral, they have successfully increased the number of marine species (Florence & Jealous 2004. p. 369). Tourists suggested trying to incorporate all HMMRs into travel guides or even create a travel guide solely for HMMRs and eco-friendly hotels (Figure 7.6), which would certainly contribute to awareness building. This brief mention in the Lonely Planet, together with word of mouth are the main reasons why the majority of tourists already knew that WIR was an eco-friendly resort (Table 7.2), since the resort did not advertise over the internet when these surveys were conducted.

Unfortunately, choosing hotels according to environmental certification or environmental award schemes was the last choice when choosing hotels (Figure 7.3), which is not surprising since the majority of tourists do not know where to look for eco-friendly hotels (89 %), despite 76 % wishing to see hotels' environmental policies, including awards and certifications, before booking a room (Table 7.2). There are over 70 sustainable tourism certification programs in the world (Rainforest Alliance 2008a), either currently active or in development, which legitimize eco-friendly hotels and grant awards after scrutinized inspections, Green Globe probably being the most recognised on a global level. These and other specialized websites such as www.responsibletravel.com, or more country specific: www.turismosostenible.co.cr, are places where tourists can find awarded or environmentally conscious accommodations, but obviously they are not well enough advertised, or tourists are not as interested as they indicate.

There is certain concern that tourists aren't as interested in eco-friendly hotels (and HMMRs) as the high support for HMMRs (97.5 %) and relatively high WTP seem to indicate, since even though 58.6 % of tourists knew beforehand that WIR was eco-friendly, only 7.9 % considered its eco-friendliness to be important when deciding to stay at WIR (after location and facilities; Figure 7.3). This concern is compounded by the low rating environmental awards attained when tourists choose their hotels. If there is in fact a lower regard for HMMRs than gleaned, this could reduce the usefulness and success of the future potential development of more HMMRs worldwide and the use of a user fee system to securing a constant supply of funding. In such circumstances, HMMRs would be no better than other failing MPAs, resulting in these being stamped as 'paper parks'. Before more research is conducted with a greater number of HMMRs, these results should therefore be viewed with a certain amount of caution, despite the overwhelming amount of positive responses.

Despite the current involvement of environmental award systems, the majority of tourists also do not know how to locate eco-friendly hotels, causing both the environment and potential eco-friendly travellers to be neglected. It may be possible to increase tourists' awareness and interest in HMMRs conservation practices if managed effectively and certified globally through a central accrediting body. Such a central body for accrediting HMMR is currently not available, however, possibly due to the complexity of management of community, NGO and government involvement, property rights of the oceans, and the concern about private ownership of public space becoming exclusionary, but also because of the relative novelty of such endeavours. While beachfront resorts are dependent on the 'bottom line', they may not be able to profit in the long term because of the growing need and environmental concerns of a growing ecotourism clientele.

Notwithstanding, if standards and controls were adopted, there will inevitably be a period when some hotels will try to proliferate on the merits of others, but will hopefully fail pending tourists' scrutinized judgment and subsequent word of mouth advertising.

The CS representing the total amount tourists were willing to pay on top of the normal room rate to stay at an HMMR equalled US$ 162,437, based on WIR's average room rate (US$ 96), which would be equivalent to US$ 23.18 per room per night at 60 % occupancy. This amount, as well as the average WTP (US$ 12.86), may be considered too high; a better representation is the median US$ 9.6 (10 % of the room rate), which 70 % of tourists were willing to pay and which also amounted to the highest revenue (US$ 78,550) for willing-to-pay tourists (Figure 7.7), demonstrating inelasticity of demand for HMMRs up to 10 % of the room rate. If all guests were to pay 10 % of the room rate, per room per night stayed, total revenues per annum would equal US$ 67,277 based on 60 % occupancy. This figure is, however, only an estimate of WTP in monetary terms, since it is an example from WIR's room rate. For a 50-room hotel costing US$ 200 per night with 75 % occupancy, total revenues based on 10 % of the room rate would amount to US$ 273,750, a substantially higher potential fund for the MPA; even 5 % would still generate US$ 136,875 per annum. Therefore, total revenues are dependent on the room rate, number of rooms, yearly occupancy and the user fee percentage.

A user fee of only 1 % per room and night (generating US$ 6728/year) would nearly suffice to cover the conservation costs at WIR, covering leasing costs (the marine portion equalling approximately US$ 4000), moorings, maintenance and repairs (US$ 300), management and salaries (US$ 3800), totalling US$ 8100 per annum. The high interest for HMMRs expressed in the CS (US$ 162,437) would cover the running costs of the reserve 20 times over. The running costs of WIR's, area-equivalent 15 ha marine sanctuary on Gilutongan Island, Philippines, however, requires a higher yearly budget of US$ 21,000, to pay for surveys and maintenance, community organizing, education and training, law enforcement (small patrol boat), information dissemination and salaries (White et al. 2000). The CS from the WIR example would, however, still, easily cover these costs (7.7 fold) and even if the CS were halved to compensate for a person's over-generosity when dealing with hypothetical scenarios (Loomis et al. 1996), costs would be covered with plenty to spare to invest in enhancing reserve effectiveness or provide alternative livelihood support to affected communities. Therefore, a very achievable, and acceptable, fee of 5 % to support WIR's HMMR would generate considerable extra income (US$ 33,638 if all tourists paid and US$ 28,054 if only willing to pay tourists paid), which would, under current circumstances, provide approximately US$ 20,000-25,000 extra spending money for such future investment in the MPA and/or local communities.

7.5 Conclusion

Based on the results and reasoning from this survey, several recommendations can be made which could potentially increase a hotel's chances of biological and social success, while staying economically secure.

After establishing that a hotel can lease an area of the coastline, the local communities and government should be consulted and an appropriate size and location for the reserve negotiated. The size of the reserve should be large enough to maximize biological potential, small enough to allow spillover and to be economically feasible and not so large that the loss of fishing grounds puts an unmanageable strain on local communities (Hastings & Botsford 2003). Next, the hotel, local communities and government should align their reserve objectives with an environmental agency to avoid differing interests (Christie 2005) and try to validate the MPA internationally. A user fee amount for tourists should also be calculated based on stakeholders' fixed expenses. Here it is important that the needs of all stakeholders are considered and that the hotel makes every attempt to integrate themselves and help the local communities wherever possible, especially in situations where the hotel owners are foreigners (Langholz & Lassoie 2001).

Tourists seem to prefer a user fee in the form of a percent of the room rate, with 10 % per room per night representing both the optimal and maximum amount, considering revenue versus WTP (Figure 7.7). Only the absolute necessary amount should, however, be demanded and the hotel and environmental agency should provide clear information how guests' money is invested (Depondt & Green 2006).

The hotels should advertise their HMMR and associated projects on their homepage and with a local environmental agency, since no central body certifying HMMRs thus far exists, providing more clarity in operations (Depondt & Green 2006) and, if possible, over the country's official tourism website and/or through dive companies. Additional advertising with travel guides, as well as information dissemination through seminars and brochures available at the hotel, explaining projects and monitored progress should be available to raise awareness and interest.

Optimal location of the hotel is important, since this is the first thing tourists consider when choosing their destination (Figure 7.2). From a biological and socio-economic point of view, the farther away the hotel is from inhabited land, the better (Balmford et al. 2004), unless transportation costs and resulting pollution negate the positive benefits. Location is, however, only the first step. To assure guests' user fees are maintained, it is suggested that their stay meets or surpasses their expectations (Ahmed et al. 2007; Lindberg 1991; Ross & Wall 1999), with visible improvements in HMMR biota compared with unprotected areas. This latter achievement may be difficult in the first few years, even with effective management; tangible projects may be an option, such as building artificial reefs to attract fish and attempting coral transplantations.

In some cases, hotels have initiated marine protection, only to be incorporated into government protected areas in the future (Langholz & Lassoie 2001), including the areas protected by Lankayan Island Dive Resort and Anse Chastanet, which later developed into Sugud Islands Marine Conservation Area (SIMCA) and Soufriere Marine Management Area (SMMA) (Roberts & Hawkins 1997). The period during which the hotels were protecting these areas could be seen as money saved by the government for an area which actually needed protecting (Langholz & Lassoie 2001).

HMMRs are quite recent developments and, therefore, still quite scarce, so further research into the effectiveness of HMMRs from a biological and socioeconomic perspective is still necessary. This survey nevertheless proves great interest and commitment to HMMRs from predominantly Western countries. Further research involving a more nationality-balanced sample would be necessary to confirm results, but they still give indication of the great potential of HMMRs as an economically sustainable conservation tool.

8. Hotel Managed Marine Reserves: An analysis of current status

8.1 Introduction

Coral reefs occur primarily in developing countries and play an important role in providing livelihoods, nutrition and food security, especially in times of economic and social hardship or disturbance (Cesar et al. 1997; Sadovy 2005). With an estimated 746 million people in Asia living under the poverty line (<US$ 1 per day) (Stobutzki et al. 2006), compounded with an ever growing population size, the importance of maintaining or increasing the landings of reef fisheries from an already overfished and damaged resource (Mora 2008; Stobutzki et al. 2006) will be crucial to the survival of millions.

Marine Protected Areas (MPAs) can potentially help battle the causes of degrading fishery resources. They have the potential to protect critical spawning stock biomass, provide recruits to fishing grounds and produce spillover of adult species to surrounding fished areas (Abesamis & Russ 2005; Polunin & Roberts 1993; Trexler & Travis 2000). MPAs can also significantly increase average species richness, density and size of organisms within 1-3 years, independent of the size of the protected area (Chapter 4; Halpern & Warner 2003).

Protection of marine resources is not a new phenomenon. Articles dating back to the 19^{th} century mention the widespread presence of customary management practices in the Pacific Islands, which limited access to marine resources, so called 'Taboos' (Somerville 1897). These customary management practices limit extraction by spatial area, time, gear or harvesting technology, effort (through the number of participants), types of species that can be harvested and the number of fishes harvested (e.g. through quotas) (Cinner & Aswani 2007). These are techniques similar to those used today and the 1300 reported MPAs worldwide (Spalding et al. 2001) further reflect their value as a successfully proven management tool. Community-managed marine reserves are another form of management, often referred to as the most effective management system in the tropics (White & Vogt 2000). These are often managed in partnership with other stakeholders, including local governments, Non-Government Organisations (NGOs) or the private sector.

A large percentage of established MPAs is not effectively managed and have thus been deemed 'paper parks'. Only 6 and 14 % of 285 reviewed MPAs in the Caribbean and Southeast Asia respectively, were found to be effectively managed (Burke & Maidens 2004; Burke et al. 2002). The inability of MPAs to secure sufficient funding has been identified as the most important barrier to successful MPA implementation and long-term success (Dharmaratne et al. 2000; Green & Donnelly 2003). In several of these circumstances, local hotels have taken over the day-to-day management of the protected zone and, in some cases, full responsibility for the reserve (entrepreneurial MPAs) (Colwell 1999).

Of late, there have been several reported cases of hotels which have taken the initiative of implementing, and subsequently managing marine reserves, termed Hotel Managed Marine Reserves (HMMRs), on their own, or in collaborations with other stakeholders (e.g. (Teh et al. 2007). They are thought to have been established for a number of reasons: governments' inability to satisfy the public demand for nature conservation, in quality and quantity alike; a growing societal interest in biodiversity conservation; and the rapidly growing ecotourism industry (Langholz & Lassoie 2001; Riedmiller 1999). Hotels also have the resources and financial backing to protect adjacent coastal areas and, with the added incentive of taking responsibility for the environment, they are also securing a client base and future business.

In a survey conducted with hotel guests at an HMMR in Vietnam, it was found that 97.5 % (n=202) support HMMRs and 86.3 % (n=205) would be willing to pay extra per room and night, to stay at such hotels (Chapter 7; Svensson et al. 2008). Several MPA managers recognise the value of user fees as an excellent and accepted way to ensure that the MPA is sufficiently funded (Arin & Kramer 2002; Scura & van't Hof 1993). It has also been suggested that MPAs only become truly successful and economically sustainable when they reach a self-financing status (Davis & Tisdell 1996). Hotels generally have the financial stability to provide long-term financing (Colwell 1999), and several HMMRs worldwide have implemented a user fee system for their HMMR to help fund the management and maintenance of the reserve, as well as pay staff, provide money for other marine conservation projects, and often provide financial incentives to affected fishing communities to help ensure compliance.

HMMRs are frequently also required to pay a lease to the area-owning unit, which could be in the form of yearly contracts, making long-term conservation efforts unpredictable, but they are generally longer, lasting a decade or more and open for renewal. Such leases are generally well accepted, especially in developing countries, since they provide a stable source of income, while the effects of tourist establishments may provide for additional and alternative livelihoods, which can strengthen a community (Colwell 1999). Submerged land leasing is not a new phenomenon, nor is it seldom. In researching the coastal states surrounding the United States, Slade et al. (1997) found that nearly one third of submerged lands were owned or leased by the private sector, developing marinas, private docks, fisheries, aquaculture or other ventures. Leasing submerged lands for conservation purposes is however relatively rare, even though it is, for example, possible, to lease up to half of California's kelp forests, as well as sponge and soft coral habitats in Florida (Beck et al. 2004).

Some protected areas have also been initiated and managed by hotels, only to be expanded and relieved of management by a government body, after the effectiveness of their conservation efforts become visible. These precursors to government managed MPAs can be seen as costs saved by the government for an area, otherwise previously needing protection (Langholz & Lassoie 2001). An advantage HMMRs have to several MPAs is their general small size and the fact that they are mostly adjacent to the hotel, making overseeing and patrolling the area both easy and cost effective. Small no-take areas are also more likely to result in a higher level of compliance than large, no-take zones that, by their nature, will affect the socio-economic welfare of dependent communities (Unsworth et al. 2007). A trade-off is required between maximizing the size of the HMMR for biological reasons, while still being small enough not to staunch spillover (Hastings & Botsford 2003), and minimizing negative economic impacts on local communities (Unsworth et al. 2007). Even though many of the HMMRs may be small in size, this might not be adequate to deter poachers without patrolling boundaries, especially if they realise that the effort of catching fish within the reserve is lower (Sethi & Hilborn 2008). Small reserves are more vulnerable to poaching, so in order for HMMRs to be effectively protected, committed cooperation and support from local populations is essential (Wells & McShane 2004). Some evidence suggests that while an HMMR may be generally well accepted, a relatively high level of government involvement to verify the authenticity of the protection would be preferable (Chapter 6). Advocating the benefits of protected areas, involving communities from the start of the project, coupled with regular consultations with local communities to ensure their well-being, as well as making sure promises are kept, will greatly improve cooperation and compliance (Fiallo & Jacobson 1995; McClanahan et al. 2005; White & Vogt 2000). The hotel may also be able to add incentive to adhere to the no-fishing ban, by providing financial assistance to affected communities or help establish alternative livelihoods by working with the hotel or reserve, or helping to develop sustainable aquaculture.

In this chapter, the current status of some of the existing HMMRs today is analysed. Through questionnaires sent to hotel managers, or managers in charge of the HMMRs, I: 1) investigate some of the management strategies hotels have employed to develop their HMMR; 2) rate the eco-friendliness of the establishment; 3) give a management rating for the HMMR; and 4) evaluate the acquired findings to provide an overall assessment of the potential of a more widespread application of HMMRs as an alternative management tool for protecting a part of our coastal natural resources.

8.2 Methodology and study area

Questionnaires were sent to 56 hotel managers in tropical coral reef areas around the world. Upon further research, only 30 were found to meet the requirements of private management of marine reserves (Figure 8.1). The others did, however, have marine projects and/or education or awareness programs managed by the hotel. Some were already incorporated into government managed MPAs. After several reminders in some cases, a total of 17 managers responded: 14 of the 30 hotels matched the HMMR criteria. This represents a response rate of 47 % (Figure 8.1).

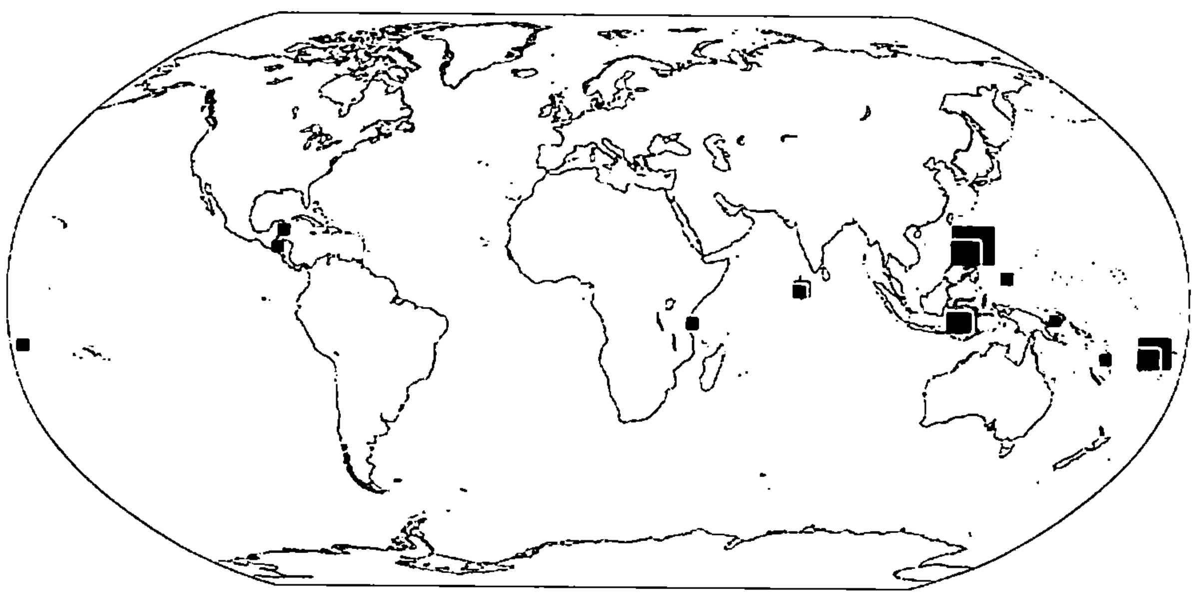


Figure 8.1. World map indicating the locations of 30 Hotel Managed Marine Reserves (HMMRs) (grey squares) and the 14 which responded (black squares)

Three questionnaires were sent by email to the hotel owners, managers or reserve-responsible persons. The primary questionnaire focuses on describing the hotel, its reserve, manager perceptions and strategies. The second and third questionnaires rate the hotel's eco-friendliness and reserve management, based on satisfactorily fulfilled criteria. The details of each of these are outlined below.

8.2.1 HMMR survey

This questionnaire contained qualitative and quantitative, open and close-ended questions, which consisted of several loosely defined sections. The first section requested details on the operational aspects of the hotel, its location and surroundings. The following section is dedicated to the reserve itself, including size, protected habitats, HMMR regulations and year of establishment questions. Next, the history, legal basis for establishment, reserve objectives and management bodies, followed by HMMR financing details and potential advertising benefits, were scrutinized. The next four questions refer to the perceived state of the reserve, whether there is a noticeable change in biological parameters over time, how it compares to adjacent similar unprotected areas and asks for apparent man-induced damaging factors. The final question asks whether the hotel managers think the reserve is effectively protected. The full questionnaire can be found in Appendix 5.

8.2.2 HMMR rating

This questionnaire was modified from a survey created by the Coastal Conservation and Education Foundation Inc. (CCEF 2006) to be appropriate for HMMRs. The CCEF survey is an MPA management rating system intended to assist local governments and communities to improve the management of their MPA. Managers in this study were informed that the questionnaire is not an officially legal document and can thus not be treated as such, but that it can give them an indication of how the management of their HMMR rates compared with officially established MPAs in the Philippines. They were asked to tick the criteria which are fully satisfied or accomplished, the sum giving the unofficial rating (Table 8.1). To acquire the different levels, a minimum number of points (or percentage of all requirements) have to be accumulated: Passing - HMMR is initiated (7 points – 17 %); Fair – HMMR is established (14 points – 33 %); Good – HMMR is enforced (22 points – 52 %); Very good – HMMR is sustained (29 points – 69%); Excellent – HMMR is institutionalised (38 points – 90 %).

The questionnaire is sectioned into five groups of management activities, which should ideally have been accomplished within certain time periods. If the hotel is proactive and has managed to complete later, more demanding levels earlier than required, these would obviously also be included. A summary of requirements can be found in Table 8.1 and the full questionnaire in Appendix 6.

Table 8.1. Details of management requirements of Hotel Managed Marine Reserves (HMMRs) which need to be satisfactorily fulfilled. (broken down to levels and time periods)

Level	Reserve status	Time period	Criteria fully satisfied
1	Initiated	< 1 year	Local acceptance, biophysical baseline surveys, management body tentatively determined, management plan and objectives drafted, HMMR reserve legally established, information disseminated to guests and staff, boundary markers installed
2	Established	< 2 years	Biophysical surveys includes local participation, management body recognised, objectives adopted, education programs for staff, tourists & local community, management activities started e.g. surveillance, managing violators, user fees etc., reserve rules and guidelines posted, anchor buoys placed
3	Enforced	> 2 years	Regular biophysical surveys with local participation, management body actively implementing management plan, regular education programs for staff, tourist & local community, funds allocated to maintain enforcement, no poaching events, illegal fishing reduced by 50 % within 500 m of reserve
4	Sustained	> 3 years	Biophysical analysis available, management body successfully runs reserve and management plans updated in a participatory process (e.g. amended with participation stakeholders), education programs for staff, tourist & local community maintained, no poaching events, illegal fishing stopped within 500 m of reserve, hotel is environmentally friendly and/or collects user fees as a sustainable financing strategy
5	Institutionalized	> 4 years	Biophysical and socio-economic analyses available, management body capacitated for financial management and fund sourcing, management plan refined for adaptive management, education programs for staff, tourist & local community maintained, budget allocated from various sources, reserve expanded, additional marine conservation activities initiated, reserve used as a study site for public education or scientific research, local communities supported, environmental awards attained, reserve officially and legally recognised as an MPA.

8.2.3 Eco-friendliness

This questionnaire was adapted from Australia's eco-certification program (Charters et al. 2003), which was established to help identify genuine nature ecotourism establishments. The original survey was modified and shortened to reflect only hotels' situations and possibilities. Managers were asked to mark the criteria, which were fully satisfied or accomplished and were also informed that the survey is not an officially recognised legal document, and they could therefore not claim eco-certification based on the results. The total number of marks gives an indication of the hotels' environmental policy and provides a rating on the hotels' eco-friendliness. The rating system is similar to the HMMR rating, whereby the level of eco-friendliness is determined by accumulated points, or percentage of the total number of requirements which need to be fulfilled, although to a tougher rating system (Passing - 25 points (49 %), Fair - 30 points (59 %), Good - 35 points (69 %), Very good - 40 points (78 %); Excellent - 46 points (90 %).

The questionnaire is split into seven categories representing various aspects of eco-friendly activities hotels could pursue. An illustration of these categories is provided in Figure 8.2 and the questionnaire can be found in Appendix 7.

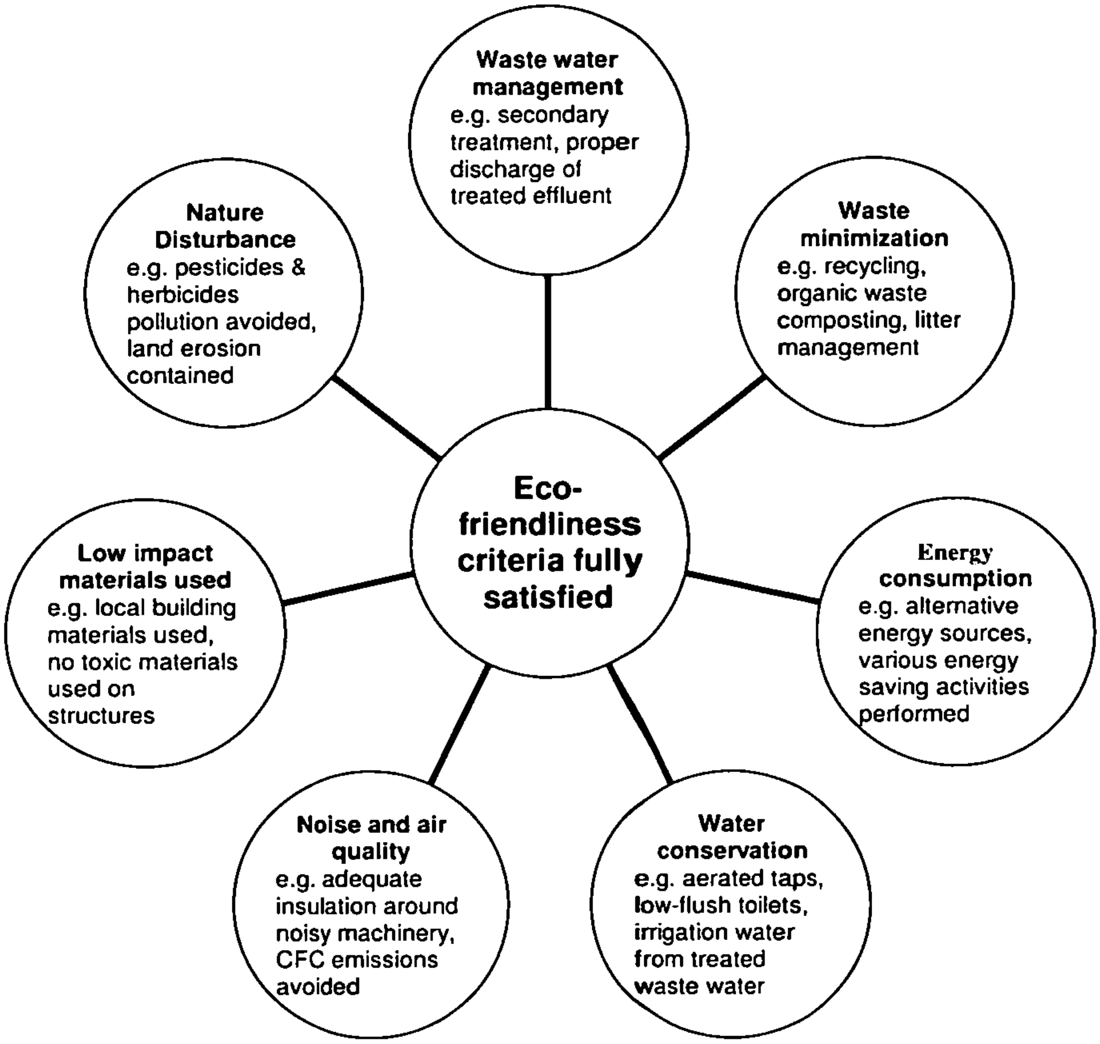


Figure 8.2. Details of eco-friendliness requirements of Hotel Managed Marine Reserves (HMMRs) which need to be satisfactorily fulfilled (broken down to 7 conservation topics)

The author is fully aware of the limitations of these surveys. The results will be biased, since hotel managers will most likely embellish certain aspects to make their establishment look better and under-represent others to create the same effect. A more reliable approach would have been to travel to these hotels personally to verify and triangulate the attained data or to employ the services of local NGOs to conduct the surveys. Unfortunately such a thorough research design was not possible, making the second-best option the only option. The author will seek to interpret the data bearing these biases in mind.

8.3 Results

8.3.1 HMMR survey

The locations, HMMRs strategies, size and class of hotels, as well as size of the reserves and different marine conservation projects varied greatly. HMMRs have been reported across all the Indo-Pacific, protecting reserves as small as 1 ha to 700 ha (average 110 ha +/- 13.22 SE) and the full range of coral reef ecosystems (Table 8.2). The hotels themselves range from no stars to top of class, 5-star resorts, with as few as 7 bungalows to massive 547 room complexes (average 90 rooms +/- 9.70 SE), with a rack rate ranging between US$ 70 - 960 for a double room and night (average US$ 309 +/- 15.46 SE). The average yearly occupancy was 67 % (+/- 0.68 SE), the average length of stay, 6.5 days (+/- 0.40 SE), average return guests, 26.5 % (+/- 2.11 SE) and 10 of 14 hotels which replied, employed more than 90 % local staff, with an average workforce of 104 per hotel (Table 8.2). Most of the hotels are located on Islands (79 %) and from the 9 hotel managers who answered, the number of resident fishermen within 1 km ranged widely (0 – 1500), with an average of 200 (+/- 38.72 SE).

Table 8.2. Operational, reserve and location details of the 14 Hotel Managed Marine Reserves (HMMRs), listed alphabetically by country

Hotel Name	Country	Area (ha)	Protected habitats	Protection	Star rating	Ave. length of stay (days)	Yearly occup-ancy (%)	Return guests (%)	Rack rate $US	No. Rooms	No. Staff	No. local staff	Location
The Rarotongan Beach Resort and Spa	Cook Islands	38	Coral Reefs	No-take zone (Raui)	4	6	75	30	265	159	160	100	Island
Beachcomber Island Resort	Fiji	245	Coral reef, seagrass beds	No-take zone (Tabu)	3	3,5	67	12	200	38	70	70	Island
Navini Island resort	Fiji	15	Coral reefs	No-take zone (Tabu)	4	7	50	40	360	10	36	34	Island
Treasure Island Resort	Fiji	270	Coral reefs	No-take zone (Tabu)	4	NA	NA	NA	542	66	112	111	Island
Selayar Dive Resort	Indonesia	145	Coral reef, seagrass beds	No-take zones	NA	15	70	30	166	8	20	18	Island
Taman Sari Cottages	Indonesia	2	Coral reefs	No-take zone	NA	NA	50	NA	100	39	50	50	Mainland
Wakatobi Dive Resort	Indonesia	700	Coral reef, seagrass beds, mangroves	No-take zone / traditional fishing by locals permitted	NA	10	NA	NA	300	26	149	135	Island
Four Seasons, Landaa Giravaru	Maldives	15	Coral reefs	No-take zone	5	5,5	68	NA	960	102	300	100	Island
Palau Pacific Resort	Palau	1	Coral reef, seagrass beds	No-take zone	5	5	75	25	255	160	225	195	Island
Alegre Beach Resort	Philippines	16	Coral reef, seagrass beds, macro-algae beds	No-take zone	NA	3	65	NA	315	38	120	116	Mainland
Duka Bay Resort Inc.	Philippines	40	Coral reefs, macro-algae beds	No-take zone	NA	NA	80	60	70	30	32	32	Mainland
Shangri-la's Mactan Resort and Spa	Philippines	5	Coral reefs	No-take zone	5	NA	NA	NA	230	547	NA	NA	Island
Chumbe Island Coral Park Ltd.	Tanzania	30	Coral reef, seagrass beds, mangroves	No-take zone	NA	2	75	10	400	7	43	41	Island
Whale Island Resort	Vietnam	16	Coral reefs	No-take zone	NA	4	60	5	160	32	35	32	Island

8.3.1.1 Basis for reserve establishment

The oldest reported HMMR (40 years) is the 245 ha reserve, managed by the owners of Beachcomber Island Resort, Fiji. Several other HMMRs were similarly found in the South Pacific, where there is a strong tradition of community-level ownership of marine resources. Here, the fishing rights (Qoliqoli) belong to the land-owning unit (individual, family, clan, community). The hotels abide by the customary management rights/bans (Tabu, Raui; no-fishing or extraction of living organisms, or any activity that could damage the reef), while having the rights to stop outsiders accessing the inshore marine resources (Ruddle 1996) (Table 8.3).

Apart from the reserve managed by the Four Seasons, Maldives, which only has an unwritten understanding with local communities to honour the no-take zone, the remaining HMMRs are reported to being officially recognised by the local, regional or national authorities. Many of these have financial agreements with the local governments and some claim to be giving separate financial support or providing other services to local communities and affected fishermen – also sometimes from collected user fees (Table 8.3).

Table 8.3. Details of the management strategy, objectives and additional environmental projects of the 14 HMMRs, listed alphabetically by country

Hotel Name	Country	Year Established	Basis background for reserve establishment	Additional projects	Objectives	Annual reserve costs	Effectively protected
The Rarotongan Beach Resort and Spa	Cook Islands	2000	The area or Raui is owned by a local family, who bought the land rights in 1978 when the government became insolvent. The hotel has leased the Raui for 50 years and pays an annual lease + 1 % turnover to the landowning family	Clam reseeding	To protect the marine environment and attract tourists	NA	Yes
Beach-comber Island Resort	Fiji	1969	Island and seas are leased (2.5 % of turnover). Customary fishing rights 'Qoliqoli' from landowning matagali clan approved no-take zone and give the hotel powers to police it	Yearly Crown of Thorn extractions	To stop decimation of marine life through fishing and to attract tourists	800	Yes
Navini Island resort	Fiji	1989	Reef Protection Agreement (lease) with local chief. Annual payment (US$ 1500) made upon renewal of agreement. Monthly amount paid (US$ 400), provided no-take agreement has been upheld	Coral reef monitoring conducted by Coral Cay Conservation and the Mamanuca Environment Society. Educational and awareness building workshops with member resorts, tourism and business operators. Yearly donations to local school projects and books	To establish a reef system that would remain in its natural state, to be enjoyed by visitors to the area	5000	Yes
Treasure Island Resort	Fiji	1975	Island and fishing rights 'Qoliqoli' owned by theTokatoka Nakelo from the Matagali clan. Leased (99 years) by Treasure Island Resort Ltd., which is partly owned (50 %) by their company; Nakelo Ltd. & Hunts Investments Ltd. Landing fees from non-guests collected. Wardens report non-compliance, who alerts the village head, who alerts the Fisheries Department officials	Coral reef monitoring, Coral transplanting, Giant clam reseeding. Green Globe benchmarked since 2003	1. Save coral communities in order to help increase fish stock. 2. Preserve our Marine Biodiversity 3. Help recover community livelihood for the betterment of our future generations	NA	No - poaching takes place
Selayar Dive Resort	Indonesia	2000	45 ha in front of resort and 100 ha 5 km further away. Agreement/contract with government, patrolled by local police. Island is owned and taxed. User fees (US$ 13/guest & liveaboard visitor diver) split between local tourism organisation (60 %) and local villages (40 %). An additional US$ 13 given to local villages if no fishing takes place in the no-take zone during the fishing season	Coral reef monitoring	To protect the area	NA	Yes - but with minimal poaching
Taman Sari Cottages	Indonesia	2008	Approved by government after being proactive for several years in the Reef Restoration Project (BIOROCK), established in 2002. 10% of every dollar spent with Bali Diving Academy Pemuteran goes to the local community	BIOROCK (TM) reef regeneration project. Involved in training programs, scientific studies and environmental audits. Awards attained	To restore damaged coral, re-establish marine ecosystem, protect surrounding areas, educate locals	2500	Yes - but with minimal poaching
Wakatobi Dive Resort	Indonesia	2002	A pilot leasing project of the Collaborative Reef Conservation Program concept was approved by the district government and launched in 1998, turning 6 km of reef into a no-take zone. Protection expanded to include all 17 adjacent communities, stretching over 20 km. Community adheres to business agreement, villagers patrol area, enforce and maintain compliance	Coral reef monitoring. Sponsoring: Schools with education material, waste management facilities in surrounding villages, electricity to nearby village, scholarships for orphans, credit scheme for small businesses, public awareness meetings about conservation etc. Several environmental awards attained	To maintain and improve long-term the most important business asset for the promoted world class diving product, by respecting the local communities owning the rights to exploit the resources. Cooperation and financial incentives instead of a 'fence and fine policy'. A business approach to conservation	250000	Yes
Four Seasons, Landaa Giravaru	Maldives	NA	Island is leased and surrounding reefs are protected by hotel marine staff. Unwritten agreement for no-fishing	Coral reef monitoring. Established research centre tracking tagged manta rays and monitoring marine mammals, deployment of 300 artificial reefs, awareness building sessions on marine life and conservation, capturing commercially high valued ornamental post larvae fish, which are grown and exported into the ornamental fish trade	To protect the reefs for the benefit of the local ecosystem and for our guests	NA	Yes - but with some turtle egg poaching

Palau Pacific Resort	Palau	2002	Sanctioned by Koror state government and local communities after several years negotiation and education programs with the local communities of reserve benefits. No tax or lease is paid. Resort patrols area and reports to government rangers	Education program for hotel guests (Clam Planting Program). Education programs for local villagers	Improving and protecting the quality of the environment around the area for our future generations to enjoy	1900	Yes
Alegre Beach Resort	Philippines	1995	Municipal Ordinance passed and foreshore lease paid by sister company (US$ 550). Protection accepted after many years of proactive reef conservation work and talks with local fisher folk and public consultations, before being considered at the local barangay level and then the municipal level. Passing boats are charged mooring fees (US$ 10.5) and divers (US$ 3.2)	Coral reef monitoring. Helped establish, maintain and monitor 8 local government-unit managed MPAs. Several research studies conducted with a university. Presented in the ITMEMS 2 (International Tropical Marine Ecosystems Symposium 2) as an example of a resort-based marine sanctuary. Two teacher salaries paid. Artificial reefs, sea grass bed planting, desiltation of reef, reseeding giant clams, mussel culture for alternative livelihoods and others in planning. Crown of Thorn and drupe shell extractions. Environmental awards attained	Preservation and development of the environment - both terrestrial and aquatic	50000	Yes - but with minimal poaching
Duka Bay Resort Inc.	Philippines	1997	Municipal ordinance Nr. 97-199. Protected and managed by the aqua sports manager/ Duka reef divers in collaboration with Xavier University and the Philippine army	Coral reef monitoring. Coral transplantation activities using 'Acantasia Module', (Silver award in Holcim Sustainable construction competition (Regional) for Asia Pacific region 2005. Also creating local livelihoods. Education programmes established	To restore corals and fish diversity to the area	2100	Yes
Shangri-la's Mactan Resort and Spa	Philippines	2006	Lapu-Lapu City Ordinance 425-B-2006. User fees (US$ 3 for divers and US$ 1.5 for snorkellers) are split between the local government, the three managing stewards and local fishermen	Coral reef monitoring with reef check since 2003, coral recovery programs, giant clam program. Proposal to establish a marine learning centre. Education programmes established	To attain food security and to enhance marine resources based on ecotourism, consistent with the principle of sustainable development. To enhance optimum ecological biodiversity and protection of the area	NA	Yes
Chumbe Island Coral Park Ltd.	Tanzania	1994	Fisheries Act 1988, Investment Protection Act 1986. 1991-1992 Negotiations on Investment Plan including gazetted MPA & Forest reserve. 1992 Chumbe Island Coral Park Ltd. (CHICOP) founded. 1992 Provisional reef closure, first rangers employed, posted and trained, baseline surveys started. 1993 Landlease on Island granted, 1994 Gazettement. Advisory committee include government departments, university and representatives of adjacent fishing villages	Coral reef monitoring and research conducted by several research students yearly. Crown of Thorn removal. The Chumbe Education Program sponsoring children/materials and teacher training (450 teachers up to 2007). Several environmental and awareness awards attained	To manage, for conservation purposes, the Chumbe Island Reef Sanctuary and the Chumbe Island Closed Forest Habitat. This includes educational and commercial activities related to the non-consumptive use of the above mentioned natural resources and doing all of such other things as are incidental or conducive of the above object	75000	Yes
Whale Island Resort	Vietnam	2000	Lease from local government (US$ 15,000 for part of Island - 600 m radius around resort). Fishing families consulted before protecting 11 ha. Another 5 ha protected since 2005. Local coast guard can be contacted in case of poachers	Artificial reefs and Fish Aggregating Devices constructed. Funded the building of a local temple. Funded author for marine monitoring surveys	Protect the seas and ensure only low impact on land	5000	Yes - but with minimal poaching

8.3.1.2 Marine conservation projects

All hotels actively pursue additional marine conservation projects. The number and complexity of these projects varied from hotel to hotel, ranging from Crown of Thorn starfish (*Acanthaster planci*) extractions, to multi-featured research projects, conducted with researchers from various universities, or on-site marine biologists (Carran 2003; CHICOP 2008; Duka Bay Resort; Scuba Diver Magazine 2004; Tuxson 2005; Wakatobi Dive Resort 2008). 10 of 14 hotels constantly monitor the state of the HMMR on their own or with affiliated environmental agencies and half have constructed artificial reefs for their coral transplantation projects. Taman Sari Cottages, Indonesia, even legally established an HMMR, thanks to their many years of work with their reef restoration project (Scuba Diver Magazine 2004). 9 hotels also report being very active in public awareness programs, both for staff and tourists, as well as local communities (Table 8.3).

8.3.1.3 Finances

Several hotels were reluctant to provide financial information on the reserve's cash flow, but the few existing examples provided interesting figures. The Wakatobi Dive Resort, Indonesia profess to paying US$ 250,000 annually to village councils, covering the lease for 17 adjacent communities, on top of various other community, and environment-supporting activities (Table 8.3). The Chumbe Island Coral Park Ltd (CHICOP), Tanzania, and Alegre Beach Resort, Philippines, equally claim to be paying large amounts to maintain their HMMRs. The lease on at least the

Rarotongan Beach Resort and Spa, Cook Islands, and Beachcomber Island Resort, Fiji, reserves is paid according to the hotels' yearly turnover. Only CHICOP, Four Seasons, Maldives and Taman Sari Cottages, Indonesia, receive small grants. CHICOP receives a government grant for their education program, and the latter two receive funding from private donations. The remaining pay from the revenue incurred from their business and/or through guest user fees. Most hotels did not wish to show exactly how expenses are broken down, but all claim to have security, staff or marine wardens to protect the reserves from poaching.

8.3.1.4 Enforcement

In the South Pacific, a copy of the agreement with the land owning unit showing extractive bans is shown to poachers. The owners are duly notified and can take appropriate actions. Most of the other hotels claim to have an official authority (police, military, coast guard or government wardens), who can be contacted if poachers are found within the reserves. Selayar Dive Resort has a slightly different approach, where additional financial incentives are only paid in full if there is compliance with the no-fishing rule. Patrolling of the Taman Sari HMMR is financed by local businesses and Wakatobi Dive Resort sponsors patrol boats, and representatives from the local villages enforce and maintain compliance. All apart from the manager at Treasure Island Resort perceive the reserve to be effectively protected, but several do admit to limited instances of poaching (Table 8.3).

8.3.1.5 Objectives

It seems most hotels do not have predetermined objectives for their HMMRs, but generally the owners and managers suggest that their main concerns are for the well-being and betterment of the environment. Some maintain awareness and education objectives, and several affirm a business approach to attracting tourists (Table 8.3).

8.3.1.6 Advertising

Only half the hotels advertise their HMMR, but many that do, report benefits from their cause-related marketing. The hotel managers were asked to indicate if they believe that their HMMR status has increased their yearly occupancy, guests' average length of stay or the number of return guests and if so, by what percentage (Table 8.4). The managers, who hazarded an estimate, implied substantial increases for yearly occupancy and number of return guests in particular.

Table 8.4. A list of hotels which advertise that have a Hotel Managed Marine Reserve (HMMR), including the perceived influence of HMMR marketing on occupancy, average length of stay and number of return guests

Hotel	Occupancy (%)	Ave length of stay (%)	No. return guests (%)
The Rarotongan Beach Resort and Spa	5 - 10	5 - 10	5 - 10
Navini Island resort	5 - 10	5 - 10	5 - 10
Treasure Island Resort	>20	Don't know	>20
Selayar Dive Resort	Don't know	Don't know	Don't know
Wakatobi Dive Resort	10 - 20	<5	>20
Duka Bay Resort Inc.	Don't know	Don't know	Don't know
Whale Island resort	Don't know	Don't know	<5

8.3.1.7 Biological status

Hotel managers were asked how they perceive the state of their reserve in terms of abundance of organisms, diversity of species and coral and algae cover (Figure 8.3). The majority of hotel managers reported high or fairly high for most parameters apart from algae cover, which was rated lower. A follow-up question requested managers to suggest how they perceive these parameters to have changed since reserve establishment. Only 6 managers partially answered these questions, often because they themselves had not worked with the hotel since reserve inauguration. Of the responses received, however, the managers affirmed an average positive growth of marine life: fish species richness (40 %), fish abundance (160 %), coral diversity (27 %), coral cover (28 %) and invertebrate abundance (48 %). To conclude the perceived biological effectiveness of HMMRs, managers were requested to compare their HMMR with similar unprotected areas, which resulted in extremely favourable results for the HMMRs (Figure 8.4).

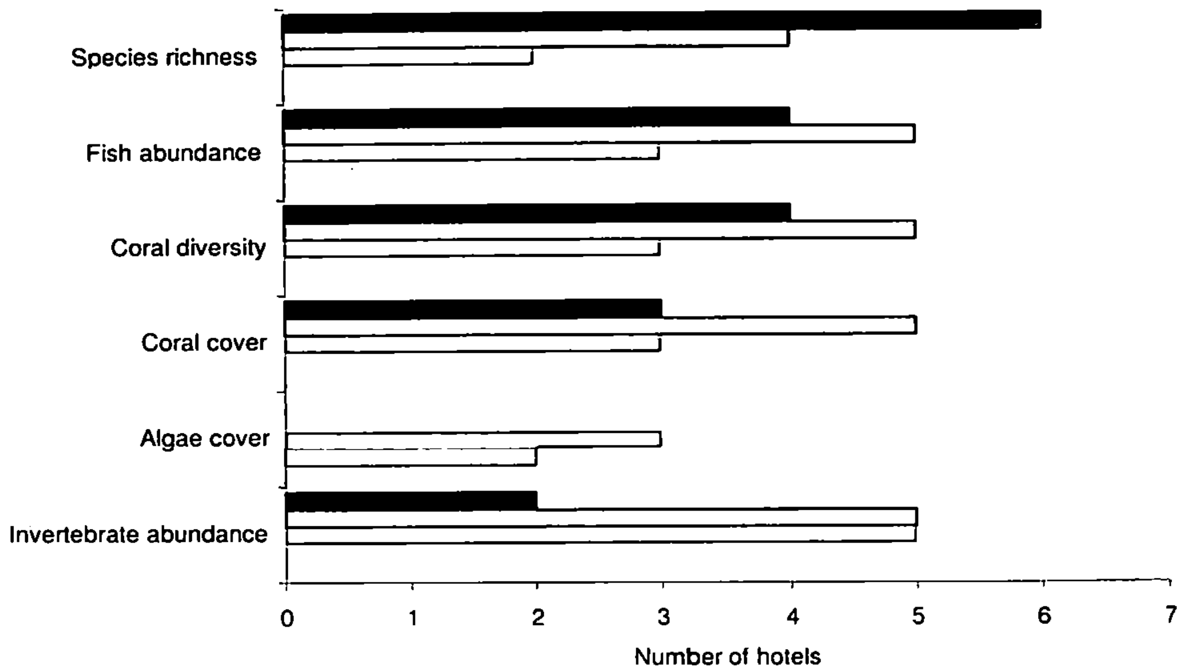


Figure 8.3. The perceived state of species richness, fish abundance, coral diversity and invertebrate abundance inside the Hotel Managed Marine Reserves (HMMRs), ranging from high, fairly high, average, fairly low and low. For coral cover and algae cover: high (>75 %) , fairly high (50-75 %), average (25-50 %), fairly low (10-25 %) and low (<10 %) (black - white shading)

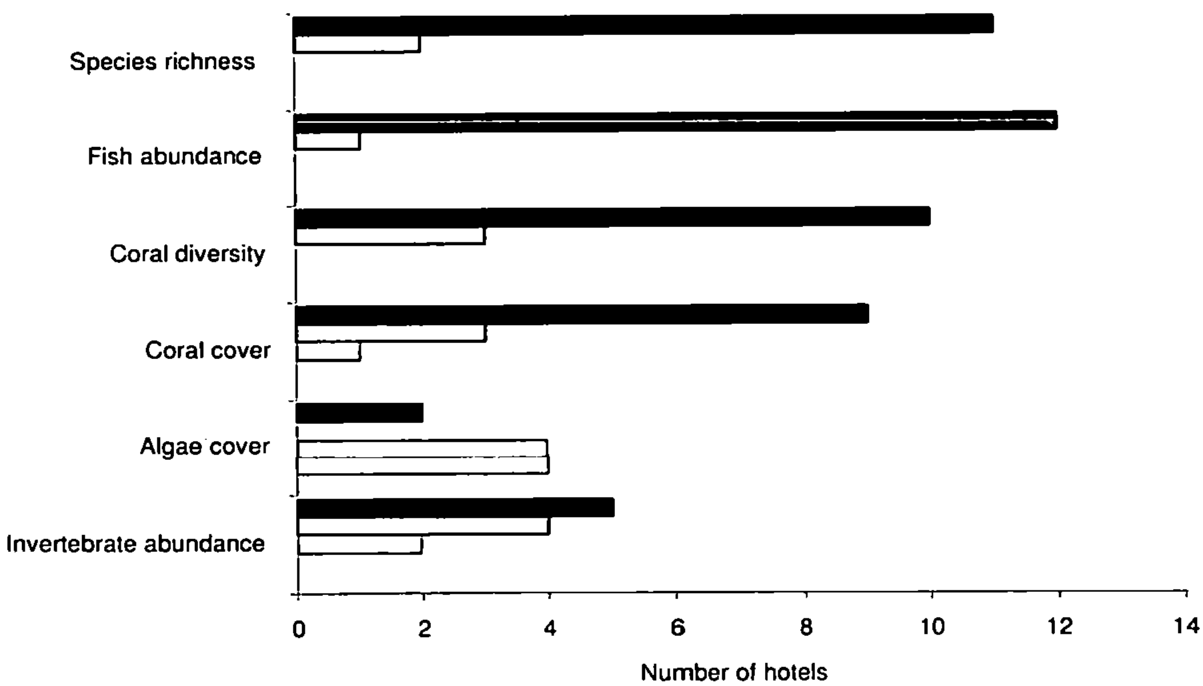


Figure 8.4. The perceived state of species richness, fish abundance, coral diversity, coral cover, algae cover and invertebrate abundance inside the Hotel Managed Marine Reserves (HMMRs) compared with unprotected areas, ranging from much higher, higher, no change, lower and much lower (black - white shading)

8.3.1.8 Anthropogenic damaging factors

From a range of proposed options, managers were invited to identify man-induced damaging factors to their surrounding area, or provide alternative suggestions (Figure 8.5). Damage from fishing activities and coastal development were the most reported activities.

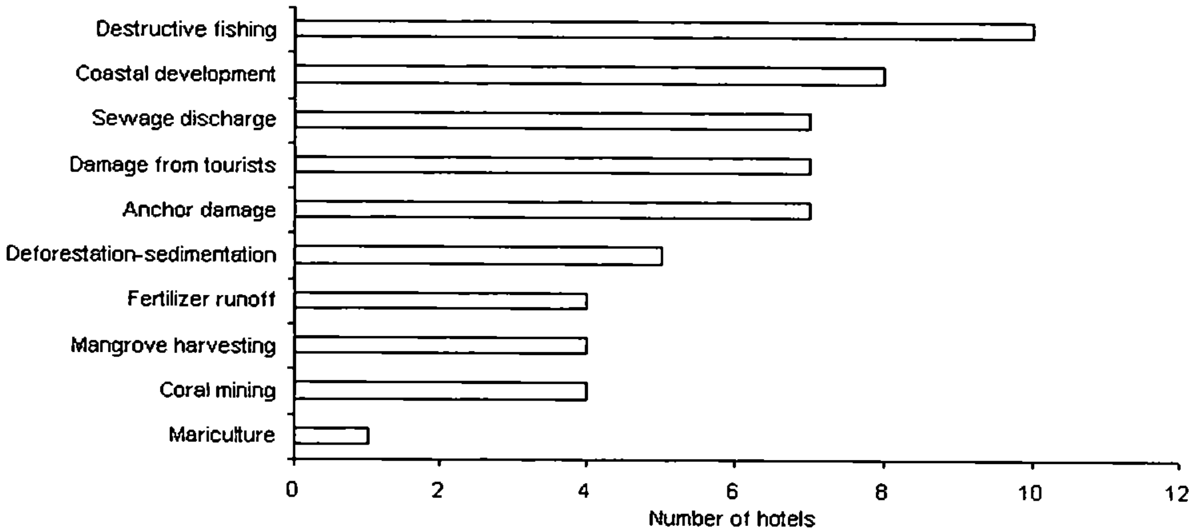


Figure 8.5. Anthropogenic factors identified by hotel managers causing damage to their surrounding coral reef ecosystem

8.3.2 HMMR rating

Of the 14 hotels that replied, only 12 completed the HMMR rating survey; 10 had not been in operation long enough to complete all 5 levels (4 years or older). A break-down of the number of hotels fully satisfying the requirements at each level (representing stages of HMMR qualification within suggested time periods) can be found in Figure 8.6. A high number of hotels suggest they are providing education programs for staff, local communities and tourists, while structured management activities and regular monitoring of the reserve with local participation seem to be slightly under-managed. Only one hotel has managed to attain funding from the government or other funding group and half pf the HMMRs actively support local communities through financial means, on top of the required leasing fees to the property-owning clan or local government.

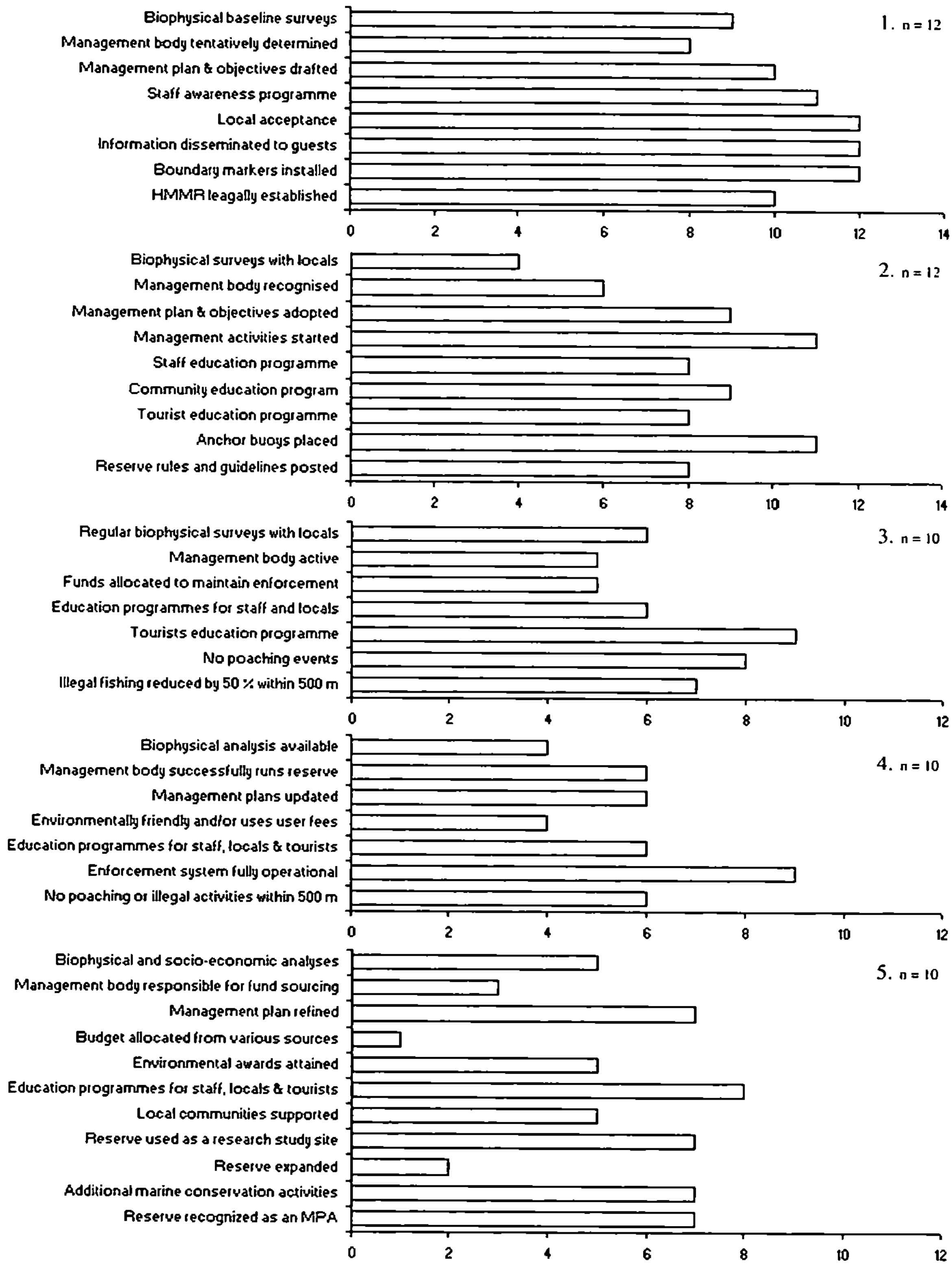


Figure 8.6. A break-down of number of hotels fully satisfying Hotel Managed Marine Reserve (HMMR) management requirements at each level: 1. HMMR initiated, 2. HMMR established, 3. HMMR enforced, 4. HMMR sustained, 5. HMMR institutionalised

As the levels increase, the requirements become more challenging to fulfil, which has duly led to a decreasing average score per level (Table 8.5). Several hotels, including CHICOP, Tanzania, Wakatobi Dive Resort, Indonesia and Alegre Beach Resort, Philippines, scored extremely high (>38 points), awarding them an "Excellent – marine reserve institutionalized" (Figure 8.8). These three resorts are also the hotels which have spent most money on their HMMRs (Table 8.3). There is a larger group of hotels scoring 'Good' or 'Very good' (>22 or >29 points): Navini Island resort, Fiji, Palua Pacific Resort, Palau, Duka Bay Resort Inc., Philippines, Taman Sari Cottages, Indonesia and the Rarotongan Beach Resort and Spa, Cook Islands (Figure 8.8). The final 4 hotels score either passing or fair (>7 & >14 points), but 2 of these could only complete the first three levels. The average score of 25 points puts HMMRs in a solid 'Good – HMMR is enforced' category (Table 8.5).

Table 8.5. Average scores of fully satisfied Hotel Managed Marine Reserve (HMMR) management requirements per level (SE), the score range of these and the average score from the number of questions (%)

Level	Average score (SE)	Range	Average score (%)
Initiated (score out of 8)	7.0 +/- 0.09 (n=12)	5 - 8	87.5
Established (score out of 9)	6.2 +/- 0.17 (n=12)	3 - 9	68.5
Enforced (score out of 7)	4.6 +/- 0.17 (n=10)	2 - 7	65.7
Sustained (score out of 7)	4.1 +/- 0.26 (n=10)	0 - 7	58.6
Institutionalised (score out of 11)	5.7 +/- 0.33 (n=10)	0 - 10	51.8
Average total score (42)	**25.2 +/- 0.86**	**11 - 41**	**59.9**

8.3.3 Eco-friendliness survey

All 14 hotel managers completed the eco-friendliness survey. A total of 51 questions were asked, divided into 7 conservation topics. The results suggest an average 71 % satisfactorily fulfilled criteria, which gives an average eco-friendliness rating of 'Good'. Waste water management was best practiced by hotels; noise and air quality, the least (Figure 8.7).

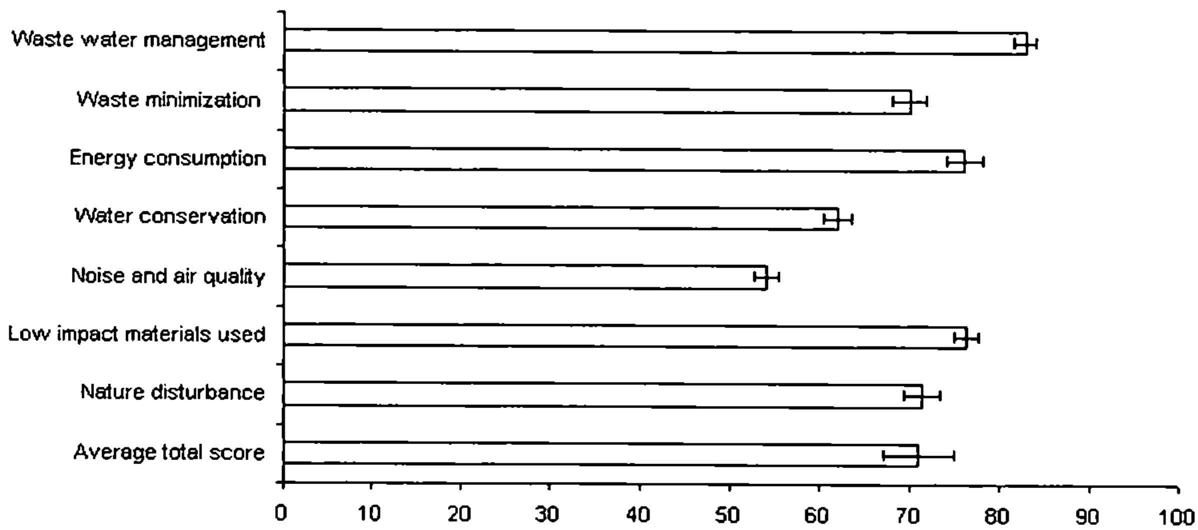


Figure 8.7. Hotels fully satisfying eco-friendliness requirements per environmental category (average scores expressed as %, including average total score across all categories, +/- SE)

The results from the eco-friendliness survey were compared with the HMMR rating survey, to give an understanding of how hotels' overall environmental policy compares with their marine conservation projects (Figure 8.8). The majority of hotels' environmental concept compared well with HMMR rating results, differing by one rating or none, apart from 3 hotels, which stand out. Shangri-La's Mactan Resort and Spa, Philippines and Selayar Dive Resort, Indonesia, scored much higher on their eco-friendliness rating, than their HMMR rating. Vice-versa for Taman Sari Cottages, Indonesia.

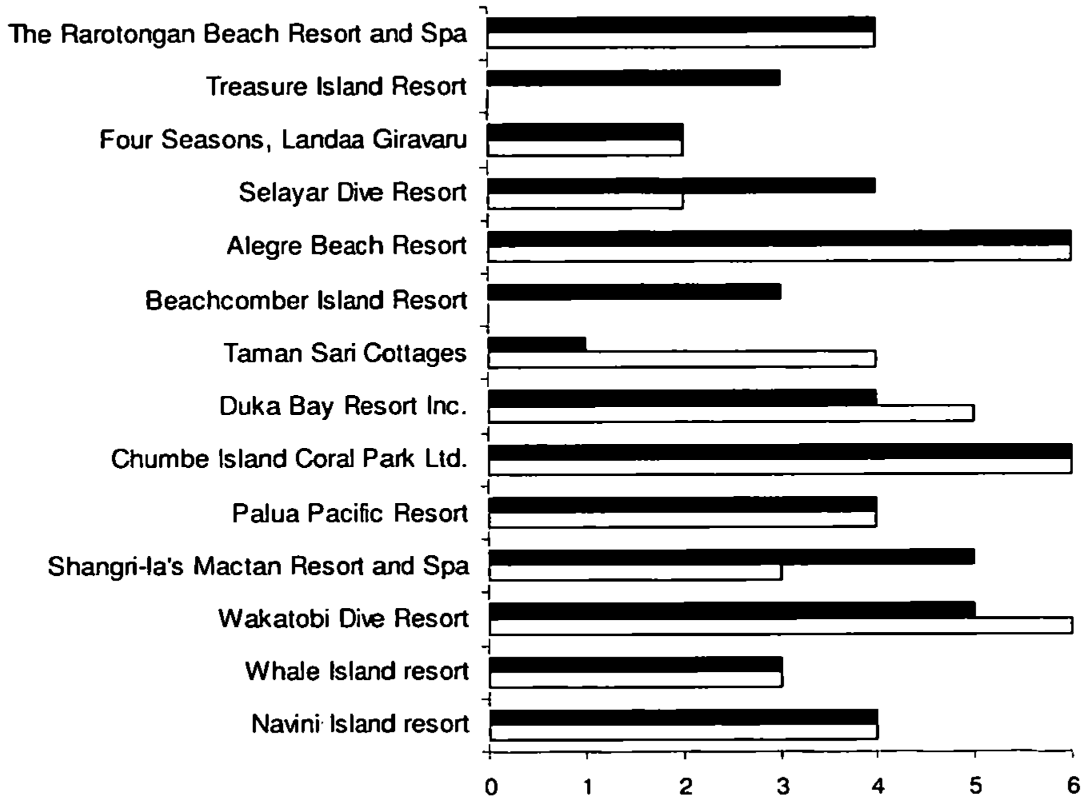


Figure 8.8. A comparison of the hotels' achieved eco-friendliness rating (black) and Hotel Managed Marine Reserve (HMMR) management rating (Grey) (0: NA, 1: No pass, 2: Passing, 3: Fair, 4: Good, 5: Very good, 6: Excellent)

8.4 Discussion

There is no central database for HMMRs, which made finding suitable hotels for this study difficult. The fact that only half of the hotel managers who responded advertise their HMMRs suggests that many more HMMRs than the 30 identified in this study are likely to have been established. Despite the relatively small sample size, the 14 hotels detailed here provide an insight into the variety of HMMRs, their basis for legally establishing marine reserves and information on how each is being managed.

A wide range of hotels, in terms of size, luxury and location, has created HMMRs, some dating back several decades (Table 8.3). The areas these hotels are protecting are, in some cases, also relatively large. When comparing the sizes of these HMMRs with recognised MPAs in the Philippines, only 26 out of 330 of these MPAs were found to be larger than Wakatobi Dive Resort's HMMR (700 ha); 175 cover an area less than 15 ha (HMMRs: 3) and only 40 are larger than 100 ha (HMMRs: 4) (CCEF 2008). Due to the low number of HMMRs investigated here, a representative comparison cannot be accurately made, but it does show that a very high number of MPAs in the Philippines are in fact relatively small. In contrast, unlike government managed MPAs, which also protect very large areas (several thousand ha), it is doubtful you'll currently find HMMRs much larger than Wakatobi Dive Resort, Indonesia. The average 110 ha protected by these 14 hotels is, however, a promising start to aid the global expansion of protected areas, if these are proven capable of increasing fish stocks to sustain local fisheries.

In order for HMMRs to actively contribute to world conservation, a set of requirements needs to be fulfilled for them to be more than just 'paper parks'. Firstly, they need to be legally recognised, which all but one hotel has accomplished, either by municipal ordinance or lease contract with the land-owning unit. This ensures that legal steps can be taken in case fishermen are found poaching in the reserve (Depondt & Green 2006). Results from the community perceptions surveys (Chapter 6) indicate that fishermen would be more inclined to respect reserve boundaries if there is a strong government presence legally validating protected areas.

Guidetti et al. (2008) similarly suggested that adequate enforcement support with legal representation is necessary to successfully manage MPAs. Most HMMRs have some kind of boundary marker system in place: several areas are enclosed with buoys, others have marker buoys, and some have painted markers on the equivalent coastline. The areas are either kept under surveillance from the resorts by security staff or reserve wardens if the area is small enough. Others are boat-patrolled by the hotel or by local communities if the areas are larger. In the Pacific Islands, the landowning unit, which has the power of legal action, is informed of poaching activities. For the other hotels, non-compliance is dealt with by government representatives or local community chieftains. They have the power to give fines, confiscate gear and in extreme cases, the vessel. How quickly these can act on individual poaching occurrences is not clear, but all hotels except for one claimed that their HMMR was effectively protected, although some admit to infrequent poaching events (Table 8.3). However, only approximately two thirds of the hotels claimed that poaching and illegal activities had been reduced or stopped inside the reserve and within 500 m of the reserve, suggesting that some hotels are either reporting incidences of fishermen 'fishing the line' (Figure 8.6) or that managers are under-representation non-compliance incidents, or a combination of both.

To try and help reduce non-compliance, a few hotels provide additional financial incentives to local fishermen/communities if the no-fishing ban is upheld, with the cash amount rewarded decreasing with increasing number of offenders. In the case of Wakatobi Dive Resort, Indonesia, adjacent villages are financially protected by the 'Collaborative Community-based Reef Resource Management Concept' (Wakatobi Dive Resort 2008), giving local communities strong incentive to protect the reserve from poachers residing inside and outside the reserve (>US$ 250,000). On top of additional financial support, one hotel even encourages fishermen to inform on poachers for monetary gain. While this method may help reduce non-compliance, it is questionable whether it is ethical or helpful in the long-run, since it may irrevocably damage the hotel/local community relationship.

Francis et el. (2002) suggest that MPAs cannot succeed without support by the local communities. While the majority of hotel managers clearly consider their HMMR as being effectively protected, only half are providing additional support to affected communities (Figure 8.6). Amongst others, added support has been given in the form of financial compensation, educational funding, infrastructure benefits or establishing alternative aquaculture (CHICOP 2008; Scuba Diver Magazine 2004; Tuxson 2005; Wakatobi Dive Resort 2008). These projects are additional to the lease or taxation which is annually paid to the local government or land owning unit, which should ideally be used to help local communities or for Pacific Island property, be distributed back to clan members. The large local community workforce employed by hotels must also be taken into account as providing alternative livelihoods. An average of 77 local people is employed by these hotels, with 10 out of 14 hotels employing >90 % local staff. Further research into local community perceptions of other HMMRs, such as described in Chapter 6, would however be helpful to determine community acceptance and support.

A stable source of sufficient funding has been advocated crucial to MPA success (Dharmaratne et al. 2000). This is fortunately less of a hindrance for HMMRs, compared with MPAs, if the hotels continue to attract tourists. The future of tourism looks promising in light of the ever expanding industry and the growing demand for eco-tourism (Dharmaratne et al. 2000). While only three hotels receive grants to aid their projects, a few others collect user fees from hotel guests or mooring and diving fees from visiting boats and tourists, to help maintain the reserve or support local communities. User fees are often described as accepted by tourists as a direct means to contribute to conservation (Depondt & Green 2006; Tongson & Dygico 2004). In Chapter 7, I found that the majority of tourists are willing to pay an extra 10 % of the room rate per room and night to stay at HMMRs, albeit, in several instances with reservations, wanting third-party, guaranteed better biophysical conditions in the reserve, transparency in cash flow and benefits to local communities (Chapter 7; Svensson et al. 2008).

The financial requirements to maintain the various HMMRs differ radically however. These ranged from approximately US$ 2000 to more than US$ 250,000 per year

(Table 8.3), depending on the size of the protected area, the location, management structure and agreements/contracts, as well as additional community support and conservation projects. While the three most costly HMMRs to maintain also scored highest on the HMMR rating survey (Excellent – HMMR is institutionalised) (Figure 8.8), the hotels scoring 'Good – HMMR is enforced' or 'Very Good – HMMR is sustained', only pay a few thousand per year to maintain the reserve. Some of these have, however, smaller areas to protect and most are involved in fewer supporting projects, or at least less costly.

The effectiveness of the HMMRs in enhancing the biophysical environment should obviously be of top concern when considering HMMRs as an added potential future tool for marine resources protection. Figures 8.3 and 8.4 display hotel managers' perceptions of the biophysical state of their reserve and how it compares with unprotected areas. While they mostly perceive the state of their reserve as 'high' or 'fairly high', for specifically coral and fish abundance and diversity, some do rate these parameters as 'average'. When compared with unprotected areas, however, these parameters are almost unreservedly rated as 'much higher' or 'higher' within the reserve, suggesting that hotel managers may not necessarily have over-emphasized the state of their reserve, but comparatively, they certainly perceive the biophysical state in the reserves as better than the surrounding unprotected areas. These results must however be examined with caution, as they are not empirical data or even third party data, but mere perceptions, which are likely to be biased in favour of the hotel and its reserve. Most hotels do report regular reserve monitoring (Table 8.3), albeit not always with local participation (Figure 8.6), so physical evidence should be available, which managers could refer to. Copies of these were, however, not requested for this survey. In addition, more HMMR underwater survey results over a time period, such as described in Chapter 4, would provide more robust biophysical evidence of the ecological status of the HMMR. The results of surveys dating back to reserve establishment would be helpful to identify the effectiveness of the HMMR concept. In most cases, even a perception of HMMR progression was not available here. The few managers who had been present from the start of the HMMR stated that they had noticed considerable improvements, especially in fish abundances, which coincidently agrees with previous findings, where significant increases in fish stocks had been observed in reserves of all sizes in a relatively short time once the reserve was enforced (Halpern & Warner 2002). Such observations by hotel managers should, however, once again be viewed with scepticism before proven objectively and empirically.

No-fishing zones potentially achieve two things for fisheries management. They provide insurance against unsustainable declines of species due to overfishing and they supplement their production of fisheries species in the surrounding fished area (Sale et al. 2005). This is crucial to achieve in order to justify the promotion of HMMRs. Further research into the effectiveness of HMMRs at increasing spillover of fisheries species is needed, but several studies from similarly small MPAs provide evidence of such activities (Abesamis et al. 2006; Alcala et al. 2005). In Chapter 6, I show that the vast majority of fishermen, who fish within 200 m of Whale Island Resort's HMMR boundary, had noticed a higher abundance of fish in this area.

To further establish the effectiveness of HMMRs, managers were asked to complete an HMMR rating questionnaire (Figure 8.6). This highlighted areas which could be improved and the areas where the hotels are generally performing well. A better structured and organised hotel managing body to implement management plans and objectives, and which actively seeks funding sources and specifically manages reserve finances, has been identified as under-developed. According to the tourist willingness to pay survey discussed in Chapter 7, tourists would more actively support HMMRs if a separate, or better defined managing body would represent the marine reserve, especially when requested to pay user fees.

The HMMR management plan and objectives seem ill-defined, suggesting that many of these had not been previously determined. Nevertheless, all hotel managers express their wish to help protect the environment. Some objectives include awareness building, while others also admit to business goals. This does not seem to overly concern visiting HMMR tourists, as 97.5 % expressed support for HMMRs, even though 12 % realised, and expressed the view, that the hotel would also profit (Chapter 7; Svensson et al. 2008).

More of a concern for these tourists was that they required guaranteed better biophysical conditions in the reserve when the reserve is advertised and when the hotel demands user fees (chapter 7). An environmental agency with the power to grant awards was suggested. In this study, it was found that only half the hotels actually advertise their protected area and only one of these collects user fees. It would be interesting to survey these tourists, and compare their support for HMMRs to another hotel in this survey, which collects direct user fees from guests, but does not advertise. Ahmed et al. (2007) suggest that with more awareness campaigns, a larger WTP for the management of coral reefs can be attained. From the few examples of the hotel advertising its reserve and environmental projects, especially occupancy and number of return guests are perceived to have increased as a result (Table 8.4), suggesting the effectiveness of cause-related marketing and the growing interest in ecotourism. These findings can currently, however, not be objectively confirmed, but they may nevertheless be viewed with optimism.

Advertising, actively involving hotel guests in marine projects and providing education programs, which several hotels offer, will help raise awareness for the need to protect our marine resources. Staff and local community awareness sessions will also ensure added support for the protected areas (Alder 1996). It has also been suggested that increasing public awareness, and gaining acceptance from local communities before reserve establishment, will positively influence hotel/community relations (Bunce et al. 1999). All hotel managers ensured that local acceptance was sought and attained before reserve inauguration (Figure 8.6) but, as with WIR, perhaps acceptance was only attained by limited members of affected local communities. Community surveys, as described in Chapter 6, would help clarify this, as well as give another, perhaps more accurate measure of management performance.

The overall average score for the HMMR rating was 25.2 (Table 8.5), which places the management of HMMRs in a solid 'Good – HMMR is enforced' category. When compared with the available management ratings for 18 MPAs in the Philippines in 2005, this average score is higher than their average accomplished: 'Fair – HMMR is established' (CCEF 2008). These scores can not be compared absolutely, however, since some questions were changed to reflect an HMMR situation. Also, the MPA management rating was only given after thorough investigations by a third party, while the HMMR rating results were provided by resort managers, leaving room for bias.

In Chapter 7, I showed that tourists who were interested in hotels' environmental policy were also willing to pay extra to stay at HMMRs, providing further evidence of eco-awareness. Hotel managers were asked to complete an eco-friendliness questionnaire to give an understanding of the hotels' general attitude to environmental concerns (Figure 8.7). Most environmental categories were relatively well fulfilled. Noise and air pollution, as well as water conservation management were slightly under-managed. The low score for these two categories can be partially explained by inappropriateness of the questions asked. This questionnaire was constructed for a standard hotel, and does not leave room for superfluous or alternative eco-friendly processes, which hotels may have, depending on their specific situations or circumstances. The owners of Selayar Dive Resort, Indonesia, for example, inform that they have a natural stream running through the resort. With its origin in the mountains, it provides a continuous and high-pressured supply of fresh water. The goal of this questionnaire was, however, not to go into specifics of hotels eco-friendliness, but to see if the hotels' eco-friendliness matches their marine reserve management rating (Figure 8.8); also giving a more holistic impression of the hotels' conservation-mindedness, which could contribute to determining tourists' impressions of HMMRs. This could perhaps give an indication of the direction of word-to-mouth advertising for HMMRs and willingness to pay user fees, since it has been recognised that tourists are more inclined to pay, if they are interested in or provided with information on environmental efforts and policies (Chapter 7; Dharmaratne et al. 2000) and their stay surpasses their expectations (Ahmed et al. 2007; Lindberg 1991; Ross & Wall 1999). In most cases the hotels' overall environmental policy closely coincided with the HMMR rating. Exceptions with two or more separating rating levels were Shangri-La's Mactan Resort and Spa, Philippines and Selayar Dive Resort, Indonesia, which scored higher on their eco-friendliness rating, and Taman Sari Cottages, Indonesia, which scored higher on the HMMR rating survey.

Shangri-La's discrepancy is easily explained by the fact that the HMMR was only established in 2006, and thus only completed the first two HMMR rating categories. Selayar Dive Resort is on an island with no reported fishermen nearby; the nearest city located 40 km away. This seclusion may partly explain the lower perceived need for structured reserve management. Taman Sari Cottages, on the other hand, had a higher HMMR rating than eco-friendliness. Here again, the eco-friendliness questions may not be specific enough for the hotel's situation. The manager explains that the area is extremely poor and also very dry. They therefore, by default, use very little freshwater, but do not have any specific water conservation programmes. Their recycling efforts entail bringing the material to the mainland, where it is thoroughly picked through by the local people. Most hotels, however, did have a relatively high eco-friendliness rating, which tourists may notice, and which, may potentially help promote the HMMR concept.

These HMMR-related surveys show very positive and promising results. However, to determine whether HMMRs have the potential to function as an alternative or complementary tool to protecting at least a part of our degrading marine resources on a global level, thereby sharing the financial burden with local governments, a more objectively-conducted survey, and taking an ecosystem-based approach to marine resources management, involving a greater number of HMMRs, will be necessary. Albeit, keeping potential biases in mind, several hotels seem to exhibit an extremely well-structured and well-managed approach to marine conservation, and often, actively compensate and support local communities and provide job security for a large number of people. Many hotels also, additionally, manage other related marine conservation projects, which contribute to further ecosystem conservation and awareness building. The biophysical state, especially fish stocks, inside the reserves also *seems* to be improving, which could potentially lead to higher catches outside the reserve. Further research into the effectiveness of HMMRs as a fisheries management tool is, however, still needed. This is extremely important, since most hotel managers report highest concerns from fishing activities (Figure 8.5).

The research for this thesis suggests that the number of hotels establishing HMMRs, or are actively involved in marine conservation, is increasing. Other hotels have established and managed HMMRs, before another management body assumed control (e.g. Lankayan Island Dive Resort, Malaysia; Teh et al. 2007), and some provide resources and support to government-managed MPAs (e.g. El Nido Resorts: Miniloc Island & Lagan Island, Philippines (Talbot & Wilkinson 2001). Other private enterprises are also helping to manage protected areas. Managers from six dive operations in the Gili Islands, Indonesia, for example, have founded the Gili Eco Trust, which collects money from divers to fund a patrolling unit to stop poaching in the 6 protected areas, give monthly cash allowances to local communities as an incentive to increase compliance, and manage rubbish collections (Gili Eco Trust 2009).

There is strong evidence of goodwill from the private sector, with many examples of hotels going the extra mile to protect our environment. Some hotels, however, have purely a business approach to potential conservation projects. One hotel manager who was contacted in the course of this research, admitted to only establishing an artificial reef to impress his clientele and to provide occasional meals for his guests.

Establishing a centrally governed environmental agency for all HMMRs, or expanding the award system of an existing, globally recognised environmental agency (e.g. Green Globe) to monitor HMMR protection and to ensure affected community involvement and support, may be a solution to sustainably expanding the HMMR concept and guaranteeing the effectiveness of HMMRs. This could furthermore, help raise awareness and consequential growth of protected areas, potentially establishing a network of thousands of marine reserves, which is suggested to increase fish assemblages and thereby, fisheries yield (Dawson et al. 2006; Roberts et al. 2001).

9. Thesis conclusion

More protected areas lining increasingly overpopulated and overfished tropical coastal countries is considered a very viable option to help sustain nearshore resources (Kleypas & Eakin 2007). This thesis proposes that hotels may be able to help local governments protect small areas from fishing and damaging practices, and help alleviate the financial burden such protections would inevitably entail. Before such Hotel Managed Marine Reserves (HMMRs) can be considered, however, an analysis of existing HMMRs is needed, establishing their worth at: successfully improving the biophysical state inside reserves, increasing fish stocks and providing spillover, being accepted and supported by the wider public and especially by local communities.

The interdisciplinary approach of this thesis provides an enlightening holistic view of the biological effectiveness and socioeconomic aspects related to the management of an HMMR. It is aligned with the fundamental concepts of an Ecosystem-based Management (EBM) approach, which is arguably one of the best, relatively newly-emerged frameworks to successfully establishing and maintaining Marine Protected Areas (MPAs). This integrated management approach considers all aspects of the ecosystem, including humans, to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need (McLeod et al. 2005).

The Driving force – Pressure – State – Impact – Response (DPSIR) conceptual framework model was used in this thesis, as it simplifies linkages of environmental functions, identifying environmental and societal problems and solutions. These indicators stress the cause and effect relationships between human activities that exert pressures on the environment, condition of the environment, and the impact on societies with a resulting policy change addressing these problems (Mangi et al. 2007). In this thesis, the major impact indicators identified livelihood concerns for coastal communities following the establishment of HMMRs.

Consequently, surveys were conducted with a locally affected community of fishermen (Chapter 6). The results of these surveys, however, showed ambiguous results, making the interpretation of the welfare of the communities difficult. In retrospect, it is apparent that the survey design could have been improved upon. Potentially biased, vague or unaccredited results were attained, which could have been prevented. Instead of conducting two surveys: 1. Surveys distributed to fishermen by the Chairman of the People's Committee, 2. Interviews conducted with families at their homes, an individual, singular, interview-based survey design, involving a larger sample size (possibly also conducted with fishermen of other nearby villages), performed by approaching fishermen as they are returning with their catch, thereby avoiding the influential opinions of their elders at home and possible biases resulting from the distribution and influence of the Chairman of the People's Committee, may have provided a greater and more accurate understanding of the management effectiveness of the HMMRs.

Similarly, a more encompassing set of results could have been attained if interviewed surveys would have been conducted with tourists of the nearby city of Nha Trang, and not only with guests of the hotel. Although the sample consisted of a wide range of ages and income earners, the fact that they had all found their way to the hotel (80 km from Nha Trang), demonstrates a similar mindset, which could potentially have biased the results. Similarly, interviews with tourists in Nha Trang may have provided a more nationality-balanced sample; a larger Asian representation.

Establishing the management effectiveness of HMMRs through surveys completed by hotel owners and mangers also provides a setting for biased results. The best approach would have been for the author to travel to each location to conduct the interviews and biological surveys personally, or for an impartial, third-party member to do so. As this was not possible, the questionnaires were sent and returned by email or completed via telephone interviews. Telephone interviews with all managers would have been preferred, but this was not always possible due to time-limitation of managers. Further, similar research as conducted in this thesis, involving biological and socioeconomic surveys, but performed at several HMMRs around the world, would be necessary to establish HMMR potential on a larger scale. Such research would also give a better understanding of policy implications that would need to be adopted for successful implementation and ongoing management. Results here suggest that at least a nation-wide, preferably, a globally established and reputed environmental agency, monitoring HMMR initiation, integration and progress, would be important to make sure that the needs of the environment, affected communities and hotel are equally considered.

The biological surveys had a robust study design, but additional surveys to confirm spillover of fish to fished areas would have strengthened the perceived convictions of spillover uttered by many local fishermen, who confirm they fish adjacent to the reserves. These mentioned an increase in the number of some groups of large commercially valuable food fishes (e.g. Carangidae, Serranidae), although surveys within the reserves found only relatively low densities of species belonging to such families.

Nevertheless, similar to other centralized or community-managed MPAs of equivalent size (Halpern 2003; Russ & Alcala 1989), the density, species richness, average size and number of fish >15 cm at the 11 ha and 5 ha reserves at Whale Island Resort (WIR), were significantly higher than unprotected areas. Particularly, the 11 ha, 6-year protected Whale Island Bay reserve (WIB) showed successful results following protection compared with control sites, providing shelter for 22 times the number of fish >15 cm, 2.9 times the density, 2.6 times species richness and 1.5 times the average size (Chapter 4). Coral cover in the same reserve was also 7 times higher on the rocky habitats, potentially as a result of inhibiting destructive fishing techniques, such as hose and hook fishing and beach seining. All surveyed fishermen whom had been inside the reserve confirmed the higher abundances of biota in the reserves (Chapter 6).

The speed at which enforced protected areas can increase fish stocks is very promising when considering establishing many more HMMRs. Already after half a year, Whale Island Bay Peninsula reserve (WIBP) contained 13 times the number of fish >15 cm compared with unprotected areas, representing an increase from 2-

9.4 % of the total fish population. This rapid increase in size following protection confirms the findings of other authors (Halpern & Warner 2002; Roberts & Hawkins 1997). Enforcement was relaxed soon after this, however, giving rise to non-compliance, compromising earlier successes (Chapter 4). Small reserves are consequently particularly vulnerable to lax enforcement (Roberts & Hawkins 1997), where only a few poaching events can cause serious damage, negating many years of protection, depending on the fishing technique used.

Results from these biological surveys suggest that HMMRs may be able to sustain fisheries on a local level but more research pertaining to the optimal reserve size needs to be conducted. Palumbi (2004) suggests that large reserves protect larger-bodied species better than small reserves because they are more likely to contain their home ranges, but in order to provide spillover, a larger size is less effective because of the decreasing edge to area ratio (Hastings & Botsford 2003). Species within small HMMRs (HMMR average: 110 ha +/- 13.22 SE) may equally not be as resilient to global pressures, such as natural disasters, disease outbreaks, global warming etc., since they may not contain adequate genetic diversity to recover from, or adapt to such events (Frankham 2005). However, Jones et al. (2009) demonstrate that coral and fish populations are often partially self-replenishing, even on reefs <1 km^2, but are also linked to other populations 10-100s of km away by larval dispersal. A network of HMMRs, though producing fewer larvae due to their smaller populations, is therefore still likely to contribute to population resilience and growth (Almany et al. 2009).

Privately managed marine reserves contributing to, or creating a network of protected areas covering tropical coastal countries may be possible, but probably only if an ecosystem approach to protection is employed and the principals of co-management are introduced.

Hotels often have the funding, resources and incentive to protect coastal areas from overfishing and destructive practices (Colwell 1999). These relatively financially stable enterprises could secure adequate long-term funding (especially if a user fee system were introduced); a lack of which has been declared the main factor leading to inadequate law-enforcement and the ultimate demise of an MPA (Depondt & Green 2006; Dharmaratne et al. 2000). Private enterprises can lease submerged lands for conservation purposes, although the leasing contract is time-limited (mostly open to renewal), but generally well received as a regular income to the region (Beck et al. 2004). Hotels have the staff and equipment to patrol the predominantly overseeable boundaries and the legal power to enforce rules and restrictions as stated in the property rights imposed by the government (Colwell 1999; Depondt & Green 2006). HMMRs can also be seen as money saved by the government for areas otherwise needing protection (Langholz & Lassoie 2001). They provide direct and indirect employment and regional income through their tourism activities, while securing a market niche for their business, potentially attracting eco-tourists and increasing occupancy and return guests.

The results of this thesis suggest, however, that it is more likely for HMMRs to succeed if other stakeholders are more actively involved. Several local fishermen expressed displeasure with the hotel and its reserve, indicating that they had not been informed or been given the opportunity to voice their concerns. Many fishermen would therefore welcome more government involvement, strengthening the validity of the protected areas and they would appreciate feedback on reserve progress. A relatively large percentage of tourists would also prefer an external environmental agency to validate the proclamations of hotels with regards to hypothetically advertised higher fish and coral diversity and abundances, especially if they accept to pay a room surcharge to access the HMMR. A co-management approach involving the hotel, affected communities, an environmental agency and the government may therefore be a good combination. The environmental agency and hotel could initially provide education programmes to local communities and staff, explaining the potential long-term benefits of MPAs in order to gain trust and support for the project, which should increase compliance. The government would need to clearly state the property rights of the protection, including penalties for non-compliance. A management board with stakeholder representatives would introduce a management plan with objectives that maximises reserve potential for conservation and fisheries purposes, while minimising the negative impact on local fishermen. Perhaps an alternative livelihoods plan can be developed, until such time as the reserve can at least match the losses incurred by the no-take zone. The environmental agency could also monitor the reserve and provide regular updates and act as an objective third party to resolve any potential conflicts. With government involvement, it is also more likely that the lease of the protected area will be offered on renewable long-term bases; tax reductions may be offered or the government may even take over the lease completely (Colwell 1999; Riedmiller 1999).

With government involvement and an environmental agency (e.g. Green Globe) setting standards and ensuring that these are adhered to in a large number of HMMRs lining coastal countries, it may eventually be possible to create an effective network of protected areas, with HMMRs and other MPAs building the backbone of the network. By applying an EBM approach, involving all protected areas, but also looking at protection on a broader, regional/national level, and involving scientists to model a nation-wide network, taking the direction of currents, diversity hotspots, larval dispersal distances, resource needs etc. into account, it may be possible to build upon this backbone and create an effective system of reserves offering refugia at various distances for adults, larval and propagule dispersal and settlement, which can have a cumulative positive effect on fish stocks (Dawson et al. 2006; Roberts et al. 2001).

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Appendix 1. Identified fish species from Whale Island Bay reserve, Whale Island Bay Peninsula reserve and two Control sites

Fish Family	Fish family common name	Fish species	Fish species common name
Acanthuridae	Surgeonfish	*Acanthurus grammoptilus*	FINE-LINED SURGEONFISH
Acanthuridae	Surgeonfish	*Acanthurus mata*	YELLOWMASK SURGEONFISH
Acanthuridae	Surgeonfish	*Acanthurus triostegus*	CONVICT TANG
Acanthuridae	Surgeonfish	*Ctenochaetus striatus*	LINED BRISTLETOOTH
Acanthuridae	Surgeonfish	*Naso lopezi*	SLENDER UNICORN FISH
Acanthuridae	Surgeonfish	*Zebrasoma veliferum*	PACIFIC SAILFIN TANG
Antennariidae	Frogfish	*Anntenarius striatus*	STRIPED FROGFISH
Antennariidae	Frogfish	*Antennarius pictus*	PAINTED FROGFISH
Atherinidae	Silverside	*Atherinomorus lacunosus*	ROBUST SILVERSIDE
Balistidae	Triggerfish	*Pseudobalistes flavimarginatus*	YELLOWMARGIN TRIGGERFISH
Balistidae	Triggerfish	*Rhinecanthus aculeatus*	PICASSO TRIGGERFISH
Balistidae	Triggerfish	*Sufflamen chrysopterus*	FLAGTAIL TRIGGERFISH
Caesionidae	Fusilier	*Caesio caerulaurea*	SCISSORTAIL FUSILIER
Caesionidae	Fusilier	*Caesio teres*	BLUE AND YELLOW FUSILIER
Caesionidae	Fusilier	*Caesio xanthonota*	YELLOWBACK FUSILIER
Caesionidae	Fusilier	*Pterocaesio digramma*	DOUBLE-LINED FUSILIER
Caesionidae	Fusilier	*Pterocaesio tessellata*	NARROWSTRIPE FUSILIER
Caesionidae	Fusilier	*Pterocaesio tile*	BLUESTREAK FUSILIER
Carangidae	Jacks	*Alepes melanoptera*	BLACKFIN SCAD
Carangidae	Jacks	*Carangoides ferdau*	BLUE TREVALLY
Carangidae	Jacks	*Carangoides orthogrammus*	YELLOW-SPOTTED TREVALLY
Carangidae	Jacks	*Scomberoides commersionnianus*	TALANG QUEENFISH
Carangidae	Jacks	*Scomberoides lysan*	DOUBLE-SPOTTED QUEENFISH
Centriscidae	Razorfish	*Aeoliscus strigatus*	RAZORFISH
Chaetodontidae	Butterflyfish	*Chaetodon adiergastos*	PANDA BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon auriga*	THREADFIN BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon auripes*	ORIENTAL BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon ephippium*	SADDLED BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon lineolatus*	LINED BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon lunula*	RACOON BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon lunulatus*	REDFIN BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon melannotus*	BLACK-BACKED BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon octofasciatus*	EIGHT-BANDED BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon rafflesi*	LATTICED BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon speculum*	OVALSPOT BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon trifascialis*	CHEVRONED BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon vagabundus*	VAGABOND BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chaetodon wiebili*	BLACKCAP BUTTERFLYFISH
Chaetodontidae	Butterflyfish	*Chelmon rostratus*	LONG-BEAKED CORALFISH

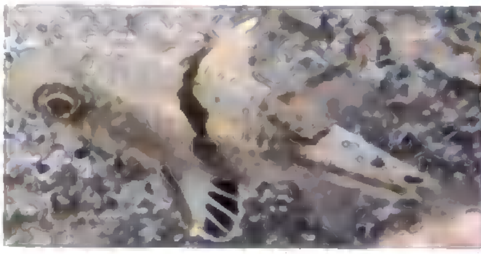
Chaetodontidae	Butterflyfish	*Heniochus acuminatus*	LONGFIN BANNERFISH
Chaetodontidae	Butterflyfish	*Heniochus chrysostomus*	PENNANT BANNERFISH
Chanidae	Milkfish	*Chanos Chanos*	MILKFISH
Fistulariidae	Cornetfish	*Fistularia commersonii*	CORNETFISH
Gerreidae	Mojarras	*Gerres erythrourus*	DEEP-BODIED SILVER BIDDY
Gerreidae	Mojarras	*Gerres oyena*	BLACKTIP SILVER BIDDY
Haemulidae	Sweetlip	*Diagramma pictum*	SILVER SWEETLIP
Haemulidae	Sweetlip	*Plectorhinchus chaetodonoides*	MANY-SPOTTED SWEETLIP
Haemulidae	Sweetlip	*Plectorhinchus chrysotaenia*	GOLDSTRIPED SWEETLIPS
Haemulidae	Sweetlip	*Plectorhinchus picus*	DOTTED SWEETLIP
Holocentridae	Squirrelfish	*Myripristis violacea*	VIOLET SOLDIERFISH
Holocentridae	Squirrelfish	*Sargocentron cornutum*	THREE-SPOT SQUIRRELFISH
Labridae	Wrasse	*Cheilinus chlorourus*	FLORAL WRASSE
Labridae	Wrasse	*Cheilinus fasciatus*	REDBREASTED WRASSE
Labridae	Wrasse	*Choerodon anchorago*	ANCHOR TUSKFISH
Labridae	Wrasse	*Diproctacanthus xanthurus*	YELLOWTAIL TUBELIP
Labridae	Wrasse	*Halichoeres argus*	ARGUS WRASSE
Labridae	Wrasse	*Halichoeres biocellatus*	TWOSPOT WRASSE
Labridae	Wrasse	*Halichoeres chloropterus*	PASTEL-GREEN WRASSE
Labridae	Wrasse	*Halichoeres hortulanus*	CHECKERBOARD WRASSE
Labridae	Wrasse	*Halichoeres marginatus*	DUSKY WRASSE
Labridae	Wrasse	*Halichoeres melanochir*	BLACK WRASSE
Labridae	Wrasse	*Halichoeres nigrescens*	GREENBACK WRASSE
Labridae	Wrasse	*halichoeres richmondi*	TAILSPOT WRASSE IP
Labridae	Wrasse	*Halichoeres vrolikii*	INDIAN PINSTRIPE WRASSE
Labridae	Wrasse	*Halichores leucurus*	CHAIN-LINED WRASSE
Labridae	Wrasse	*Hemigymnus melapterus*	BLACKEYE THICKLIP
Labridae	Wrasse	*Labroides dimidiatus*	BLUESTREAK CLEANER WRASSE
Labridae	Wrasse	*Macropharyngodon meleagris*	LEOPARD WRASSE
Labridae	Wrasse	*Neon Green Wrasse*	NEON GREEN WRASSE
Labridae	Wrasse	*Oxycheilinus bimaculatus*	TWOSPOT WRASSE
Labridae	Wrasse	*Pseudocheilinus hexataenia*	SIXSTRIPE WRASSE
Labridae	Wrasse	*Stethojulis interrupta*	CUTRIBBON WRASSE
Labridae	Wrasse	*Stethojulis strigiventer*	THREE-LINE WRASSE
Labridae	Wrasse	*Thalassoma lunare*	CRESCENT WRASSE
Labridae	Wrasse	*Thallassoma hardwicke*	SIXBAR WRASSE
Lethrinidae	Emperor	*Lethrinus amboninensis*	AMBON EMPEROR
Lethrinidae	Emperor	*Lethrinus erythropterus*	LONGFIN EMPEROR
Lethrinidae	Emperor	*Lethrinus harak*	THUMBPRINT EMPEROR
Lethrinidae	Emperor	*Lethrinus nebulosus*	SPANGLED EMPEROR
Lethrinidae	Emperor	*Lethrinus obsoletus*	ORANGE-STRIPED EMPEROR
Lethrinidae	Emperor	*Lethrinus ornatus*	ORNATE EMPEROR
Lethrinidae	Emperor	*Monotaxis grandoculis*	HUMPNOSE BIGEYE BREAM
Lutjanidae	Snapper	*Lutjanus bohar*	RED SNAPPER
Lutjanidae	Snapper	*Lutjanus carponotatus*	SPANISHFLAG SNAPPER
Lutjanidae	Snapper	*Lutjanus ehrenbergii*	BLACKSPOT SNAPPER

Lutjanidae	Snapper	*Lutjanus fulvus*	BLACKTAIL SNAPPER
Lutjanidae	Snapper	*Lutjanus gibbus*	HUMPBACK SNAPPER
Lutjanidae	Snapper	*Lutjanus lemnisciatus*	DARK-TAILED SNAPPER
Lutjanidae	Snapper	*Lutjanus quinquelineatus*	FIVE-LINED SNAPPER
Lutjanidae	Snapper	*Lutjanus vitta*	BROWNSTRIPE SNAPPER
Lutjanidae	Snapper	*Macolor niger*	BLACK SNAPPER
Monacanthidae	Filefish	*Acreichthys tomentosus*	BRISTLE-TAILED FILEFISH
Monacanthidae	Filefish	*Aluterus scriptus*	SCRAWLED FILEFISH
Monacanthidae	Filefish	*Pseudomonacanthus macrurus*	STRAPWEED FILEFISH
Mullidae	Goatfish	*Mulloidichthys flavolineatus*	YELLOWSTRIPE GOATFISH
Mullidae	Goatfish	*Parapeneus multifaciatus*	MANYBAR GOATFISH
Mullidae	Goatfish	*Parupeneus barberinoides*	BICOLOR GOATFISH
Mullidae	Goatfish	*Parupeneus barberinus*	DASH-DOT GOATFISH
Mullidae	Goatfish	*Parupeneus heptacanthus*	CINNABAR GOATFISH
Mullidae	Goatfish	*Parupeneus indicus*	INDIAN GOATFISH
Mullidae	Goatfish	*Parupeneus macronemua*	LONGBARBEL GOATFISH
Mullidae	Goatfish	*Upeneus tragula*	FRECKLED GOATFISH
Muraenidae	Moray	*Echidna nebulosa*	SNOWFLAKE MORAY
Muraenidae	Moray	*Gymnothorax chilospilus*	WHITELIP MORAY
Nemipteridae	Coral Bream	*Scolopsis affinis*	PALE MONOCLE BREAM
Nemipteridae	Coral Bream	*Scolopsis affinis*	PALE MONOCLE BREAM JUVENILE
Nemipteridae	Coral Bream	*Scolopsis bilineatus*	BRIDLED MONOCLE BREAM
Nemipteridae	Coral Bream	*Scolopsis ciliatus*	WHITESTREAK MONOCLE BREAM
Nemipteridae	Coral Bream	*Scolopsis margaritifer*	PEARLY MONOCLE BREAM
Nemipteridae	Coral Bream	*Scolopsis monogramma*	MONOGRAM MONOCLE BREAM
Ostraciidae	Boxfish	*Lactoria cornuta*	LONGHORN COWFISH
Ostraciidae	Boxfish	*Ostracion cubicus*	YELLOW BOXFISH
Pomacentridae	Damselfish	*Abudefduf bengalensis*	BENGAL SERGEANT
Pomacentridae	Damselfish	*Abudefduf septemfasciatus*	BANDED SERGEANT
Pomacentridae	Damselfish	*Abudefduf sexfasciatus*	SCISSORTAIL SERGEANT
Pomacentridae	Damselfish	*Abudefduf sordidus*	BLACKSPOT SERGEANT
Pomacentridae	Damselfish	*Abudefduf vaigiensis*	INDO-PACIFIC SERGEANT
Pomacentridae	Damselfish	*Abudefduf whitleyi*	GREEN SERGEANT
Pomacentridae	Damselfish	*Amblyglphidodon ternatensis*	TERNATE DAMSEL
Pomacentridae	Damselfish	*Amblyglyphidodon curacao*	STAGHORN DAMSEL
Pomacentridae	Damselfish	*Amblypomacentrus clarus*	BANGGAI DEMOISELLE
Pomacentridae	Damselfish	*Amphiprion akallopisos*	SKUNK ANEMONEFISH
Pomacentridae	Damselfish	*Amphiprion clarkii*	CLARK'S ANEMONEFISH
Pomacentridae	Damselfish	*Amphiprion frenatus*	TOMATO ANEMONEFISH
Pomacentridae	Damselfish	*Amphiprion perideraion*	PINK ANEMONEFISH
Pomacentridae	Damselfish	*Amphiprion polymnus*	SADDLEBACK ANEMONEFISH
Pomacentridae	Damselfish	*Amphiprion sandaracinos*	ORANGE BUTTERFLYFISH
Pomacentridae	Damselfish	*Chromis cinerascens*	GREEN CHROMIS
Pomacentridae	Damselfish	*Chromis fumea*	SMOKY CHROMIS
Pomacentridae	Damselfish	*Chromis viridis*	BLUE-GREEN CHROMIS

Pomacentridae	Damselfish	*Chrysiptera biocellata*	TWOSPOT DEMOISELLE
Pomacentridae	Damselfish	*Chrysiptera rollandi*	ROLLAND'S DEMOISELLE
Pomacentridae	Damselfish	*Chrysiptera unimaculata*	ONESPOT DEMOISELLE
Pomacentridae	Damselfish	*Dascyllus aruanus*	HUMBUG DASCYLLUS
Pomacentridae	Damselfish	*Dascyllus flavicaudus*	YELLOW-TAILED DASCYLLUS
Pomacentridae	Damselfish	*Dascyllus melanurus*	BLACK-TAILED DASCYLLUS
Pomacentridae	Damselfish	*Dascyllus reticulatus*	RETICULATED DASCYLLUS
Pomacentridae	Damselfish	*Dascyllus trimaculatus*	THREE-SPOT DASCYLLUS
Pomacentridae	Damselfish	*Dischistodus fasciatus*	BANDED DAMSEL
Pomacentridae	Damselfish	*Dischistodus melanotus*	BACKVENT DAMSEL
Pomacentridae	Damselfish	*Dischistodus perspicillatus*	WHITE DAMSEL
Pomacentridae	Damselfish	*Dischistodus prosopotaenia*	HONEYHEAD DAMSEL
Pomacentridae	Damselfish	*Dischistodus pseudochrysopoecilus*	MONARCH DAMSEL
Pomacentridae	Damselfish	*Hemiglyphidodon plagiometopon*	LAGOON DAMSEL
Pomacentridae	Damselfish	*Neoglyphidodon melas*	BLACK DAMSEL
Pomacentridae	Damselfish	*Neopomacentrus filamentosus*	BROWN DEMOISELLE
Pomacentridae	Damselfish	*Pomacentrus alexanderae*	ALEXANDER'S DAMSEL
Pomacentridae	Damselfish	*Pomacentrus coelestis*	NEON DAMSEL
Pomacentridae	Damselfish	*Pomacentrus cuneatus*	WEDGESPOT DAMSEL
Pomacentridae	Damselfish	*Pomacentrus grammorhynchus*	BLUESPOT DAMSEL
Pomacentridae	Damselfish	*Pomacentrus moluccensis*	LEMON DAMSEL
Pomacentridae	Damselfish	*Pomacentrus opisthostigma*	BROWN DAMSEL
Pomacentridae	Damselfish	*Pomacentrus pavo*	BLUE DAMSEL
Pomacentridae	Damselfish	*Pomacentrus proteus*	COLOMBO DAMSEL
Pomacentridae	Damselfish	*Pomacentrus simsiang*	BLUEBACK DAMSEL
Pomacentridae	Damselfish	*Pomacentrus taeniometopon*	BRACKISH DAMSEL
Pomacentridae	Damselfish	*Pomacentrus tripunctatus*	THREESPOT DAMSEL
Pomacentridae	Damselfish	*Stegastes lividus*	BLUNTSNOUT GREGORY
Pomacentridae	Damselfish	*Stegastus altus*	JAPANESE GREGORY
Scaridae	Parrotfish	*Chlorurus bleekeri*	BLEEKER'S PARROTFISH
Scaridae	Parrotfish	*Chlorurus microrhinus*	STEEPHEAD PARROTFISH
Scaridae	Parrotfish	*Chlorurus sordidus*	BULLETHEAD PARROTFISH
Scaridae	Parrotfish	*Hipposcarus longiceps*	PACIFIC LONGNOSE PARROTFISH
Scaridae	Parrotfish	*Scarus dimidiatus*	YELLOW-BARRED PARROTFISH
Scaridae	Parrotfish	*Scarus ghobban*	BLUE-BARRED PARROTFISH IP
Scaridae	Parrotfish	*Scarus rivulatus*	SURF PARROTFISH
Scorpaenidae	Lionfish	*Dendrochirus zebra*	ZEBRA LIONFISH
Scorpaenidae	Lionfish	*Pterois miles*	CLEARTAIL LIONFISH
Serranidae	Grouper	*Cephalopholis boenak*	CHOCOLATE GROUPER
Serranidae	Grouper	*Diploprion bifasciatum*	DOUBLEBANDED SOAPFISH
Serranidae	Grouper	*Epinephelus bontoides*	PALEMARGIN GROUPER
Serranidae	Grouper	*Epinephelus malabaricus*	MALABAR GROUPER
Serranidae	Grouper	*Epinephelus merra*	HONEYCOMB GROUPER
Serranidae	Grouper	*Epinephelus ongus*	WHITE-SPECKLED GROUPER

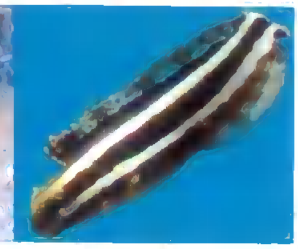
Serranidae	Grouper	*Epinephelus spilotoceps*	FOURSADDLE GROUPER
Siganidae	Rabbitfish	*Siganus canaliculatus*	WHITE-SPOTTED RABBITFISH
Siganidae	Rabbitfish	*Siganus guttatus*	GOLDEN RABBITFISH
Siganidae	Rabbitfish	*Siganus vermiculatus*	VERMICULATE RABBITFISH
Siganidae	Rabbitfish	*Siganus virgatus*	VIRGATE RABBITFISH
Soleidae	Sole	*Pardachirus pavoninus*	PEACOCK SOLE
Sphyraenidae	Barracuda	*Sphyraena barracuda*	GREAT BARRACUDA
Sphyraenidae	Barracuda	*Sphyraena qenie*	BLACKFIN BARRACUDA
Synanceiidae	Stonefish	*Inimicus didactylus*	SPINY DEVILFISH
Syngnathidae	Seahorse	*Hippocampus taeniopterus*	COMMON SEAHORSE
Synodontidae	Lizardfish	*Synodus dermatogenys*	CLEARFIN LIZARDFISH
Tetraodontidae	Puffer	*Arothron hispidus*	WHITE-SPOTTED PUFFER
Tetraodontidae	Puffer	*Arothron immaculatus*	IMMACULATE PUFFER
Tetraodontidae	Puffer	*Arothron nigropunctatus*	BLACKSPOTTED PUFFER
Tetraodontidae	Puffer	*Canthigaster valentini*	BLACK-SADDLED TOBY
Zanclidae	Moorish Idol	*Zanclus comutus*	MOORISH IDOL

Appendix 2. Pictures of some fish species mentioned in this thesis, found around Whale Island (Hon Ong), Vietnam



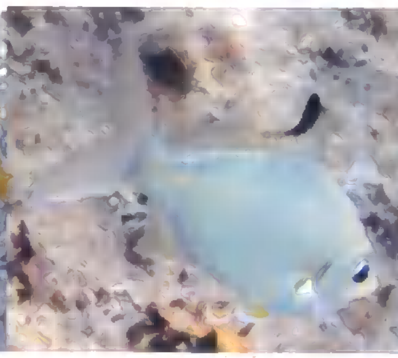
Orbicular Cardinalfish
Sphaeramia orbicularis
Apogonidae

Clearfin Lizardfish
Synodus dermatogeny
Synodontidae

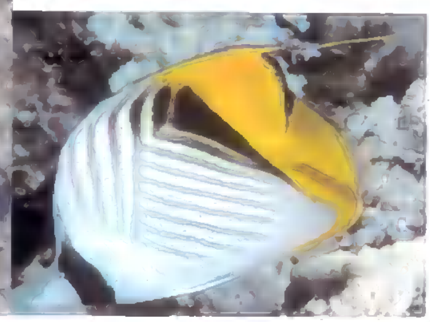


Shorthead Fangblenny
Petroscirtes breviceps
Blenniidae

Banded Shrimpgoby
Cryptocentrus cinctus
Gobbidae

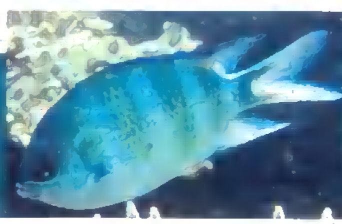


Blacktip Silver Biddy
Gerres oyena
Gerreidae



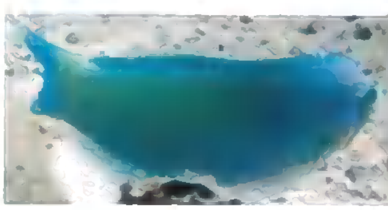
Threadfin Butterflyfish
Chaetodon auriga
Chaetodontidae

Brown Demoiselle
Neopomacentrus filamentosu
Pomacentridae

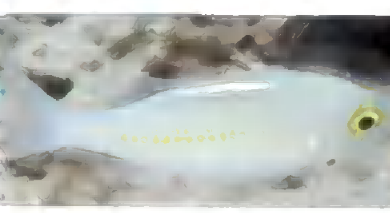


Scissortail Sergeant
Abudefduf sexfasciatus
Pomacentridae

Anchor Tuskfish
Choerodon anchorago
Labridae

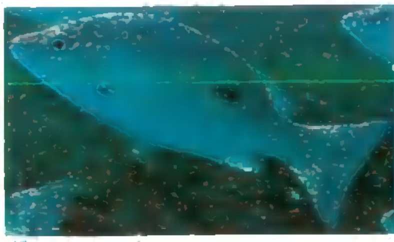


Pastel-green Wrasse
Halichoeres chloropterus
Labridae

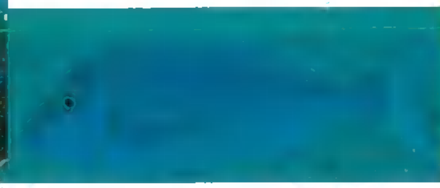


Whitesteak Monocle Bream
Scolopsis ciliatus
Nemipteridae

Chocolate Grouper
Cephalopholis boenak
Serranidae

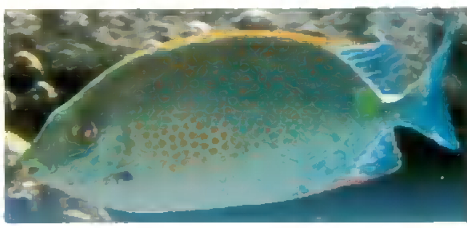


Blackspot Snapper
Lutjanus ehrenbergii
Lutjanidae

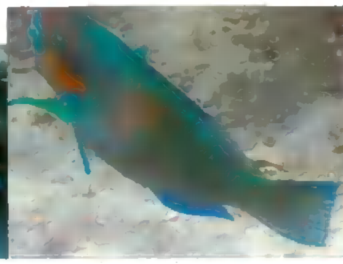


Spangled Emperor
Lethrinus nebulosus
Lethrinidae

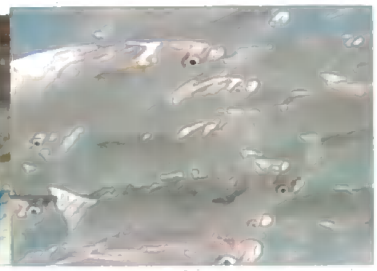
Blue and Yellow Fuslier
Caesio teres
Caesionidae



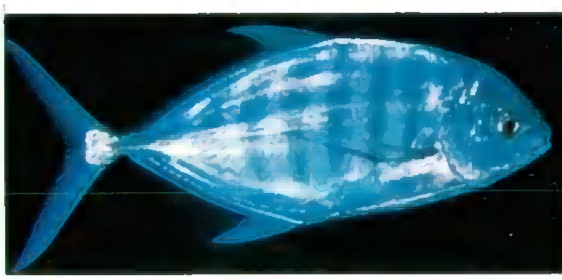
Golden Rabbitfish
Siganus guttatus
Siganidae



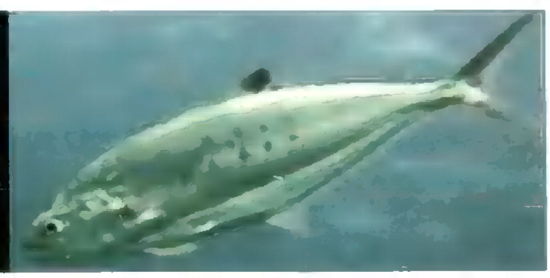
Surf Parrotfish
Scarus rivulatus
Scaridae



Acute-jawed Mullet
Neomyxus leuciscus
Muglidae

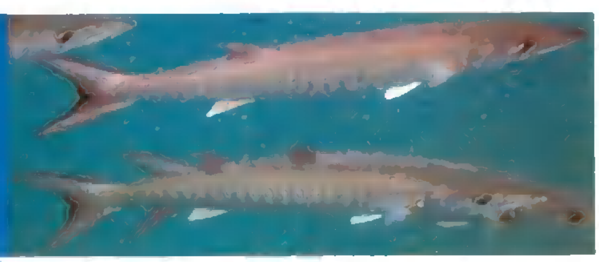


Blue Trevally
Carangoides ferdau
Carangidae



Double-spotted Queenfish
Scomberoides lysan
Carangidae

Milkfish
Chanos chanos
Chanidae



Blackfin Barracuda
Sphyraena qenie
Sphyraenidae

Appendix 3. Fishers questionnaire

1. **Please state your sex and age.** 1[ ]Male 2[ ]Female

1[ ]<18 2[ ]18-25 3[ ]26-35 4[ ]36-45 5[ ]46-55 6[ ]56-65 7[ ]>65

2. **Education attained** 1[ ]Elementary 2[ ]High School 3[ ]College

3. **Please state your household's average monthly income** ______________

4. **Do you think the amount of fish in the ocean has increased or decreased in the last 10 years?** 1[ ]Decreased 2[ ]No change 3[ ]Increased

5. **What do you think are the top 5 reasons why the amount of fish has decreased?**

1[ ]Better fishing techniques 2[ ]Boat anchors damaging corals
3[ ]Blast fishing 4[ ]Sewage outflow
5[ ]Tourists diving, snorkelling 6[ ]Oil pollution from boats
7[ ]Cyanide fishing 8[ ]Using coral for building
9[ ]Fertilizer run-off 10[ ]Over-fishing
11[ ]Rubbish dumping 12[ ]Other________________

6. **Do you think the coral reefs and fish need protection?** 1[ ]Yes 2[ ]No

If **Yes**, please suggest how they should be protected?____________________

____

7. **What fishing technique(s) do you use?**

1[ ]Line fishing 2[ ]Trawling 3[ ]Drag net fishing
4[ ]Cast net fishing 5[ ]Cyanide fishing 6[ ]Trap fishing
7[ ]Blast fishing 8[ ]Spear fishing 9[ ]Hose and hook fishing
10[ ]Electricity 11[ ]Bright light fishing 12[ ]Other______________
13[ ]Other________

8. **What species do you target when fishing?**

____

9. **Please explain why you think Whale Island Resort closed off the bay with buoys?**

____

____

10. Do you think you and your community have benefited from Whale Island Resort and its marine protected area (marine area inside buoys)?
1[ ]Yes 2[ ]No

If **Yes**, please explain ______________________________

____

11. Please specify if you have noticed a change in the number, size and number of different fish within 200m of the buoys enclosing the bay of Whale Island Resort. 99☐ I do not fish within 200m of the marine reserve

1. Number of fish	1[ ]Much Higher	2[ ]Higher	3[ ]No change	4[ ]Lower	5[ ]Much Lower
2. Size of fish	1[ ]Much Bigger	2[ ]Bigger	3[ ]No change	4[ ]Smaller	5[ ]Much smaller
3. Number different fish	1[ ]Much Higher	2[ ]Higher	3[ ]No change	4[ ]Lower	5[ ]Much Lower

12. Please indicate if your monthly income has changed because of Whale Island Resort and its marine protected area.

1[ ]>20% Increase 2[ ]>10% increase 3[ ]No change 4[ ]>10% decrease 5[ ]>20% decrease

If change, please indicate why

____

____

13. Please state if you have found more of any particular species within 200m of the buoys since Whale Island Resort closed the bay from fishing?
1[ ]Yes 2[ ]No
If **Yes**, which? ______________________________

14. Some fishermen sometimes fish inside the buoys. Please suggest what you think the hotel could do so that fishermen agree not to fish inside the bay enclosed by the buoys.

____

____

15. Please explain if you think it would be a good idea if the hotel were to close off more coastal areas with buoys around Whale Island (Hon Ong) from fishing. 1[ ]Good Idea 2[ ]Bad idea

Please explain ______________________________

____

Appendix 4. Tourist questionnaire

Nationality.. **Sex:** 1☐ Female 2☐ Male
Country of Residence.................................

1. **Please state your age.**

1☐ <18 2☐ 18-25 3☐ 26-35 4☐ 36-45 5☐ 46-55 6☐ 56-65 7☐ >65

2. **Please indicate your level of education.**

1☐ Secondary School 2☐ College 3☐ University 4☐ PhD

3. **Please state your yearly gross income in US$.**

1☐ No income 2☐<15000 3☐<30000 4☐<45000
5☐<60000 6☐<75000 7☐<90000 8☐>90000

4. **Please choose the top 3 methods you usually use to locate your hotels**

1☐ Internet hotel search 2☐ Travel Agencies
3☐ Travel Magazines .... 4☐ Word of Mouth
5☐ Environmental hotel awards sites ....
6☐ Travel guides 7☐ Other...................................

5. **Please specify how you found Whale Island Resort?**....................................

6. **Please specify on a scale from 1 – 5 the importance of the following in choosing your hotel. 1 being the most important.**

1☐ Facilities 2☐ Environmental Awards 3☐ Price
4☐ Service 5☐ Location

7. **Please choose the top 3 reasons for choosing Whale Island Resort as your destination?**

1☐ Island Setting 2☐ Service
3☐ Inexpensive 4☐ Eco friendly
5☐ SCUBA Diving/snorkelling 6☐ Away from Mass Tourism
7☐ Safety 8☐ Other...

8. How many different countries have you visited since April 2005 for leisure?

1☐ 1 – 5   2☐ 6 – 10   3☐ 11 – 15   4☐ 16 – 20   5☐ >20

9. Do you know what Marine Protected Areas / Marine Reserves are?

1☐ Yes   2☐ No

10. Do you know how to find environmentally friendly hotels?

1☐ Yes   2☐ No

If **Yes**, please explain how...

11. Would you like to be able to have access to information on the hotel's environmental policies before staying in a hotel? 1☐ Yes   2☐ No

12. Did you know that Whale Island Resort is an environmentally friendly hotel which is protecting an area of coastline from over-use and over-fishing (marine reserve) to help save the ecosystem? 1☐ Yes   2☐ No

13. Have you snorkeled/dived inside the protected area (Area within the buoys surrounding the bay) AND outside?

1☐Yes   2☐No   Please proceed to question number 14

If so, how would you assess the state of the ecosystem within the reserve compared with surrounding areas?

1. General state	1☐ Much Better	2☐ Better	3☐ Same	4☐ Poorer
2. Fish Diversity	1☐ Much Higher	2☐ Higher	3☐ Same	4☐ Lower
3. Number of Fish	1☐ Much Higher	2☐ Higher	3☐ Same	4☐ Lower
4. No. of Invertebrates	1☐ Much Higher	2☐ Higher	3☐ Same	4☐ Lower
5. Size of Fish	1☐ Much Bigger	2☐ Bigger	3☐ Same	4☐ Smaller
6. Coral Cover	1☐ Much Higher	2☐ Higher	3☐ Same	4☐ Lower

14. Please indicate if you have previously stayed at Whale Island Resort.

1☐Yes, once   2☐Yes 2-3 times   3☐Yes 4-5 times   4☐Yes, >5 times   5☐No

If Yes, please specify the importance of the hotel-managed marine reserve for returning to the hotel and state if you think you've seen a change in the number of fish within the reserve.

1☐Extremely important   2☐Very important   3☐Important   4☐Quite important   5☐Not important

Number of Fish: 1☐ Much Higher   2☐ Higher   3☐ Same   4☐ Lower

15. Would you want to return to Whale Island Resort in the future?

1☐ Yes Please explain..

2☐ No Please explain..

16. Please explain if you support the concept of hotels managing marine reserves?

1☐ Yes Why?..

2☐ No Why?...

17. How should information about hotel-managed marine reserves be accessible to you?

....

....

18. Were you to choose between two hotels, both hotels being equal except for one hotel having a hotel-managed marine reserve, would you be willing to pay more to stay there?

1☐ Yes 2☐ No (General question: Whale Island Resort not intended!)

If yes, how much more would you be willing to pay per night in US$ or in % of room rate? ....

Appendix 5. Hotel Managed Marine Reserve questionnaire

Your name:________________________ Position:____________________
Sex: 1[ ]Male 2[ ]Female Date:________ Email____________________
Nationality:________________________ Hotel star rating________________
Hotel name:________________________ Hotel homepage:______________
Rack rate (Db/night – US$)______________ No. rooms____________________
Hotel total capacity:__________(No. guests) No. Staff_____No. local staff_____
Ave. length of stay____________________ Return guests (%)______________
Ave. yearly occupancy (%)______________ HMMR name:__________________
HMMR website?____
Address:____

1. Hotel clientele (%)

1[ ]Tourist 2[ ]Business 3[ ]Other____________________

2. Marine activities available to guests

____

3. Hotel's location and surroundings

1[ ] Mainland 2[ ] Island – Distance to mainland (Km)_____
3.Estimated number of resident fishers w/in 1Km_______
4. No. mariculture within 500m of HMMR__________
5.Nearest city____________ 6.Distance from hotel (Km)_______
7.Est. Population size (thousands)__________
8.Estimated coast built up with structures (%)_________
9.Number of ports/factories/industries within 1Km________
10.Distance to next MPA (Km)__________
11.Owned by or name____________

4. Habitat/ecosystem(s) within marine reserve

1[ ] Coral Reef 2[ ] Seagrass bed 3[ ] Sandy bottom 4[ ] Rocky intertidal
5[ ] Mangrove 6[ ] Macro-algal bed 7[ ] Soft bottom 8[ ] Open water

5. Type of coral reef

1[ ] Fringing 2[ ] Barrier 3[ ] Pinnacle rock
4[ ] Patch 5[ ] Atoll 6[ ] Offshore reef / Shoal

6. Boundary coordinates if known (Latitude e.g. N 12° 39'20.3" Longitude e.g. E 109° 23'69.3")

Point 1 ________________ ________________
Point 2 ________________ ________________
Point 3 ________________ ________________
Point 4 ________________ ________________

7. Management zones and size (if unknown - 1ha is approx. the size of a soccer field)

1.Core Zone Size (ha)______
Regulations____

2.Buffer Zone Size (ha)______
Regulations____

3.Other Zone Size (ha)______
Regulations____

8. Year legally established _________

9. Basis for legal establishment (laws permitting establishment)

____

10. HMMR establishment history (brief chronological order of events)

____

11. HMMR objectives (initiator and reason for establishment)

____

12. Main managing group of HMMR and responsibilities:

____

13. Assisting managing group of HMMR and their responsibilities

1.____
2.____
3.____

14. Financial mechanisms/income in place?

	Amount ($US)	Specifics/Guidelines/Policy
1[ ] User/entry fee	________	______________________________
2[ ] Trust Fund	________	______________________________
3[ ] Gov't Budget allocation	________	______________________________
4[ ] Grants	________	______________________________
5[ ] Other	________	______________________________
6[ ] Other	________	______________________________

15. Who manages the funds ______________________________

16. How much is the estimated annual gross income of the HMMR ($US)?

____

17. How much was spent on annual HMMR management/operations ($US)?

____

18. Expenditures cover what items?	**Amount per annum ($US)**
1[ ] Enforcement support	
(e.g. marker buoys/billboards/leaflets/guardhouse/boat)	________
2[ ] HMMR ranger salary - Number of rangers?________	________
3[ ] Other salaries - pls specify ________________	________
4[ ] Materials and supplies (e.g. office supplies/gasoline)	________
5[ ] Moorings/anchor buoys - Number in possession?_____	________
6[ ] Repairs and maintenance	________
7[ ] Education programs - pls specify________________	________
8[ ] Artificial reef/FAD etc. pls specify________________	________
9[ ] Advertising	________
10[ ] Other - pls specify________________	________
11[ ] Other - pls specify________________	________

19. Supplemental or alternative livelihoods created as a result of establishing the HMMR?

____

20. Has advertising that you have established an HMMR increased the number of guests to your hotel over the last year?

1[ ]Yes 2[ ]No, we do not advertise the MPA – proceed to Q22.

1.Occupancy	1[ ]< 5%	2[ ]5-10%	3[ ]10-20%	4[ ]>20%	5[ ]Don't know
1.Ave. length of stay	1[ ]< 5%	2[ ]5-10%	3[ ]10-20%	4[ ]>20%	5[ ]Don't know
1.No. return guests	1[ ]< 5%	2[ ]5-10%	3[ ]10-20%	4[ ]>20%	5[ ]Don't know

21. Please state how you advertise the HMMR and which method you believe is most effective

____

22. How would you assess the state of your HMMR?

1.Fish Diversity	1[ ]High	2[ ]Fairly High	3[ ]Average	4[ ]Fairly Low	5[ ]Low
2.Number of fish	1[ ]High	2[ ]Fairly High	3[ ]Average	4[ ]Fairly Low	5[ ]Low
3.Coral Diversity	1[ ]High	2[ ]Fairly High	3[ ]Average	4[ ]Fairly Low	5[ ]Low
4.Coral cover	1[ ]>75%	2[ ]50-75%	3[ ]25-50%	4[ ]10-25%	5[ ]<10%
5.Algae cover	1[ ]>75%	2[ ]50-75%	3[ ]25-50%	4[ ]10-25%	5[ ]<10%
6.No. invertebrates	1[ ]High	2[ ]Fairly High	3[ ]Average	4[ ]Fairly Low	5[ ]Low

23. How would you assess the changes to the HMMR since legal establishment?

	% Increase	% Decrease		% Increase	% Decrease
1.Fish Diversity	1[ ]	2[ ]	2.Number of Fish	1[ ]	2[ ]
3.Coral Diversity	1[ ]	2[ ]	4.Coral Cover	1[ ]	2[ ]
5.Algae Cover	1[ ]	2[ ]	6.No. Invertebrates	1[ ]	2[ ]

24. How would you assess the state of the HMMR compared with adjacent similar unprotected areas?

	Much Higher	Higher	No Change	Lower	Much Lower
1.Fish Diversity	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
2.Number of Fish	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
3.Coral Diversity	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
4.Coral Cover	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
5.Algae Cover	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]
6.No. Invertebrates	1[ ]	2[ ]	3[ ]	4[ ]	5[ ]

25. What are the man-induced damaging factors to the marine ecosystem in your area?

1[ ]Coastal Development 2[ ]Fertilizer Runoff 3[ ]Destructive Fishing
4[ ]Coral Mining 5[ ]Deforestation-Sedimentation
6[ ]Sewage Discharge 7[ ]Mangrove Harvesting 8[ ]Anchor Damage
9[ ]Damage from Tourists 10[ ]Mariculture
11[ ]Other____________________
12[ ]Other____________________

26. Please state if you think your HMMR is effectively protected

1[ ]Yes 2[ ]No

If '**No**' please state what the major problems are and how you think they can be rectified

____

27. Please specify other hotels (& manager contact emails if known), which have established an HMMR

____

Appendix 6. Hotel Managed Marine Reserve rating

This questionnaire is modified from a survey created by the Coastal Conservation and Education Foundation Inc. (CCEF) (www.coast.ph). Their survey is a Marine Protected Area (MPA) management rating system intended to assist local governments and communities to improve the management of their MPA. This survey is not an officially recognised legal document but it can give you an indication of how the management of your Hotel Managed Marine Reserve (HMMR) rates compared with officially established MPAs. The simple rating system is dynamic and does not give a definite statement on the status of your marine reserve.

Please put a cross (X) in the space provided to the right if the criterion is fully satisfied or accomplished. At the end of each level there is a space where you can add additional comments. Simply add up the number of crosses you have and check your rating at the bottom of the survey. Carefully consider the age of the marine reserve when completing this assessment.

Level 1: Marine reserve is initiated - **within 1 year of legal establishment**

1a	Adjacent local community, fishermen, resource user acceptance established prior to marine reserve initiation.	
1b	Biophysical baseline assessment survey of the site using standard accepted methods complete *(Surveys on fish abundance, density, coral cover, invertebrates, diversity)*	
1c	Management body of marine reserve tentatively determined (*Main management group starting to conduct regular meetings*)	
1d	Management plan and objectives drafted (*Marine reserve rules, regulations and objectives drafted*)	

1e	Marine reserve legally established (*Accepted within the local laws*)	
1f	Leaflets/signs at the hotel informing guests of marine reserve (*Information and warning not to damage corals etc.*)	
1g	Marker buoys and/or boundary markers/signs installed	
1h	Hotel staff awareness program initiated to help raise understanding and support for the marine reserve (*Management plan and objectives conveyed and the benefits of marine reserves communicated*)	

Comment: ____

Level 2: Marine reserve is established - **within 1 or 2 years of legal establishment**

2a	Local community education programs started to help raise awareness/understanding and support for marine reserve (*Conducted a series of public education activities*)	
2b	Management body formally organised and recognised (*Main and potential assisting managing group conducting regular documented meetings*)	
2c	Management plan and objectives successfully adopted (*Marine reserve rules and regulations disseminated using appropriate and practical means to target all direct users and other stakeholders*)	
2d	Management activities started (*Conducted at least 2 marine reserve activities such as: installation of enforcement support structures, patrolling and surveillance, maintenance of buoys, managing violators, user fees implemented etc.*)	
2e	Biophysical monitoring includes local participation (*Locals were trained to do biophysical surveys using standard/accepted methods*)	
2f	Marine reserve rules and guidelines posted at strategic locations	
2g	Staff education/training programs in place (*Marine reserve management plan, objectives and progress of MPA disseminated to staff. Further training given, if applicable to support management plan and objectives*)	
2h	Education programs set up for visiting tourists (*Presentations and/or snorkelling/diving tours given addressing the importance and progress of the marine reserve*)	
2i	Anchor buoys placed	

Comment: ____

Level 3: Marine reserve is enforced - **only applies for 2 years or older since legal establishment**

3a	Local community and staff education programs are now conducted regularly	
3b	Management body active (*Implements the management plan; coordinates enforcement activities; members attend meetings regularly*)	
3c	Funds allocated to maintain enforcement support structures (*e.g. boundary markers, buoys, signs etc.*)	
3d	Regular biophysical monitoring measuring habitat condition and changes conducted (*at least annual monitoring with local participation*)	
3e	Fishing effectively stopped inside the marine reserve (*no violations reported in the last year*)	
3f	Illegal and destructive fishing reduced outside of the marine reserve (*Violations/apprehensions reported within 500 m from the marine reserve boundary was reduced by 50% for the past year*)	
3g	Tourist education and awareness program active (*tourists are actively educated in the importance of marine conservation and encouraged to participate in your conservation activities*)	

Comment: ____

Level 4: Marine reserve is sustained - **only applies for 3 years or older since legal establishment**

4a	Local community, staff and tourist education programs maintained over the years	
4b	Management body runs the marine reserve successfully (*Management body supervises management activities i.e. implementation of plans, enforcement, budgeting, monitoring, evaluation, and coordinates activities with eventual partners*)	
4c	Management plan updated in a participatory process (*Management plan amended with the participation of various stakeholders: fishermen, local community, local government units, other private enterprises etc.*)	
4d	Annual biophysical monitoring and feedback of results supervised by the managing body (*Document is surveyed using standard/accepted methods. Reports are available*)	
4e	Enforcement system fully operational (E*nforcement support structure such as guardhouse, buoys and signs maintained and patrolling activities sustained over the years*)	
4f	Illegal and destructive activities stopped inside and within the vicinity of the marine reserve (*No violations reported inside and within 500m from the marine reserve boundary in the past year*)	
4g	Environment friendly enterprise and/or user fees collected as a sustainable financing strategy (*Sells environmentally friendly products/goods to tourists; imposes collection of user-fees etc.*)	

Comment: ____

Level 5: Marine reserve is institutionalized - **only applies for 4 years or older since legal establishment**

5a	Information and education programs on marine reserve for local community, staff and tourists are maintained over the years	
5b	Management plan refined for adaptive management (*Incorporates further refinements after gaining much experience to improve management strategies*)	
5c	Management body capacitated for financial management and fund sourcing (*Revenues from enterprise and/or fees are well-managed, well-documented and sustained; management body is also trained to seek financial assistance: financial reports easily accessible*)	
5d	Budget from government or other sources allocated (*There is a legal document made by the local government or an agreement with a funding group allocating budget for marine reserve operations*)	
5e	Evaluation of impacts on ecology, and socio-economy conducted and feedback of results completed (*Assessment of resource status and long-term trends conducted. Analysis of change in local economy and long-term trends of user groups conducted. Reports of these studies have been completed and reported back to stakeholders. Reports are available*)	
5f	Expansion of marine reserve since it was legally established	
5g	Enhancement programs initiated (*Scope of conservation activities heightened e.g. clam re-seeding, turtle conservation, artificial reefs, Fish Aggregating Devices (FAD), reef ball program etc.*)	
5h	Marine reserve used as a study site for either public education or scientific research (*After much knowledge has been gained, members are ready to share lessons and impart knowledge. Scientists are invited to conduct their research at your marine reserve publishing your success stories*)	
5i	Community support (*Financially or through building of schools, churches, other support etc.*)	
5j	Environmental award(s) attained	
5k	Marine reserve officially and legally recognised as a Marine Protected Area	

Comment: ____

Total points accumulated__________

- Total possible points: 42
- All points are cumulative
- Points from higher levels can be used to satisfy lower rating levels

Passing	(Marine Reserve is initiated)	7 points
Fair	(Marine Reserve is established)	14 points
Good	(Marine Reserve is enforced)	22 points
Very Good	(Marine Reserve is sustained)	29 points
Excellent	(HMMR is institutionalized)	38 points

Appendix 7. Eco-friendliness rating

This questionnaire is modified from Australia's EcoCertification program, which was established to help identify genuine nature eco-tourism products (www.ecotourism.org.au/neap.asp). This survey is not an officially recognised legal document so it does not equal eco-certification but it will give you an indication of how eco-friendly your hotel is and possibly give you an idea of how to improve your sustainable activities.

Please put a cross (X) in the space provided to the right if the criterion is fully satisfied or accomplished. At the bottom of the each section there is space where you can add comments pertaining to the criteria or comment on other practices maintained at your hotel.

	Wastewater management	
1a	Wastewater receives at least secondary treatment or is composted. Where this is not practical, the method of wastewater treatment (direct disposal of sewage or septic system) is justifiable and the ongoing impacts on ground and surface waters have been assessed and judged sustainable	
1b	All on-site wastewater treatment has breakdown alarms, approved emergency bypass facilities and an ongoing water operations manual that is administered by a trained operator	
1c	Treated effluent discharged to land or water meets or exceeds statutory requirements	
1d	Biodegradable cleaning chemicals used	

Comments:____

	Waste minimization and management	
1a	Glass recycling	
1b	Plastic recycling	
1c	Paper recycling	
1d	Rubbish bins strategically located throughout premises	
1e	Food and materials purchased in bulk	
1f	Majority of food/drinks purchased from local vendors/communities	
1g	Organic waste composting	
1h	Organic kitchen waste given away to be used, e.g. pig farms	
1i	Cleanup days are organized and tourist participation is encouraged	
1j	All encountered litter is picked up and removed e.g. daily beach cleanups	

Comments:______________________________________

	Energy consumption management	
1a	Timers/movement detectors used to controlling lights and/or air-conditioner	
1b	Compact fluorescent bulbs used wherever possible	
1c	Key-tag used as power switch in rooms	
1d	Staff trained in energy preservation	
1e	Alternative energy source available e.g. solar	
1f	Only natural light used during the day	
1g	Heat recovered from equipment, e.g. waste heat from diesel generators	

Comments:______________________________________

	Water conservation management	
1a	Aerated taps	
1b	Low pressure shower heads	
1c	Low flush toilets	
1d	Guests participating in a towel and linen reuse program	
1e	Staff trained in water preservation	
1f	Irrigation water used from treated wastewater	
1g	Rainwater/stormwater collection	
1h	Low water-volume gardens e.g. native plants	
1i	Guests advised to use minimal water	

Comment: ______________________________________

	Noise/Air quality management	
1a	Chlorofluorocarbons (CFC) emissions avoided from refrigerators, air conditioners etc.	
1b	No offensive odours	
1c	Smoking discouraged in public enclosed areas	
1d	Minimal heat and/or steam emissions	
1e	Adequate insulation around noisy machinery e.g. generators	
1f	Noise pollution kept minimal	

Comment: ______________________________

	Low environmental impact for construction and maintenance of ecotourism infrastructure	
1a	Building material sourced from local renewable products where possible	
1b	Recycled building material has been used wherever possible	
1c	Water runoff causing siltation is kept to a minimum	
1d	Minimal excavation and dredging	
1e	No toxic material on structures e.g. copper/arsenic on timber, copper/zinc antifouling paint on boats	

Comment: ______________________________

	Minimal nature disturbance management	
1a	Minimal clearing of natural area	
1b	Erosion not evident or actions taken to avoid erosion	
1c	Herbicides or pesticides leaving residual pollution are avoided	
1d	Drains/sediment traps/wetlands constructed to impede sediment/nutrient runoff from rainwater/stormwater	
1e	Low disturbance to local wildlife enforced	
1f	The hotel reflects the character of the surrounding natural environment	
1g	Defined nature trails if available	
1h	Avoiding disruption of wildlife movement/breeding sites	
1i	Divers and snorkelers when on diving trips are lectured to be mindful of the environment and told not to damage the coral or to collect corals or shells etc.	
1j	Sale of items extracted from the ocean i.e. coral fragments, shells etc. not permitted on the property	

Comment: ______________________________

- Total number of points: **Total points accumulated** __________

Passing 25 points
Fair 30 points
Good 35 points
Very Good 40 points
Excellent 46 points

Appendix 8. Accepted articles

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Hotel managed marine reserves: A willingness to pay survey

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ABSTRACT

The 2003 Marine Parks Congress recommended networks of marine reserves to be established covering 20–30% of habitats by 2012. Most marine reserves are, however, failing to meet their objectives, the main reason being attributed to lack of funding. In light of the growing need for effectively managed marine reserves, a survey ascertaining tourists' support and willingness to pay extra to stay at reserves managed by the private sector – Hotel Managed Marine Reserves (HMMRs) was conducted at Whale Island Resort, Vietnam. A total of 97.5% support HMMR, 86.3% were willing to pay, the median amounting to US$9.6/room/night, or 10% of the average room rate, equaling US$67,277 at 60% occupancy.

1. Introduction

Marine Protected Areas (MPAs), independent of their size [1], have been recognized as an effective method to sustain or increase species diversity, fish size, density and biomass from an otherwise over-fished coastline and to enhance fishing yields in the surrounding fished area through the process of 'spillover' of fish from the MPA [2–4]. A number of different types of MPAs with a variety of managing bodies have been adopted, including: government, Non-Government Organisations (NGOs), community and private management, plus various combinations thereof.

The bottom-up approach of community-managed marine reserves is widely considered key to effective reef management in the tropics [5]. Local fishermen's knowledge of the surrounding seas can help provide information of possible locations for the marine reserve and without local community cooperation and participation, reserves may quickly be confronted with protest and rejection, resulting in poaching. Community-managed marine reserves are, however, not generally managed by local communities alone but rather as a joint venture with other stakeholders – the local government, an NGO or the private sector in the form of a joint venture. In such situations, the private sector is meant to bring capital, business and marketing know-how and a client base; the community partner usually brings the location, labour and local knowledge, while an NGO or local government may mediate negotiations between the private and community partners, strengthen community capacity, provide basic infrastructure and other necessities [6].

In several circumstances, private enterprises such as hotels and resorts have taken over the day-to-day management of a protected area and, in some cases, full responsibility for the reserve [7]. In other instances, hotels have been the initiator and subsequent manager of the reserve, termed Hotel Managed Marine Reserve (HMMR), with varying degrees of participation from the local governments and/or communities. While private parks may be covering a substantial area on land and growing rapidly, they are only recently becoming more popular at sea. Private parks on land, like those at sea, are still widely undocumented and insufficiently researched, but both are believed to have been initiated because of the same reasons. Firstly, the government's inability to satisfy public demand for nature conservation, in quality and quantity alike [8,9], which has led to inefficiently managed parks "paper parks" and damaged ecosystems. In the Caribbean and Southeast Asia it was found that only 6 and 14%, respectively, of 285 MPAs reviewed were effectively managed [10,11]. Some countries have even become indebted, having to rely on international support [12]. In a report on a change in governance of protected area systems between 1992 and 2002 in 41 countries, Dearden et al. [12] found increasingly more countries, therefore, relying on a broader range of funding sources; the medium and less developed countries relying significantly more on funds from foreign governments, donations and concessions paid by the private sector (25% compared with 14% of total funding). There is seemingly a trend leading away from solely government-managed protected areas, towards increased participation of stakeholders, with the private sector, local communities and NGOs having a larger influence on protected area decision-making [12].

A second reason for the increasing number of private reserves is a growing societal interest in biodiversity conservation [8], peaking

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with the World Summit on Sustainable Development (Johannesburg 2002) and, later, the World Parks Congress (Durban, September 2003), where representatives of protected areas recommended networks of marine reserves covering 20–30% of habitats by 2012.

The rapidly growing ecotourism industry is another reason why the private sector is pushing for HMMRs, where they can establish a market niche. Ecotourism has been praised as one of the most promising approaches to sustainable development and protection of important environmental resources in lesser developed nations [13]. With ecotourism, it is expected that the impact from tourism on the environment is kept to a bare minimum and that tourism benefits also profit local communities, either by employment or by contributing to community projects [6].

Today, the vast majority of HMMRs are not recognized as MPAs by The World Conservation Union (IUCN). Chumbe Island Coral Park (CHICOP) is one exception, possibly also representing the first fully functioning MPA in Tanzania [9]. Several others have, however, been initiated privately, before public protection was established [8], such as: Sugud Islands Marine Conservation Area (SIMCA), which was established as a Category II conservation area under the IUCN Protected Area Management Category in 2001, after initially being protected by Lankayan Island Dive Resort [14]; the protected zone outside Anse Chastanet Resort, St. Lucia, which was later incorporated into the Soufriere Marine Management Area (SMMA) [15]. It was the resort managers' sense of responsibility to their surroundings which was the initial driving force for the effective protection programs. This was compounded by environmental agency and community collaborations to ensure stakeholders' needs were represented.

Several other HMMRs are not officially recognized as MPAs by the IUCN, but nevertheless engage in numerous conservation and education projects. The Alegre Beach Resort, Cebu, Philippines protects a 16 ha marine sanctuary, where they have established a coral reef recovery and distillation program aimed at preserving and protecting the reef ecosystem. The program involves regular collection of the coral tissue-feeding *Drupella* snails and crown-of-thorns starfish (*Acanthaster planci*), deployment of artificial reefs, reseeding giant clams (*Tridacna* spp.) and developing mussel farms intended as a source of alternative livelihood for surrounding communities. They also dredge silt from the reef flat to increase coral recruitment and settlement potential, and stabilize the benthos by planting seagrass beds. The projects are overseen and monitored by a marine biologist (Mar Cruz, Alegre aqua sports manager, pers. comm.). The owners of Wakatobi Dive Resort in south-eastern Sulawesi, Indonesia, pay a leasing fee to the affected communities of their 200 ha no-take sanctuary and 500 ha buffer zone, where fishing with traditional fishing gear is permitted. Representatives of the communities patrol the area and enforce compliance with agreed extractive bans. Amongst others, the resort owners sponsor school material, give lectures on conservation issues, provide funding for wastewater management and public projects to 17 affected communities, and employ 135 people locally (Lorenz Maeder, resort owner, pers. comm.).

These hotels have succeeded in establishing effectively protected marine reserves since they have successfully incorporated the local communities into their hotel and conservation projects. Like many dive resorts they also have boats, personnel and other equipment needed to manage local protected areas and the financial backing and incentive to protect their assets [7], but depending on the extent of their conservation projects, a little financial backing from guests in the form of HMMR user fees can go a long way. Tongson and Dygico [16] found that tourists can appreciate user fees as they are a direct means to contribute to conserving the natural resources they will enjoy. Several studies actually suggest that tourists and divers are willing to pay substantial user fees to enter MPAs, which can financially supplement or even completely cover conservation costs [16–18]. It is suggested that MPAs only start to become successfully managed when funding is secured through self-financing [19]. The constant supply of funding from user fees could, therefore, be a solution to financing and thereby effectively managing protected areas [20].

Projects, which may require financial assistance, include monitoring coral reefs, mangroves or other marine life, including sharks, dolphins or turtles, and maintaining turtle hatcheries. Projects may also involve creating artificial reefs out of concrete domes or using mineral accreting technology owned by Biorock™ to transplant coral. Other HMMRs have developed education or awareness programs for tourists, staff and local communities.

In addition to project costs, associated resources and salary costs, HMMRs generally also need to pay for the area covered by the marine reserve. This can take the form of a lease or tax to be paid to the local government [7]. In some instances a portion of user fees are delivered to local communities to build schools, hospitals or to improve infrastructure, or given to fishermen to compensate for any fishing grounds lost [8]. The costs accrued to manage HMMRs will ultimately dependent on the conservation projects they are involved in, their management set-up, location and size.

A willingness to pay (WTP) survey was conducted at an HMMR in Vietnam in order to gauge tourists' knowledge and interest in marine conservation, the importance of various factors in choosing and locating hotels, their opinion of HMMRs, and whether tourists would be willing to pay a user fee to support HMMRs. The consumer surplus was also calculated with the intent of establishing the elasticity of demand for HMMRs, resulting in the optimal user fee.

2. Study area

The tourist surveys were conducted with the hotel guests of an HMMR bi-annually over a six-week period in March/April and September/October, starting Autumn 2005, ending Spring 2007. The HMMR, Whale Island Resort (WIR), is situated on Hon Ong, a small island (approx. 100 ha), located on the south-central coast of Vietnam, 80 km north of Nha Trang, in Van Phong Bay (Fig. 1). The resort was established in 1997 with only a few bungalows. Today, WIR owns 32 bungalows accommodating maximum 70 guests. The average length of stay is three nights and average yearly occupancy is approximately 60%.

The hotel owners became concerned when they noticed the continued decline in fish and coral populations believed to be caused by over-fishing and destructive fishing techniques, such as hose and hook fishing, blast fishing and cyanide fishing. This was compounded by pollution and rubbish dumping from the nearby village of Dam Mon and other smaller villages within the bay. They, therefore, decided to enclose the bay around the resort with buoys in 2001 (Whale Island Bay, WIB), establishing a no-fishing zone and a *de facto* 11 ha marine reserve. In August 2005, a second bay was enclosed on the other side of the peninsula (Whale Island Bay Peninsula, WIBP), creating a 5 ha marine reserve (Fig. 1). Local communities were actively consulted before the areas were enclosed. Legal permission to close off these areas was attained from the local authorities of Khanh Hoa Province in the form of a 10-year lease, and initialization was supervised by the local coastguard.

The resort is eco-friendly albeit not certified; it generates low amounts of pollution from the ferry shuttling guests and supplies to the mainland, plus the activities of the daily dive boat. The effluent is collected in a septic tank, filtered, and later used as irrigation water; pamphlets are provided in the bungalows urging guests to be mindful of the environment and to avoid any trampling or damaging of the corals; inorganic wastes are collected from the beach and burned in a specially constructed high-heat furnace. The

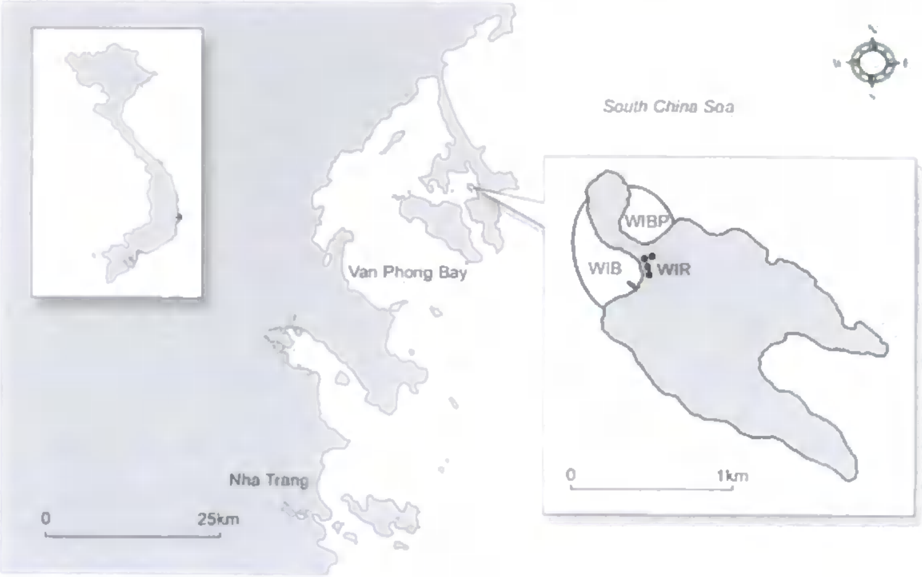


Fig. 1. Illustration of Whale Island (Hon Ong) showing the Resort, the 11 ha Whale Island Bay (WIB) and the 5 ha Whale Island Bay Peninsula (WIBP) reserves in Van Phong Bay, Khanh Hoa Province, Vietnam.

hotel has hired security officers who also acts as a reserve wardens, ensuring that no fishing is conducted within the reserves. Furthermore, specific hiking trails have been hewn into the landscape to restrict damage; several clusters of artificial reefs have been constructed out of ceramic pots and concrete domes to serve as substrate for their coral transplantation project, while creating habitat complexity for fish, increasing fish assemblages. Fish Aggregating Devices (FADs) have also been constructed, made from cut-up strips of netting, bound together, fastened to buoys and anchored to the sea floor at 9 m depth, attracting schools of fish, including large schools of Snapper (Lutjanidae), Jacks (Carangidae) and Barracuda (Sphyraenidae). It is unclear whether the marine reserve produces spillover of fish to help replenish adjacent fished areas, but the density, size and diversity of fish are significant compared with unprotected areas [21].

Apart from the managers and owner, the 40–50 staff are all from local villages and are paid above average salaries. The hotel purchases the majority of their food and beverages from local fishermen and other local vendors and the resort owner has built a school and temple. The lease paid to the local government is supposed to help provide for community needs but to what extent it helps individual fishermen more affected by the loss of a part of their fishing ground is unclear. Several fishermen do not have enough money to purchase larger boats to fish outside Van Phong Bay and must, therefore, rely on fishing in smaller bays closer at hand. Some of these families have expressed some displeasure with the reserve, while other fishermen, family members of staff, and vendors, benefit from the reserve and approve of their conservation efforts (unpublished survey data collected by PS). While the reserves are protected by a contract between WIR and the local government ensuring wider compliance to the no-fishing ban, a method for compensation or integration of affected families should perhaps be considered. An amicable relationship with local community members with agreed goals is important to effectively manage a marine reserve, especially if the HMMRs are owned by foreign investors.

3. Tourists' willingness to pay

A total of 211 questionnaires were completed by tourists during the four, six-week research visits between Autumn 2005 and Spring 2007. These qualitative and quantitative, open and close-ended questionnaires were placed on the reception desk, so the hotel guests could complete them at will, but usually they were completed during check-out. Although these questionnaires draw on a convenience sample restricted to the sample group of the hotel guests, we feel that while a survey conducted with random tourists at several locations would ultimately increase population representation, the great range in age, income, environmental knowledge and level of education at the hotel, nevertheless makes this survey representative for travelling tourists.

In this anonymous questionnaire, guests were asked to complete a demographic and personal questions section; a set of behavioural choice questions relating to the methods and reasons for choosing hotels; questions related to their environmental awareness and interests; their opinion of the biophysical state of the HMMR compared to unprotected areas; their thoughts on hotels or resorts acting as caretakers and mangers of marine reserves and how this should be advertised; and lastly, if they would be willing to pay extra for HMMRs, and if so, how much.

For the final WTP questions, a hypothetical scenario was laid out. The respondents were requested to decide if they would be willing to pay more to stay at a hotel which is managing a marine reserve, compared to an adjacent hotel, which is not, all else being equal. The follow-up question asked them to specify how much more they would be willing to pay per night in either US$ or as percent of the room rate. The additional choice to provide a WTP amount as percent of the room rate was added to the fixed US$ option because during the initial interview-based pilot surveys, the majority of tourists requested this possibility on their own accord. To convert the percentage value into monetary terms, the room rate of WIR was used as a model. The average length of stay of three nights was determined as the actual room rate (US$96) since the room rate decreases with the number of nights stayed. All percentage responses could thereby be converted to US$ and the median and average WTP calculated for the sample population. An open-ended WTP contingent valuation question, where respondents specify the amount themselves, was chosen over a dichotomous choice question because this is the first survey of its kind and we did not wish to assume on the distribution of WTP and encourage biased responses by providing pre-defined ranges [22]. Open-ended questionnaires are also understood to give a lower

WTP [23]. This was preferred, since it is suggested that when people are faced with hypothetical scenarios involving payment, they are often over-generous [24]. While they may hypothetically agree to pay a certain amount, they would commonly only agree to half in reality [25].

In order to determine statistical significance between variables and WTP amounts, we employed the non-parametric tests, Mann–Whitney *U* and Kruskal–Wallis *H*, to test the null-hypothesis that the two or more samples were drawn from a single population. We used the Chi-square cross-tabulations test to reveal significance between reasons provided for WTP. Tests excluded tourists who did not wish to comment on their WTP and ignored the final question. One additional sample was removed from the populations because the WTP was deemed far too high to be considered serious (200% of room rate per night).

We calculated the consumer surplus based on the amount guests were willing to pay and calculated the total revenue the resort could make, depending on various user fees the resort could implement per room for nights stayed.

4. Results

The European community prevailed in this study, the more numerous being the British, Dutch and then French. While the majority of the visitors resided in their home countries, one-tenth of the visitors had taken up Vietnamese residency (included in 'Other', which also includes the rest of Asia, South and Central America – Table 1). University educated visitors dominated and 69% of the population were between 26–45 years old. A larger percentage of the sample comprised women and the income level was split throughout the spectrum.

There were no significant relationships between these variables and WTP. Although there was a trend in certain categories for higher WTP, such as visitors aged 36–45 and those with PhD level education (Kruskal–Wallis $p = 0.273$, df = 4; $p = 0.168$, df = 3), the amount visitors were willing to pay varied widely, resulting in high variance (Table 1).

In the next section, tourists were confronted with behavioural choice questions: top three methods they use to locate hotels; how they located WIR; the importance of various factors for choosing hotels and the top three reasons for choosing WIR.

The method most commonly used to find tourist's choice of hotel was the internet (31.76%), followed by word of mouth (23.05%) and travel guides (22.87%). This was also the order demonstrated by guests choosing WIR (29.33%, 28.37%, and 20.67%). The method least chosen for locating hotels was 'environmental hotel award sites (0.73%), which is not so surprising since only 10.9% of the population said they knew where to look for environmentally friendly hotels (Table 2) and of these, approximately half the tourists' responses were vague, writing only 'internet'.

On a Likert scale from one to five, tourists were asked to rate certain hotel attributes in order of importance. Location was the most important attribute when choosing a hotel, followed by price, facilities, service and lastly, environmental awards (Fig. 2). The importance of 'location' also became apparent when asked why they chose WIR, the top two reasons being, 'away from mass tourism' and 'island setting' followed by facilities: SCUBA diving and snorkeling. Eco-friendliness came in forth place ahead of service and safety (Fig. 2).

In the following section dedicated to tourists' environmental awareness, interests and knowledge, a larger percentage already knew that WIR was an eco-friendly resort before arriving on the island, while the majority of visitors also knew what MPAs are and would like to have access to hotels' environmental policies before staying at a hotel (Table 2). The latter two were the only significant indicators of WTP found from this survey. While having access to hotels'

Table 1
Breakdown of tourists' demographic and personal data and their WTP (US$) extra to stay at an HMMR with Standard Errors (SE)

	Visitors (%)	WTP ($)	SE
Nationality			
European	69.46	12.55	1.01
Oceanian	16.75	14.88	3.97
North American	8.87	11.37	2.43
Other	4.93	15.49	2.63
Country of residence			
Europe	62.07	12.58	1.11
Oceania	15.27	15.66	4.23
North America	6.40	11.60	3.36
Other	16.26	12.53	1.26
Gender			
Female	56.31	12.46	1.08
Male	43.69	13.44	1.68
Age			
<26	10.10	9.30	1.74
26–35	44.23	11.73	1.22
36–45	25.00	16.63	2.73
46–55	10.10	12.40	2.44
>55	10.58	12.14	1.51
Education			
Secondary school	9.52	13.47	2.63
College	21.43	14.76	3.32
University	62.38	11.63	0.89
PhD	6.67	17.80	2.92
Gross income/year ($)			
No income	5.05	11.33	2.77
<15,000	4.04	10.71	1.95
15,000–30,000	15.66	14.01	3.33
30,000–45,000	18.18	15.31	2.54
45,000–60,000	20.71	13.78	2.68
60,000–75,000	14.65	11.84	1.71
75,000–90,000	9.60	9.76	1.47
>90,000	12.12	12.42	1.80

The sample comprises the available data from 211 surveyed guests minus 24 unusable samples. The WTP is the average, converted from % room rate where necessary, based on US$96/room/night.

Table 2
Breakdown of tourists' environmental awareness and knowledge and their WTP (US$) extra to stay at an HMMR with Standard Errors (SE)

	Visitors (%)	WTP ($)	SE
Know what MPA are?			
Yes*	78.10	13.69	1.15
No	21.90	9.89	1.41
Know how to find eco-friendly hotels?			
Yes	10.95	10.77	1.56
No	89.05	13.09	1.40
Would like to see hotel's environmental policy?			
Yes**	76.19	13.35	1.02
No	23.81	11.27	2.34
Know WIR is eco-friendly?			
Yes	58.57	13.41	1.41
No	41.43	12.47	1.29
Support HMMR?			
Yes	97.51	14.31	1.41
No	2.49	4.32	2.58
Willing to pay?			
Yes	86.27	13.81	1.34
No	13.73	0	

The sample comprises the available data from 211 surveyed guests minus 24 unusable samples. The WTP is the average, converted from % room rate where necessary, based on US$96/room/night. non-parametric Mann–Whitney *U* test. *$p < 0.05$, Chi-square test; and **$p < 0.001$.

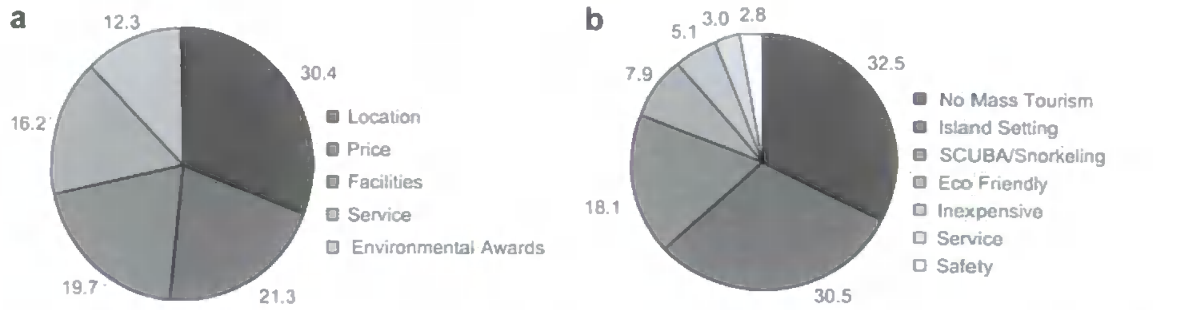


Fig. 2. The importance of various attributes to guests when choosing hotels (a) and choosing Whale Island Resort (b) expressed in % of the sample population.

environmental policies when agreeing to pay to stay at an HMMR was highly significant (Chi-square = 11.0; $p < 0.001$). whether the respondent knew what an MPA was, affected significantly the WTP amount to stay at an HMMR (Mann–Whitney $U = 2391.0$; $p = 0.047$).

Guests were thereupon asked to compare the general state of the marine environment, the fish diversity, number of fish, number of invertebrates, size of fish and coral cover within the reserve, with outside fished areas. Only 40.95% of the guests had also dived or snorkelled outside the enclosed bay, either on a dive or snorkelling trip, or if they had rented a canoe or hobby-cat and snorkelled at other areas around the Island.

The authors graded tourists' responses, giving '−1' if the tourists thought the conditions were poorer in the reserve, '0' for the same and '+1' for better conditions. All variables apart from coral cover (−0.16) averaged positively for the reserve. General state of the environment (+0.48) attained the highest rating, followed by fish diversity (+0.46), number of fish (+0.39), size of fish (+0.28) and number of invertebrates (+0.19).

In the succeeding questions, tourists were asked if they support the idea of hotels acting as caretakers and managers of protected areas: 97.51% did support HMMRs. Of the rest, nine did not have an opinion, five didn't support the concept, one of which expressing concern that the hotel would misuse the idea and profit from it; another was concerned about private ownership of public space becoming exclusionary. The remainder reserved comment since they did not have enough details.

On a follow-up, open-ended question, the majority (96.32%) reasoned HMMRs would better serve the environment, 13.50% thought private management would be better than government management, 12.88% and 12.27% thought it would benefit tourists and businesses, while others thought it would build environmental awareness (4.91%) and support fishermen (3.07%). Some were more reserved in their opinions, agreeing with HMMRs only if they were supervised and connected to an environmental agency (12.88%), or had an agreement with local communities (3.68%), while yet others considered it hotels' obligation to help protect the environment through active protection (9.82%). The remaining tourists thought the more HMMRs the better (3.68%) or that HMMRs were especially important in poor countries (3.68%).

Most guests agreed that HMMR information should best be available to them over the internet and on hotels' homepages (92.22%). A smaller contingent (17.22%) suggested that all hotels protecting marine reserves should have a website of their own, where you could browse per country for example, or that they were linked to either country environmental agency websites or diving company websites. Another faction (15%) had the same suggestions but would like the HMMRs to be incorporated into some kind of environmental standard or award system, overseen by an environmental agency. Other suggestions included brochures at the hotel (15.56%), travel guides such as Lonely Planet (9.44%), or equivalent for HMMRs (3.33%), on the country's tourism board website (6.67%), magazines (3.33%), travel agencies (4.44%) or TV advertising (2.78%).

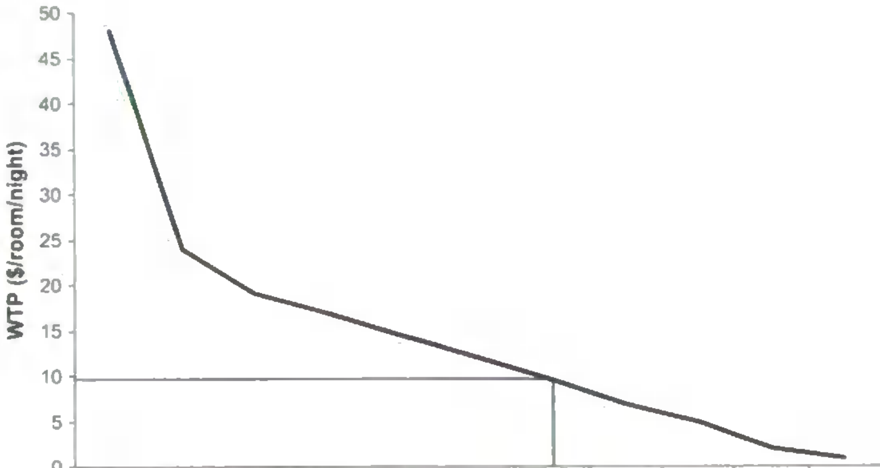
In the final WTP question, most tourists agreed they would be willing to pay more per night to stay at the HMMR (86.27%), the average being US$12.86 extra per room and night stayed, and the median: US$9.6. Of the 159 tourists willing to pay at least something, 84.28% decided to give a percent figure of the room rate. The difference between the averages given in percent (US$14.31) and in dollars (US$19.46) was significant (Two-Sample Kolmogorov–Smirnov $Z = 1.403$; $p = 0.039$).

The revenue and consumer surplus resulting from a user fee system has been calculated based on the WTP results from all tourists, willing to pay or not alike, except those who did not complete the WTP questions (11%). The results show that 85% of visitors were willing to pay at least 1% of the room rate, equivalent to US$0.96/room/night. Extrapolating this 85% to the number of rooms willing to pay per annum (9931), the hotel would make US$9534/year (Fig. 3). If all guests were to pay 1% per room per night, given an average yearly occupancy rate of 60% (7008 rooms) the resort would make US$6728 per year. If yearly occupancy increased to 70% due to HMMR marketing, the total revenue would equal US$7849. Similarly, 83.4% were willing to pay 5% of the room rate (US$4.8) and 70.1% were willing to pay 10% (US$9.6), which would amount to US$33,638 and US$67,277 per year, respectively, at 60% occupancy, to be bestowed to the management of the marine reserve, if all rooms occupied by tourists paid.

The WTP and total revenue drops dramatically beyond 10%. Only 37.4% were willing to pay 15% (US$14.4) and 26.7% were willing to pay 20% (US$19.2) of the room rate. Therefore, at 10% of the room rate and below, the demand for the HMMR is relatively inelastic and beyond 10%, the demand becomes relatively elastic and the revenue starts to decrease (Fig. 3). The consumer surplus, defined as the difference between what people are willing to pay for a good or service and what they actually pay, has been calculated based on tourists' total WTP. The total consumer surplus tourists are willing to pay beyond the normal room rate to enhance their snorkeling/diving experience and to contribute to coastal conservation has been estimated to US$162,437, based on WIR's room rate.

5. Discussion

Interestingly, the most common factors influencing WTP for other protected areas: age, education level and income [26], were insignificant when it came to WTP for an HMMR or deciding the amount, although there was some inclination towards higher WTP for tourists educated to PhD level, and those aged 26–35. The only significant variables affecting WTP were connected to a person's environmental knowledge and interest. While wishing to have access to hotels' environmental policies before staying at a hotel triggered tourists' WTP, knowing what MPAs are influenced the amount. Similar result were elicited by Dharmaratne et al. [27].



	312	1187	3123	3310	4372	5122	8182	8869	9744	9806	9931
WTP ($)	48	24	19.2	16.8	14.4	12	9.6	7	4.8	2	0.96
WTP (%)	2.7	10.2	26.7	28.3	37.4	43.9	70.1	75.9	83.4	84.0	85.0
Revenue ($)	14'990	28'482	59'961	55'614	62'960	61'461	78'550	62'085	46'770	19'612	9534
T. Rev. ($) @ 60 % Occ.	336'384	168'192	134'554	117'734	100'915	84'096	67'277	49'056	33'638	14'016	6728
T. Rev. ($) @ 70 % Occ.	392'448	196'224	156'979	137'357	117'734	98'112	78'490	57'232	39'245	16'352	7849

Number of guest rooms

Fig. 3. The percentage of guest rooms willing to pay (US$) extra to stay at an HMMR, resulting in revenue per year (US$) at 100% occupancy; and total revenue per year (US$) based on 60 & 70% occupancy if all tourists paid the specified WTP amounts; and showing the median WTP (US$9.6/room/night).

who found that people willing to become members and/or were already members of an NGO, established to manage Montego Bay Marine Park and Barbados National Park, were willing to pay more than non-members and those who showed no interest.

The average and median amounts tourists were willing to pay (US$12.86 & US$9.6) to stay at an HMMR were higher than the average and median amounts charged to divers to enter MPAs in Southeast Asia (both US$5) [17] but also lower than some WTP surveys. Divers were willing to pay on average US$27.4 to dive at the Bonaire Marine Park [28] and US$41 to dive at the Tubbataha Reefs Natural Marine Park [16]. Most commonly, MPA access is levied to individual divers, rather than dive operators, and although user fees may be charged either per dive, per day, per boat or per entry to the park, the timescale is usually per day [17]. The user fee system proposed for HMMRs is similar in terms of access to the HMMR per day, but it would not be per diver, but rather, per room, which is more likely to accommodate at least two people, and since guests are paying per night, it may potentially include an extra day, depending on arrival and departure times. Based on a median WTP of US$9.6, each tourist would then more likely be paying fees equivalent to US$4.8 per day, comparable to the average and median registered in Southeast Asia (US$5) [17].

Interestingly, 84% of respondents preferred to give a WTP value represented as percent of the room rate. The average room rate at WIR for an average length of stay of three nights amounted to US$96 (2006 rate), including meals and transportation, which could be considered on the lower end of beach resort accommodations, unless you are back-packing. The median, equivalent to 10% of the room rate per room (US$9.6) or quasi equivalent to US$4.8 per person per night could, therefore, be considered conservative, although you do have to consider that guests possibly kept WIR's room rates in mind when considering their WTP. The amount guests were willing to pay in dollars was, however, significantly higher than those who gave a WTP in percent, possibly indicating a higher believed room rate. This is likely to be influenced, however, by responses of an Australian woman and Englishman with average incomes (US$<45,000 & US$<60,000), who gave an exceptionally high WTP (US$75 & US$100). They were either very generous, or had misunderstood the question, possibly thinking it was for the length of their stay. When guests were asked why they preferred to give a WTP amount as percent of room rate, rather than a fixed dollar amount, many tourists reasoned that larger, more expensive resorts would require higher managing costs, but would ultimately also be capable of protecting a larger and 'better' reserve, compared with reserves managed by small, inexpensive resorts and the user fee should be weighted accordingly.

When tourists are actually faced with paying a user fee, they may no longer be willing to pay as much as when faced with the theoretical question of WTP. This over-estimated generous opinion of oneself has been calculated to approximately double the actual WTP [24]. There may, however, be a means to minimize this discrepancy. Research suggests that the longer tourists spend on recreational activities by the reef, the more willing they are to pay for improvements in reef quality, especially if their visit and diving/snorkeling experience meets or exceeds their expectations [18,26,29].

The average guest stays three nights at WIR, which is three to four days guests can use and benefit from the reserve. At other resorts the average length of stay may well be one week or longer, especially at dive resorts. When asked, over 90% of guests would choose to return to the resort, which suggests that their stay has met, or exceeded their expectations. Furthermore, when asked how they would compare the marine environment inside the reserve to areas they had seen when diving/snorkeling outside the reserve, except for coral cover, the responses were in favor of the marine reserve for general state of the environment, fish diversity, size and number of invertebrates. These questions have their limitations, however, because tourists are not marine biologists using unbiased monitoring methods, but rather base their answers on subjective opinions. Nevertheless, the overall tourist impression was that the hotel was effectively protecting the marine environment and increasing diversity and biomass, which obviously also increases guests' satisfaction and makes them more willing to pay for HMMRs.

The fact that tourists could utilize the reserve for several days and seemed satisfied with both the resort and the effectiveness of the reserve probably influenced the extremely high support tourists gave HMMRs (97.5%). This, however, just demonstrates that if HMMRs are managed effectively, and results are visible, at least tourists are in favor of HMMRs and are willing to pay for privately managed conservation efforts. A number of tourists (13.5%) even suggested that private management would be better or more effective than government management of marine reserves, especially in developing countries, where funding is scarce. While the vast majority stated that HMMRs would better serve the environment, several also concluded that it would be in the best interest for tourists and for the hotel alike. The majority did not object to the possibility that the hotel could profit from marketing the HMMR and increasing occupancy, as well as protecting the environment, as long as local communities weren't disturbed, but some expressed the desire for proof, i.e. when marketing the HMMR, the marine ecosystem should then also be in a "guaranteed" better condition than unprotected areas through some kind of "official stamp". It was proposed that a suitable environmental agency verify and certify that the resort is in fact dedicated to ecotourism and marine conservation and results are favorable.

Tourists concluded that HMMRs could help build awareness for protecting coral reef ecosystems on a local and international level. Since the majority of tourists choose their hotels over the internet, most recommended that HMMRs be advertised at an easily findable website either on a country's tourism site, at a website of their own, listing all HMMRs per country, or be incorporated in an existing environmental agency website confirming hotels' advertising. Word of mouth was the second highest choice for choosing hotels, so the more HMMRs there are providing information through brochures and/or lectures on the need for protection and the hotel's conservation efforts, the more environmental awareness will spread. This would be jointly beneficial to HMMRs, enabling them to maintain a suitable WTP and to increase occupancy and prestige, delivering them into a market niche. The third most important resource for choosing hotels was travel guides. In the Lonely Planet guide, there is a caption mentioning WIR and how, through their environmental protection efforts, including transplantation of coral, they have successfully increased the number of marine species [30]. Tourists suggested trying to incorporate all HMMRs into travel guides or even create a travel guide solely for HMMRs and eco-friendly hotels, which would certainly contribute to awareness building. This brief mention in the Lonely Planet, together with word of mouth are the main reasons why the majority of tourists already knew that WIR was an eco-friendly resort, since the resort does not advertise over the internet.

Unfortunately, choosing hotels according to environmental certification or environmental award schemes was the last choice when choosing hotels, which is not surprising since the majority of tourists do not know where to look for eco-friendly hotels (89%), despite 76% wishing to see hotels' environmental policies, including awards and certifications, before booking a room. There are over 70 sustainable tourism certification programs in the world [31], either currently active or in development, which legitimize eco-friendly hotels and grant awards after scrutinized inspections, Green Globe probably being the most recognized on a global level. These and other specialized websites such as www.responsibletravel.com, or more country specific: www.turismo-sostenible.co.cr, are places where tourists can find awarded or environmentally conscious accommodations, but obviously they are not well enough advertised, or tourists are not as interested as they indicate.

Despite the current involvement of environmental award systems, the majority of tourists do not know how to locate eco-friendly hotels, causing both the environment and potential eco-friendly travelers to be neglected. It may be possible to increase tourists' awareness and interest in HMMR conservation practices if managed effectively and certified globally through a central accrediting body. Such a central body for accrediting HMMRs is currently not available, however, possibly due to the complexity of management of community, NGO and government involvement, property rights of the oceans, and the concern about private ownership of public space becoming exclusionary, but also because of the relative novelty of such endeavors. While beachfront resorts are dependent on the 'bottom line', they may not be able to profit in the long term because of the growing need and environmental concerns of a growing ecotourism clientele. Notwithstanding, if standards and controls are adopted, there will inevitably be a period when some hotels will try to proliferate on the merits of others, but will hopefully fail pending tourists' scrutinized judgment and subsequent word of mouth advertising.

The consumer surplus representing the total amount tourists were willing to pay on top of the normal room rate to stay at an HMMR equaled US$162,437, based on WIR's average room rate (US$96), which would be equivalent to US$23.18 per room per night at 60% occupancy. This amount, as well as the average WTP (US$12.86), may be considered too high; a better representation is the median US$9.6 (10% of the room rate), which 70% of tourists were willing to pay and which also amounted to the highest revenue (US$78,550) for willing-to-pay tourists (Fig. 3), demonstrating inelasticity of demand for HMMRs up to 10% of the room rate. If all guests were to pay 10% of the room rate, per room per night stayed, total revenues per annum would equal US$67,277 based on 60% occupancy. This figure is, however, only an estimate of WTP in monetary terms, since it is an example from WIR's room rate. For a 50-room hotel costing US$200 per night with 75% occupancy, total revenues based on 10% of the room rate would amount to US$273,750, a substantially higher potential fund for the MPA; even 5% would still generate US$136,875 per annum. Therefore, total revenues are dependent on the room rate, number of rooms, yearly occupancy and the user fee percentage.

A user fee of only 1% per room and night (generating US$6728/year) would nearly suffice to cover the conservation costs at WIR, covering leasing costs (the marine portion equaling approximately US$4000), moorings, maintenance and repairs (US$300), management and salaries (US$3800). The running costs of the WIR area-equivalent 15 ha marine sanctuary on Gilutongan Island, Philippines, however, requires a yearly budget of US$21,000, to pay for surveys and maintenance, community organizing, education and training, law enforcement (small patrol boat), information dissemination and salaries [32]. Therefore, a very achievable, and acceptable, fee of 5% to support WIR's HMMR would generate considerable extra income for such future investment in the MPA.

6. Conclusion

Based on the results and reasoning from this survey, several recommendations can be made which could potentially increase a hotel's chances of biological and social success, while staying economically secure.

After establishing that a hotel can lease an area of the coastline, the local communities and government should be consulted and an appropriate size and location for the reserve negotiated. The size of the reserve should be large enough to maximize biological potential, small enough to allow spillover and to be economically feasible and not so large that the loss of fishing grounds puts an unmanageable strain on local communities. Next, the hotel, local communities and government should align their reserve objectives with an environmental agency to avoid differing interests and try to validate the MPA internationally and a user fee amount should be calculated based on stakeholders' fixed expenses. Here it is important that the needs of all stakeholders are considered and that the hotel makes every attempt to integrate themselves and help the local communities wherever possible, especially when the hotel owners are foreigners.

Tourists seem to prefer a user fee in the form of a percent of the room rate, with 10% per room per night representing both the optimal and maximum amount, considering revenue versus WTP. Only the absolute necessary amount should, however, be demanded and the hotel and environmental agency should provide clear information how guests' money is invested.

The hotels should advertise their HMMR and associated projects on their homepage and with a local environmental agency, since no central body certifying HMMRs thus far exists, providing more clarity in operations and, if possible, over the country's official tourism website and/or through dive companies. Additional advertising with travel guides, as well as information dissemination through seminars and brochures available at the hotel, explaining projects and monitored successes should be available to raise awareness and interest.

Optimal location of the hotel is important, since this is the first thing tourists consider when choosing their destination. From a biological and socio-economic point of view, the farther away the hotel is from inhabited land, the better [33], unless transportation costs and resulting pollution negate the positive benefits. Location is, however, only the first step. To assure guests' user fees are maintained, their stay must meet or surpass their expectations with visible improvements in HMMR biota compared with unprotected areas. This latter achievement may be difficult in the first few years, even with effective management; tangible projects may be an option, such as building artificial reefs to attract fish and attempting coral transplantations.

In some cases hotels have initiated marine protection, only to be incorporated into government protected areas in the future [8], including the areas protected by Lankayan Island Dive Resort and Anse Chastanet, which later developed into Sugud Islands Marine Conservation Area (SIMCA) and Soufriere Marine Management Area (SMMA) [15]. The period during which the hotels were protecting these areas could be seen as money saved by the government for an area which actually needed protecting [8].

HMMRs are quite recent developments and, therefore, still quite scarce, so further research into the effectiveness of HMMRs from a biological and socioeconomic perspective is still necessary, but this survey certainly proves interest and commitment to HMMRs from a large subset of tourists and thus the great potential of HMMRs as an economically sustainable conservation tool.

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Patrik Svensson, Lynda D. Rodwell and Martin J. Attrill

Privately Managed Marine Reserves as a Mechanism for the Conservation of Coral Reef Ecosystems: A Case Study from Vietnam

Coral reef ecosystems have been declining at an alarming rate during recent decades, despite increasing numbers of marine protected areas (MPAs) encompassing coral reefs. However, many MPAs have not met reserve objectives, inhibiting effective protection. This study focuses on the potential effectiveness of a Hotel Managed Marine Reserve (HMMR) at enhancing reef fish stocks. Biannual visual fish census surveys were conducted at two marine reserves adjacent to Whale Island Resort, Vietnam, October 2005 to April 2007. The 6-year protected Whale Island Bay Reserve (11 ha) showed significantly higher fish densities, richness, average size, and number of fish >15 cm compared with two unprotected control sites. Fish stocks at a second newer reserve, Whale Island Bay Peninsula (5 ha), quickly increased after protection. This study has demonstrated the effectiveness of HMMRs, suggesting a global network of such privately managed reserves could play a part in the conservation of the world's coastal resources, while alleviating financial pressure on governments.

INTRODUCTION

Coral reef ecosystems are fundamental to the sustainable development of many tropical coastal countries, providing food, minerals, and income to local fisheries while also offering natural protection against wave erosion (1). These ecosystems are, however, highly threatened today, despite a growing number of marine protected areas (MPAs) established during the last three decades, with proven success at increasing species richness, biomass, and biodiversity (2, 3). Bryant et al. (4) found that the coral reefs of Southeast Asia are the most threatened (80%), mainly because of coastal development and fishing-related pressures.

Therefore, to address this threat, and to reduce loss of biodiversity, the need for more MPAs has been recognized in recent years. At the World Summit on Sustainable Development (Johannesburg 2002), and later at the World Parks Congress (Durban, September 2003), representatives of protected areas recommended networks of marine reserves covering 20–30% of habitats by 2012 (5). Countries have acknowledged the dire consequences of losing coral reef ecosystems, and the worldwide response has been to create each year for the last decade approximately 40 MPAs that include coral reefs, thus covering 18.7% of the world's coral reef habitats (6). In 2002, 646 MPAs had been declared in Southeast Asia; however, only 8% of the countries' reef area is covered (7). Unfortunately, a large majority of MPAs in Southeast Asia and worldwide are reported as failing because they have not met their objectives, have been listed as marine reserves but not succeeded in implementing management, have failed, or lie dormant at one of the subsequent development stages (8). The major barrier has been attributed to the inability to secure adequate long-term funding for management costs (9), resulting in inadequate law enforcement (10). In a worldwide study of MPAs, only 15.7% of respondents reported funding levels to be sufficient for effective conservation (11).

The private sector, bolstered by tourism, could offer a major source of revenue, enabling MPAs to become self-financing, establishing a truly successful and economically sustainable MPA, especially in developing countries (9, 12). The Durban Action Plan (from the World Parks Congress 2003) also called on the private sector to "financially support the strategic expansion of the global network of protected areas" and states that tourism can provide economic benefits and opportunities for communities and create awareness and greater knowledge of our natural heritage (5).

Private parks on land are well known and have been accepted as conservation areas for more than half a century (13), with several large private parks existing in South America and Africa, some covering more than 100 000 ha (14). Whereas little is known about the effectiveness of such private parks, they are still expanding rapidly and number in the thousands, protecting several million hectares of biologically important habitat (15). Privately managed MPAs on the other hand are not well known, despite the private sector's growing involvement and reported higher influence in protected area decision making, especially in developing countries (16). Privately managed MPAs are still widely undocumented and insufficiently researched, but similar to terrestrial private parks, they are believed to have been initiated because of the same three reasons: government failure to satisfy public demand for nature conservation (both quality and quantity), growing societal interest in biodiversity conservation, and the rapidly expanding ecotourism industry (13, 17).

It is traditionally understood that in private-community ecotourism joint ventures, the private sector should bring capital, business, and marketing know-how and a client base; the local communities provide the location and local knowledge, whereas the local government or nongovernmental organization should mediate between the two, as well as provide basic infrastructure and other necessities (18). It is, however, a general misconception that submerged lands cannot be owned or leased by private enterprises (19). In researching the coastal states surrounding the United States, Slade et al. (20) found that nearly one-third of submerged lands were owned or leased by the private sector, developing marinas, private docks, fisheries, aquaculture or other ventures. States in the United States, in which ownership of submerged lands is possible, include Florida and Hawaii (19)—tropical states that include coral reef systems. Leasing submerged lands as a tool for marine conservation has, however, rarely been used, even though the costs of leasing such areas are generally orders of magnitude lower than equivalent schemes in the terrestrial environment. It is, for example, possible to lease up to half of California's kelp forests, as well as sponge and soft coral habitats in Florida (19).

A growing number of hotels and dive resorts are discovering the leasing potential of adjacent coastal areas with or without external stakeholders. The Navini Island Resort, Fiji, has taken advantage of the customary South Pacific practice of owned, limited access areas of the sea and its resources, so called *tabu*

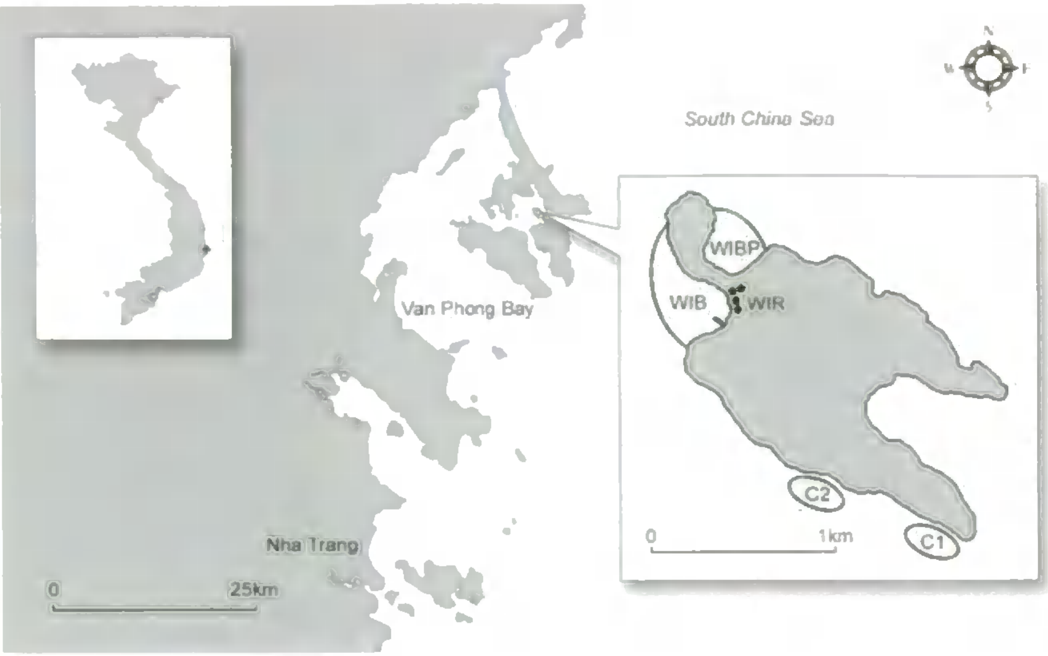

Figure 1. Illustration of the study area showing the 11 ha Whale Island Bay (WIB) and the 5 ha Whale Island Bay Peninsula (WIBP) reserves, plus the locations of the two control sites (C1 and C2) on Hon Ong (Whale Island), in Van Phong Bay, Khanh Hoa Province, Vietnam.

areas, by leasing the sea around the island up to a depth of 30 m. A monthly fee is paid to the owners, who enforce fishing restrictions, and in return the hotel agrees to follow the *tabu*, which prohibits any damaging of the coral reef ecosystem or extraction of its resources (A. Reed pers. comm.).

In other cases, resorts that have the financial backing, resources, and economic incentive have taken over the day-to-day management of an MPA. These are termed "entrepreneurial MPAs," where the MPA is officially designated, but resources are lacking to effectively manage the reserve (21). Some private no-take zones are also precursors to public protection, which could be viewed as money saved by the government for areas that may otherwise have needed protection (13). The protected zone adjacent to Lankayan Island Dive Resort, Sabah, Malaysia, which turned into Sugud Islands Marine Conservation Area, is such an example (22). The number of officially recognized privately managed MPAs is still small, but there are reported successes, such as the Chumbe Island Coral Park, which possibly also represents the first fully functioning MPA in Tanzania (17).

There is growing literature showing that MPAs can effectively increase diversity, density, and biomass of organisms within protected boundaries, irrespective of the size of the MPA (23), as well as enhance fishing yields in the surrounding fished areas through the process of fish "spillover" from the MPA (24–26). The biological effectiveness of privately or hotel managed MPAs, from here termed "Hotel Managed Marine Reserves" (HMMRs), have, however, not yet been adequately researched.

In light of the high financial costs of establishing and maintaining protected areas, this article examines an alternative approach to protecting at least a part of the 20–30% of the world's seas through private management. Hotel managed marine reserves may offer a solution to the increasing need for marine conservation by assuming responsibility for protecting adjacent marine environments yet also safeguarding the hotels' future through reputation and return guests. The future of local communities may also be sustained by ensuring direct and indirect jobs from tourism activities and growth and by providing spillover from increasing the standing fish stocks in the reserves. Here we report a local study with possible global consequences aimed at assessing the potential of marine conservation when managed by the private sector. As part of an interdisciplinary project focusing on the ecological and socio-economic consequences of HMMRs, this article reports results from a study into the effectiveness of an HMMR in Vietnam in terms of its capacity to increase coral reef fish density, diversity, and size.

METHODS

Study Site: Whale Island Resort, Vietnam

Whale Island Resort (WIR) is situated on Hon Ong, a small island (approximately 100 ha), located in Van Phong Bay on the south-central coast of Vietnam (Fig. 1), 80 km north of Nha Trang. The resort was established in 1997 and today has 32 bungalows accommodating a maximum of 70 guests.

The hotel owners noticed the continued decline in local fish and coral populations believed to be caused by overfishing and destructive fishing techniques, such as hose and hook, blast, and cyanide fishing. This was compounded by pollution and rubbish dumping from small villages within the bay. They therefore asked the 40–50 local staff to inquire with their fishing families as to whether they would have any objections to the hotel enclosing the bay around the resort with buoys, thus inhibiting fishing in the zone to protect the area and replenish stock. When no objections were made, they enclosed the bay in 2001, establishing a no-fishing zone and a *de facto* 11 ha marine reserve (Whale Island Bay [WIB]). In August 2005, a second bay was enclosed on the other side of the peninsula, creating a 5 ha marine reserve (Whale Island Bay Peninsula [WIBP]) (Fig. 1). Legal permission to close off these areas was attained from the local authorities of Khanh Hoa Province in the form of a 10-year lease (open to renewal), and initialization was supervised by the local coast guard. The added capital from the lease is welcomed by local authorities, because they can invest in infrastructure, schools, etc. Any extension of the lease period is likely to be favored under normal circumstances, making planning for long-term protection of coastal areas realistic for HMMRs.

The resort is eco-friendly, although it lacks official certification; it generates only low amounts of pollution to the reserves from the ferry shuttling guests and supplies to the mainland plus the activities of the daily dive and snorkeling boat. The vast majority of food and drink is purchased from local vendors, and security guards, who double as reserve wardens, patrol the resort and adjacent reserves during the night to protect against poaching. The costs needed to maintain the reserves are relatively low: the sea portion of the lease, the reserve wardens, plus materials, repair, and maintenance totals less than USD 10 000 per annum. No reserve-user fees are collected.

The no-take zone was not accepted by the local communities for approximately the first 2 years, despite community acquiescence to WIB when it was first enclosed, resulting in frequent poach fishing. Consequently, the local coast guard was contacted on a regular basis to deliver verbal warnings or to confiscate fishing gear from regular offenders. Poaching gradually abated, possibly because fishermen realized that the added benefit from fishing in the reserves did not outweigh the risk of being caught, or they recognized the long-term potentials of the reserves at providing spillover. Poaching is rare today at WIB reserve, but the frequency of fishermen "fishing the line" (fishing just outside the marked buoys) during the night is relatively high (2–3 times per week). Patrolling the WIBP reserve is less frequent, and, as a result, poach fishing occurs approximately every 2 weeks during the night. When fishing within the reserves, traditional line and hook fishing is used; when fishing the line or fishing at other coastal locations around the Van Phong Bay, more extractive net or trawl fishing methods are employed.

Surveys

The surveyed areas include WIB, the 150 m distant WIBP, and two control sites (C1 and C2), which have similar exposure, slope, and morphologic characteristics, located 800 m along the coast from WIB and 350 m apart (Fig. 1). As exact geographical control replicates were not possible, we used the manta tow technique to choose control sites, which were as close a fit to conditions of the HMMRs as feasible. As natural differences between locations are likely to exist, our study focused on relative change over time at our four sites rather than absolute comparisons of fish communities. We conducted the first survey in October 2005, 2 months after WIBP was enclosed, thus approximating preprotection conditions for that reserve. The following three surveys were conducted every 6 months during a 3-week period, each time in April and October, with the last survey conducted in April 2007; two seasons were therefore assessed over 2 years.

During all four survey visits (October 2005–April 2007), replicates of four 50 m transects were surveyed at 3 m and 9 m depth at each of the four survey sites (WIB, WIBP, C1, and C2) using the visual fish census method described by English et al. (27); the same transect line was used to survey the benthos using line intercept transect over 20 m. Instead of only including fish within a set perpendicular boundary to the transects, we used variable distance counting to calculate the area (and thereby density) (28). We identified the whole fish community to species, but excluded cardinalfish (Apogonidae), lizardfish (Synodontidae), and the bottom-dwelling species such as the gobies (Gobiidae) and blennies (Blenniidae) because their cryptic lifestyles made accurate enumeration difficult. We recorded the number of individual fish per species and their size and estimated their distance from the transects. To increase accuracy in length estimations, we arranged and estimated polyvinyl chloride fish models (7–49 cm) along a 50 m line while snorkeling at a constant pace. We repeated this exercise with varying configurations and distance from the observer before each survey visit until 95% accuracy was achieved.

We analyzed fish density, species richness, average size of fish, and number of fish >15 cm using a three-way analysis of variance (ANOVA) model with site, habitat, and time as factors; benthos cover (i.e. composition of benthic habitat) was analyzed with a two-way ANOVA for site and time. We checked for ANOVA assumptions using Cochran's test and transformed where necessary; Student-Newman-Keuls tests (SNK) further investigated the significant interactions between factors. All ANOVA analyses were undertaken using GMAV5 for Windows. To explore the difference in fish assemblage composition between times and sites, we conducted hierarchical agglomerative cluster analysis to produce a dendogram using PRIMER5 software on a similarity matrix (Bray-Curtis similarity index) calculated from square-root transformed species abundance data (29). Significance tests for differences between site and time were performed using ANOSIM, and the fish families contributing most to dissimilarities were determined by the similarities percentage procedure SIMPER (30).

RESULTS

During the four visual census surveys we identified 242 species of fish from 35 different families; 195 species were observed in WIB reserve, 138 in WIBP reserve, and 107 and 87 species were recorded at C1 and C2, respectively. Over all sites and survey periods densities of fish were higher at the 3 m sites (1.31 m^{-2}) compared with the 9 m sites (0.34 m^{-2}) (SNK, $p < 0.05$), as was average size (8.28 cm compared with 8.71 cm) (SNK, $p < 0.01$), average number of fish >15 cm (44.81 versus 9.04 individuals) (SNK, $p < 0.05$), and average species richness (28.12 versus 6.39 species) (SNK, $p < 0.01$).

At 3 m, the seabed is scattered with a higher rocky substrate cover ($F = 29.05$, $p = 0.013$) relative to surveys conducted at 9 m, where substratum consisted mainly of sand (average 98.1%), but no significant differences in overall benthic structure were found between WIB, WIBP, C1, or C2 ($F = 1.10$, $p = 0.368$). Coral cover on the other hand was significantly higher at WIB compared with the control sites and WIBP (SNK, $p < 0.01$), although no significant differences were evident between the controls and WIBP. Coral cover is, however, comparatively poor at each location, equaling 7% at WIB rocky habitat and less than 1% at the other locations and depths.

ANOSIM tests confirmed that the fish assemblages between the 9 m sandy habitats and the 3 m rocky habitats were significantly different (Global $R = 0.745$, Global $p = 0.001$). The families contributing most to the dissimilarity between habitats were the Pomacentridae, Nemipteridae, and Labridae (Table 1). The dendogram (Fig. 2) illustrates these findings and additionally shows a higher level of similarity between rocky sites. For both the sandy and rocky habitats, closest similarities were observed between the two control sites and WIBP (approximately 70% for rocky habitats and 55% for sandy habitats). Although 35 families were observed, the vast majority of species found at all sites belong to the damselfish family (Pomacentridae, 56–68%), followed by bream (Nemipteridae, 12–17%) and wrasse (Labridae, 6–12%). The larger predator species, jacks (Carangidae), barracuda (Sphyraenidae), and milkfish (Chanidae) were, however, exclusively found in WIB and WIBP.

Whale Island Bay contained significantly higher species richness, density, average size of fish, and number of fish >15 cm (SNK, $p < 0.01$), compared with C1, C2, and WIBP over all survey visits (Fig. 3), as well as a significantly higher number of butterflyfish (one-factor ANOVA, $F = 15.404$, $p < 0.001$). Whereas there were no significant differences between survey periods for species richness and average size, significantly higher values were found in the latter two surveys compared with October 2005 for density (SNK, $p < 0.01$) and number of fish >15 cm (SNK, $p < 0.05$), as well as density for April 2006 relative to October 2005 (SNK, $p < 0.05$).

Table 1. Fish families contributing most (90% cutoff) to the dissimilarity between sites: Whale Island Bay (WIB), Whale Island Bay Peninsula (WIBP), and time: October 2005 (1), 3 survey periods: April 2006 to April 2007 (2–4); seasonal dissimilarity across sites (including controls C1 and C2); and habitat dissimilarity across all sites, 3 m rock and 9 m sand.

Families	Ave. abundances		Diss/SD	Cum.%
	Rocks	Sand		
Pomacentridae	229.42	55.38	1.90	53.28
Nemipteridae	55.64	3.81	1.67	70.40
Labridae	35.88	0.79	1.50	83.87
Caesionidae	7.45	3.62	0.49	87.37
Gerreidae	7.08	0.52	0.67	89.35
Chaetodontidae	5.23	0.30	1.16	90.99
	October	April		
Pomacentridae	191.27	261.94	1.53	56.13
Nemipteridae	37.24	72.94	1.28	72.27
Labridae	38.79	31.75	1.16	80.10
Caesionidae	4.12	10.66	0.59	84.14
Gerreidae	6.15	7.81	0.85	87.18
Siganidae	1.03	6.06	0.27	89.37
Scaridae	3.67	3.72	0.68	91.16
	1WIBP	2WIBP		
Pomacentridae	96.75	295.25	3.30	61.96
Nemipteridae	25.75	76.50	1.18	77.18
Gerreidae	0.50	16.25	0.97	82.04
Scaridae	0.75	14.75	1.24	86.35
Labridae	34.75	33.00	1.28	90.33
	1WIBP	1WIB		
Pomacentridae	96.75	299.75	2.16	60.11
Nemipteridae	25.75	60.00	2.65	71.96
Labridae	34.75	30.75	1.01	77.47
Gerreidae	0.50	14.25	1.74	81.99
Scaridae	0.75	7.25	0.58	85.65
Caesionidae	9.75	2.00	0.73	89.05
Chaetodontidae	1.50	8.25	1.06	91.55
	2–4WIBP	2–4WIB		
Pomacentridae	289.67	525.67	1.53	58.04
Nemipteridae	73.58	101.25	1.39	69.41
Labridae	42.92	48.67	1.31	75.60
Gerreidae	7.58	19.50	1.01	80.04
Caesionidae	2.42	17.33	0.84	84.42
Scaridae	6.58	5.83	0.91	86.36
Mugilidae	2.08	8.08	0.81	88.28
Lutjanidae	1.92	8.17	0.94	90.11

* SIMPER = not transformed data; Diss/SD = dissimilarity/standard deviation; Cum.% = cumulative % contribution.

Whale Island Bay Peninsula reserve, established as a no-take zone 2 months before the first survey, showed no significant differences to controls at baseline for all parameters, except higher species richness relative to C2 (SNK, $p < 0.01$). After enclosure, WIBP increased its fish stock and size, resulting in higher overall densities of fish and numbers of fish >15 cm (SNK, $p < 0.01$) compared with controls and a higher species richness than C2 (SNK, $p < 0.01$). No significant differences were recorded for average size compared with controls or species richness compared with C1. Fish density and fish >15 cm increased significantly within WIBP (SNK, $p < 0.01$) from the first survey period to the next, but remained relatively constant thereafter (Fig. 3), with no significant differences between the latter three sampling periods; each, however, was significantly different (SNK, $p < 0.01$) from October 2005 (approximating pre-enclosure). No significant differences were evident for species richness or size. The families mainly responsible for the increase, and thus resulting dissimilarity, between the two survey periods at WIBP were the Pomacentridae, Nemipteridae, Gerreidae, and Scaridae (Table 1). The SIMPER analysis also highlights the increased average abundances of several fish families in the last three survey periods at WIBP, approximating averages attained at WIB during the first survey; averages were surpassed for Nemipteridae, Labridae, and Caesionidae.

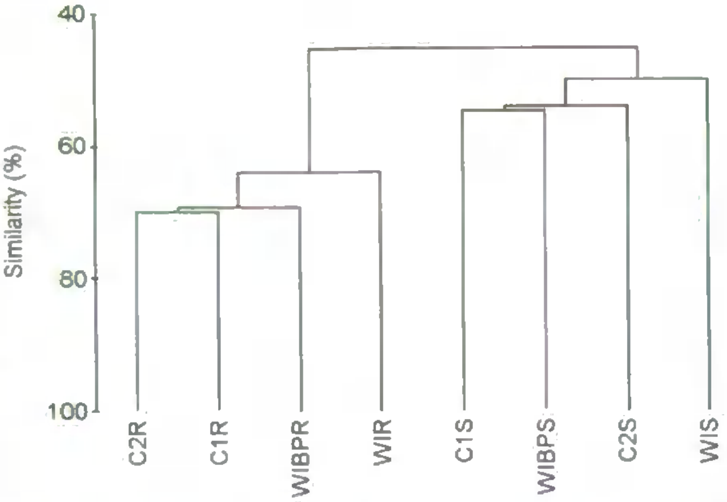

Figure 2. Dendogram illustrating similarities in fish assemblages between Whale Island Bay (WIB), Whale Island Bay Peninsula (WIBP), and two control sites (C1 and C2), for surveys conducted biannually between October 2005 and April 2007 at Whale Island Resort, Hon Ong, Vietnam. Habitats: Rock (R) and Sand (S).

The overall composition of fish assemblages were significantly different across all sites (ANOSIM, Global $R = 0.567$, Global $p = 0.001$), between sites (all $R = 0.292$–0.943, $p \leq 0.002$); across all periods (ANOSIM, Global $R = 0.502$, Global $p = 0.001$) and between periods (all $R = 0.323$–0.753, $p \leq 0.003$). Diversity was significantly higher in April 2007 (SNK, $p < 0.01$) compared with the three previous visits across all sites. For average fish size, there were no significant differences across sites and times, in part because of the high percent of small damselfish (Pomacentridae) (64.5%). There is an apparent seasonal trend for density and fish >15 cm (Fig. 4): values recorded in April 2006 were significantly higher than October 2005, and April 2007 values were significantly higher than October 2006 (SNK, $p < 0.01$). The families mostly responsible for the dissimilarity between April and October surveys were the Pomacentridae and Nemipteridae (Table 1).

DISCUSSION

The objectives of this study were to determine the effectiveness of HMMRs in terms of increasing the number, size, and diversity of fish and to assess how rapidly a previously exploited area can increase fish stocks, once protected from fishing. The results indicated that these measures of the fish community at WIB clearly surpassed those of the unprotected control sites (Fig. 3). Equivalent results have been observed at a number of similar-sized MPAs (23). Roberts and Hawkins (31) reported that the small marine reserve of Anse Chastanet, St. Lucia (2.6 ha), initially established as a protected zone for snorkelers of the hotel, managed to double the biomass of commercially important predatory fish species such as the snapper. In the Philippines, the Sumilon Island Reserve (12.5 ha, 9 year protection) had approximately 1.8 times higher density than the control sites and 1.2 times the number of species than the unprotected Sumilon sites (overall WIB density: 2.9; number of species: 2.6 compared with averaged controls). Apo Island Reserve, Philippines (11 ha, 1 year protection), reported approximately 1.4 times higher density and 1.15 times higher number of species than the unprotected Apo sites (WIBP density: 1.8; number of species: 1.2) (32). This comparison between the officially recognized Philippine reserves and the

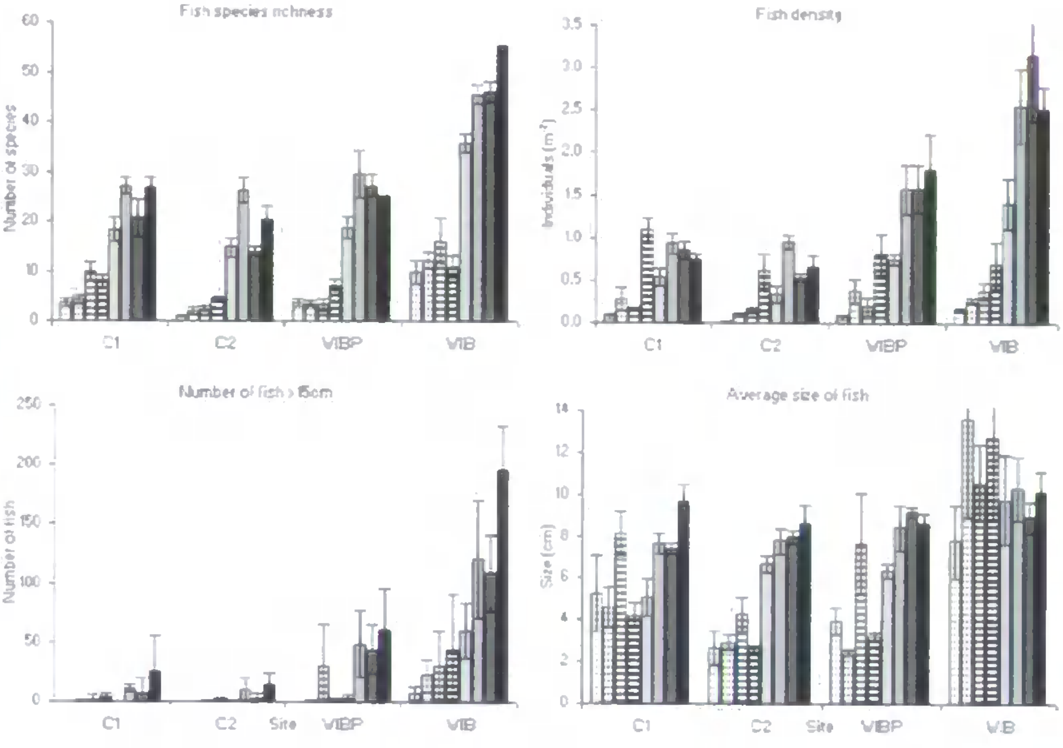

Figure 3. Visual censuses comparing fish species richness, density, number of fish >15 cm, and average size (S.E.) for Whale Island Bay (WIB), Whale Island Bay Peninsula (WIBP), and two control sites (C1 and C2), for surveys conducted in October 2005 (light grey), April 2006 (grey), October 2006 (dark grey), and April 2007 (black) at Whale Island Resort, Hon Ong, Vietnam. Striped bars are the 9 m sandy habitats, solid bars the 3 m rocky habitats.

reserves in Vietnam demonstrates at least equal effectiveness for these HMMRs. Similarly, the size of fish at WIB was overall 1.5 times higher than the control sites (WIBP, 1.3 times) and the number of fish >15 cm, 22 times higher (WIBP, 4 times) (Fig. 3). These are considerable increases for WIBP in particular, bearing in mind there were minimal differences between this site and the two control sites in October 2005. This supports the evidence that small HMMRs can, in only a short time, increase fish populations significantly following protection. Analogous results were produced by Halpern and Warner (33), who found that marine reserves can significantly increase average levels of density, biomass, and diversity within 1–3 years, independent of the size of the reserve.

Without effective protection, such small reserves can, however, be quite vulnerable. At the Anse Chastanet reserve, fish biomass dropped by 20% after a period of ineffective protection; however, biomass recovered to double the initial value within 2 years of reinstatement (31). The increase in biomass was primarily credited to an increase in fish size, much like WIBP, where the number of fish >15 cm increased 13 times from baseline to April 2006 and by 17 times from baseline to April 2007. This clearly highlights both the benefits and downfalls of small marine reserves. If small reserves are fully protected, they can increase the size and density of fish rapidly; however, if poaching does take place, the detrimental effects can be seen immediately. The magnitude of damage will depend on the intensity of fishing, the fishing gear/techniques used, and the standing stock before the event. If HMMRs become lax in maintaining effective protection, their image as an eco-friendly resort, where you can dive and snorkel off the beach, could become compromised. This could possibly result in lower occupancy rates and decreased profit—why private reserves in particular have an added incentive to uphold protection.

Although WIB is effectively protected, poaching still takes place at WIBP; unlike preprotection, however, less extractive fishing methods are used. In Van Phong Bay, one fishing method, which does not target specific species, involves dragging nets from within a small bay onto the beach (beach seining), not only causing serious damage to living coral, but also extracting a far higher number of fish than postprotection, where generally hook and line fishing is used. This may explain the rapid increase in density and number of fish >15 cm from the first survey to the next, and also why the number and size of fish did not increase further over the following year (Fig. 3). Unfortunately, the WIBP site is also currently restricted to tourists, which lessens the incentive for protection.

Beach seining may also account for the low coral cover at WIBP, C1, and C2 (<1%), although coral cover at WIB rocky habitat is also rated low with 7%. Whereas there is evidence of more numerous and diverse fish assemblages associated with coral reef habitats (1, 34), it is questionable whether such low levels would add significant value, although there were significantly more corallivorous butterflyfish (Chaetodontidae) observed in WIB (6 times more than at control sites and 4.5 times more than at WIBP). This family has been positively correlated with coral cover and marked as indicator species for healthy reefs (35, 36). A more likely scenario, perhaps, for the significantly higher number of butterflyfish and other species, as well as individual fish size in WIB compared with C1, C2 and WIBP, is the 6-year protection period and the cessation of large-scale fish netting. This would also account for the observed differences in fish assemblages for sandy and rocky habitats of WIB compared with the other sites (Fig. 2).

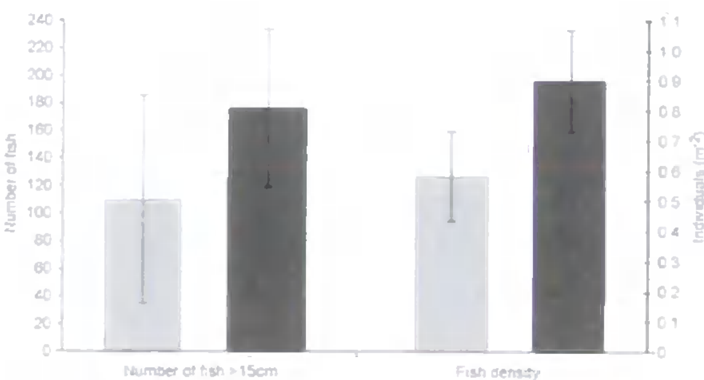

Figure 4. Seasonality of averaged density and number of fish >15 cm surveyed at both depths (3 m and 9 m) during time intervals October (2005 and 2006: light grey) and April (2006 and 2007: dark grey) at Whale Island Bay (WIB), Whale Island Bay Peninsula (WIBP), and two control sites (C1 and C2).

Rocky habitats (3 m) evidently have a richer fish assemblage than sandy habitats (9 m), mainly attributed to higher numbers of Pomacentridae, Nemipteridae, and Labridae (Table 1). This is expected for sites with higher structural complexity (1, 34), but both are highly depauperate in terms of commercially valuable groups of large food fishes: Serranidae (e.g. *Epinephelus*, *Cephalopholis* spp.), Lethrinidae (*Lethrinus* spp.), and Lutjanidae (*Lutjanus* spp.), especially at C1, C2, and WIBP. Even though the abundance of such species was notably higher at WIB, grouper, emperor bream, and snapper only accounted for a small percentage of the fish population (0.46%, 1.86%, and 0.94%, respectively). Unlike many small coastal demersal fishes, which are relatively sedentary, having a home range of <1 km^2, the size and living spaces of such species tend to be larger, requiring a larger area of protection (37).

The number of these species did not increase dramatically once WIBP was protected, but measures of the fish assemblage increased between October 2005 and April 2006, especially for the number of fish >15 cm, which increased from 2–9.4% of the population; the number of species and average density also increased. A threefold increase in Pomacentridae accounted mostly for the latter, whereas Nemipteridae, and to a lesser degree Gerreidae and Scaridae, were mainly responsible for an influx of larger fish (Table 1). This is consistent with previous findings, where predatory fish (Nemipteridae) responded strongly to well enforced reserves in the Philippines (26). Whereas this could be seen as a sign of spillover from WIB, there was no indication of simply a relocation of WIB stock (Table 1, Fig. 3). While the average abundances increased during the following three survey periods for WIB and WIBP, the average contribution to the dissimilarities for the three major families (Pomacentridae, Nemipteridae, and Labridae) remained similar to the first survey period (Table 1). The average dissimilarity decreased, however, from 55.53% to 36.59%, indicating that some movement between reserves may be taking place.

The number, size, and diversity of fish increased at C1 and C2 between the first and second survey also, but not as dramatically as at WIBP reserve, the difference probably related to the absence of larger-scale extractive fishing methods in the reserve. A seasonal trend is evident for density and number of fish >15 cm across all sites (Fig. 4), with higher values reported in April. The main contributors were species of the Pomacentridae family, followed by a much smaller contribution from the larger Nemipteridae, Caesionidae, Gerreidae, and Siganidae families (Table 1). The difference could be due to lower fishing intensity over the northeast monsoon season (October to February), when fishing is restricted by weather conditions. The higher fish densities could, however, also be related to seasonal recruitment patterns. Higher peak settlement of several damselfish species have been recorded during the wet season at San Blas, Panama, believed to be caused by the strong onshore winds (38). Srinivasan and Jones (39), however, found that recruitment densities for Pomacentridae were highest after the wet season (December–February), in April/May, and again in October/November, in Kimbe Bay (PNG). Pomacentridae was also the main contributor to the dissimilarities between the two seasons at WIR's reserves (Table 1). Without further research into temporal dynamics of fish recruitment and fish landings in Van Phong Bay throughout the year, it is not possible to unequivocally determine the cause of temporal differences.

Although there was an initial significant increase in fish stock at WIBP, the level plateaued, showing only minimal temporal differences thereafter (Fig. 3). Fish stock and sizes are, however, still increasing 6 years after protection at WIB, and because the surveys were only conducted during 2 years, further replenishment is perhaps still possible at WIBP, but more effective protection will then also be needed. Fishing the line is observed regularly at WIB, which is a good indicator that fishermen perceive the reserve to be increasing its fish stock and possibly producing spillover. Spillover was not researched outside WIB for this study, but several fishermen confirm that fish stocks have improved adjacent to the reserve (Svensson, Rodwell, and Attrill, submitted). The long-term goal of all HMMRs located near fishing villages should be to compensate or increase their fishing yields to alleviate poverty, to increase standards of living, and to repay the debt of compliance to the hotels' no-take zones.

At WIR, fishermen have also been seen fishing extensively between WIB and WIBP with nets, potentially hindering the replenishment of WIBP fish stocks to its full capacity from WIB. Although this may be a good short-term solution enabling increasing yields, arguably it may not be a good long-term strategy to allow build-up of fish stocks. A better solution to improve the marine reserve potential would be to expand both reserves to encompass the peninsula, creating one larger no-take reserve, and to increase protection efforts. This would increase the capability to self-sustain a larger fish stock, including larger economically important species with greater fecundity, enabling greater larval dispersal and adult movement across boundaries, which could better compensate, or indeed enhance, adjacent fisheries (37, 40, 41). A buffer zone adjacent to the reserve, where less extractive fishing methods are allowed, would further enhance coastal resources (42). Such unilateral protection by WIR and elsewhere (43) may, however, increase tension with some local fishermen, who already perceive WIR as a reason for their reduced catches over the last few years; the reserve protects two beaches inhibiting their more extractive beach seining method (Svensson, Rodwell, and Attrill, submitted). In a survey conducted with fishermen from the nearby fishing village, Dam Mon, the majority of fishermen would, however, welcome more protected areas, but some suggest the hotel or government could help compensate for their loss of fishing grounds by providing support to develop lobster aquaculture (Svensson, Rodwell, and Attrill, submitted).

CONCLUSION

This research provides good evidence that, with effective protection, small HMMRs can increase fish stocks rapidly, matching, or in some cases surpassing, officially established MPAs of a similar size. This study does not offer conclusive evidence for the effectiveness of all HMMRs, or whether such small HMMRs can compensate for the loss of fishing area set aside for the reserve. There is, however, evidence of spillover from the similar sized Apo Island reserve in the Philippines (44) and fishermen statements in this study suggest spillover from WIB (Svensson, Rodwell, and Attrill, submitted). Certainly, results show the promise of such schemes. One HMMR may only make a difference very locally, but many hundreds to thousands of HMMRs lining coastal countries across the tropics could create a network of marine reserves that, some argue (45, 46), can have a cumulative positive effect on fish and coral growth by providing refuge at various distances for adult, larval, and propagule dispersal and settlement. Furthermore, hotels have the incentive, and often the resources, to lease and maintain adjacent coastal areas to sustain or enhance the environment for their benefit and that of their guests.

RECOMMENDATIONS

Initiation of HMMRs should be conducted with approval and commitment from local communities and have strong government support (Svensson, Rodwell, and Attrill, submitted) to avoid conflict and to ensure effective protection. Representatives of HMMRs must therefore educate and involve the local communities and explain the benefits of long-term no-take zones and perhaps provide certain incentives to compensate for their loss of fishing grounds, through jobs with the hotel or reserve, by financial means, and/or through alternative livelihood schemes. The owners of Alegre Beach Resort, Philippines, for instance, have realized the need of the communities for added support and are planning to develop and teach local communities mussel, seaweed, salt, and/or grouper farming (G. Sola, pers. comm.). If a larger area is set aside for protection, or other more demanding marine conservation projects are initiated, financial assistance in the form of user fees may be an option, which the owners of the HMMR in turn would have to justify to guests, thereby creating greater awareness for marine conservation and our natural heritage. In a willingness to pay survey at WIR, Svensson et al. (47) found that 97.5% tourists support HMMRs and 86.3% would be willing to pay extra to stay at HMMRs. Hotels may thus be in a strong position to help alleviate pressure on governments by providing a continuous source of funding to protect a portion of coastal resources, create awareness, and educate staff/communities and tourists alike.

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The perceptions of local fishermen towards a hotel managed marine reserve in Vietnam

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ABSTRACT

Marine Protected Areas (MPAs) often fail to meet ecological, social or economic objectives due to lack of effective management by government institutions. Partly in response to this failure, a number of marine reserves managed by the private sector, Hotel Managed Marine Reserves (HMMRs), have recently been established. In this study, we investigate changes to the social and economic conditions faced by local fishermen, following the establishment of two small reserves adjacent to a hotel in Vietnam, as well as their perceptions of the reserves' ability to produce spillover. The findings are used to gauge management performance and effectiveness of the HMMRs. Two surveys with different survey designs, targeting fishermen with different fishing techniques, produced conflicting results. Fishermen mainly dependent on beach seining mostly opposed the HMMRs and the prospect of more protected areas being established. Fishermen using other fishing techniques were generally in favor of the HMMRs, welcoming more protection and confirming spillover of fish, including large food fishes.

1. Introduction

Marine Protected Areas (MPAs) have been receiving increasing attention over the last decades as an effective management strategy for conservation and fisheries management [1–3]. They have the ability to significantly increase species richness, biomass and density of fish relatively quickly (1–3 years), independent of their size [4], and protect coral reef ecosystems from overexploitation [5], if sufficiently funded and effectively managed [6]. From a fisheries point of view, it is suggested that MPAs can protect a greater spawning stock and sedentary species, allowing fish to grow larger and live longer, greatly enhancing their fecundity. This increased fecundity can in turn provide new recruits to outside fishing areas and increase the density gradient of adult species from the reserve, allowing spillover to adjacent fishing grounds [7–9].

For local fishermen to benefit from the spillover of MPAs the size and spacing of MPAs have to be carefully designed and there needs to be compliance with the no-fishing rule. Several studies of tropical fish species provide evidence of relatively short larval dispersal distances, indicating that reserves can be relatively small but should have neighboring reserves relatively close by, to allow for protected resettlement [10–12]. Small reserves are, however, more vulnerable to poaching, so, in order for MPAs to effectively protect the coastal ecosystem, committed cooperation and support from local populations is essential [13].

In order to gain commitment and to prevent non-compliance from the local communities, a proposed method is to provide intensive education programs and involve local fishermen already at the planning stages of the MPA, to ensure that their inherent cultural precepts and socioeconomic needs are considered carefully. This will give them decision power, which will help convince them that reserve objectives are not only developed for conservation purposes, but also for long-term fishermen benefits [14,15]. This is not to say that patrolling and enforcement of reserve boundaries are not necessary. If the reserve is successful at significantly increasing abundance, this will provide strong incentives for poachers [16]. Many poaching incidences may, however, not be of criminal intent, but rather a misconception of where the boundary lies [17]. Nevertheless, to deter regular misdemeanors, it is necessary that the punishment for poaching outweighs the possible gains brought on by the fishing activity [18].

Community-based MPAs are, therefore, widely considered the most effective reef management strategy in the tropics [14]. Indigenous knowledge of ecological processes can help identify interconnectivity between habitats and find potential reserve sites that incorporate biodiversity and include the presence of vulnerable and exploitable species [19] – these potential sites would be discussed

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and a balance found which would benefit the environment and local stakeholders. Other parties involved in community-based MPAs may include the local government, Non-Government Organizations (NGOs) and the private sector. In these situations, the private sector, often represented by diving operations or hotels and resorts, are meant to supply funding and bring business to the area [20].

There has been an increase in the reported cases of hotels, in particular resorts offering diving holidays, which have taken the initiative to establish marine reserves with varying degrees of participation from other stakeholders [21,22]. Similar to privately managed parks on land, many of these privately managed MPAs, termed Hotel Managed Marine Reserves (HMMRs), have been established because of the government's inability to satisfy the public's and ecotourists' demands for nature conservation in both quantity and quality (only 14% effectively managed in a review of 285 MPAs in Southeast Asia [23]), in addition to creating a potentially profitable market niche for their business [22,24]. In these cases, HMMRs generally pay a lease or tax to the owning authority and close the area from fishing, generally by buoy markers. For example, the owner of Wakatobi Dive Resort, South-eastern Sulawesi, Indonesia, pays a leasing fee to the chiefs of affected communities for a strip of coastline covering 200 ha, designated a no-take sanctuary, as well as a 500 ha adjacent area reserved for traditional fishing practices. Representatives of the communities patrol the reserve with boats sponsored by the resort and ensure compliance with agreed extractive bans. If no-poaching takes place, the full amount of the agreed lease is paid out and the money is used to develop local infrastructure, build schools and other public buildings, in addition to providing for fishermen whose fishing grounds have been lost ([25], Lorenz Maeder, resort owner, pers. comm.).

In this study, the perceptions of local fishermen living adjacent to an HMMR in Vietnam have been obtained and assessed. These are the people most affected by established marine reserves. Their perceptions are therefore extremely important to gauge the effectiveness of the protection in meeting its ecological, economic and social objectives.

2. Study area

Whale Island Resort (WIR) is an HMMR, located on a small island, Hon Ong (approx. 100 ha), in Van Phong Bay, Khanh Hoa Province, south-central Vietnam, 80 km north of Nha Trang; (Fig. 1). There are 32 bamboo-built bungalows on the Island accommodating a maximum of 70 guests. The resort is eco-friendly, producing only a minimum amount of pollution from the ferry, transporting guests and supplies to and from the mainland, and from the dive boat, which operates on a daily basis. Waste water is recycled in a septic tank and used as irrigation water; inorganic waste is collected daily from the beach and rooms and burnt in a specially constructed high-heat furnace. The resort purchases the vast majority of food and drink from local vendors and employs around 45 local staff.

The resort was established in 1997 when the fishing population of the nearby village Dam Mon was relatively small. The resort owners, however, became increasingly concerned as the population grew and a notable decline in fish and coral populations became apparent. The decline was believed to be caused by overfishing and destructive fishing techniques, such as blast and cyanide fishing, and hose and hook fishing. This was compounded by rubbish dumping and pollution from an increasing number of fishing vessels in Dam Mon and nearby villages. The owners therefore took the initiative, outlining a plan to create a no-take marine reserve to the hotel staff, and asked them to discuss this suggestion with their fishing families. Since there were no complaints, they leased a larger area from the authorities of Khanh Hoa Province, which took the form of a 10-year contract, and included the coastal seas up to 600 m from the resort. The adjacent bay (<600 m) was enclosed with buoys in 2001 to mark the no-take zone, and an 11 ha HMMR (Whale Island Bay – WIB), was thus created. In 2005, a second bay was enclosed on the other side of the peninsula, creating a 5 ha marine reserve (Whale Island Bay Peninsula – WIBP; Fig. 1).

Four fishing villages are located in Lach Cua Be channel formed by Hon Lon Island and the Dam Mon Peninsula (Fig. 1), with Dam Mon being by far the largest and one of the closest villages to the

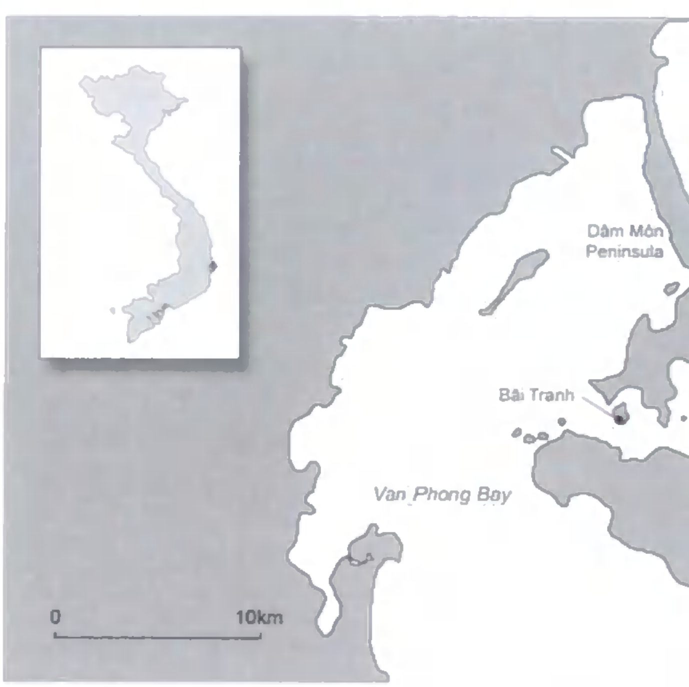

Fig. 1. Illustration of Whale Island (Hon Ong) showing: Whale Island Resort with the two adjacent marine reserves; the fishing village Dam Mon and Lach Cua Be Channel formed by Dam Mon Peninsula and Hon Lon Island; with the locations of nearby fishing villages, in Van Phong Bay, Khanh Hoa Province, Vietnam.

resort, accommodating approximately 300 families or 2000 people. Its fishing fleet comprises 50–60 vessels, which are all classed as near-shore fishing vessels, fishing within a maximum depth of 50 m [26]. Approximately half of these are large enough to venture outside the channel (10–15 NM). The small bamboo basket boats used for fishing close to home are not included in this estimate (Mr. Hung, Chairman of the People's Committee for Khanh Hoa Province, pers. comm.).

Although there were no initial arguments about creating WIB, it was not accepted by the fishermen of Dam Mon for the first couple of years, resulting in frequent poaching. On these occasions the local coast guard was contacted on a regular basis to deliver verbal warnings, or to confiscate fishing gear from regular poachers. Poaching gradually abated and today non-compliance is rare at WIB, while the frequency of fishermen "fishing the line" (fishing just outside the marked buoys) during the night is relatively high (2–3 times per week). The security guards, who also serve as reserve wardens during the night, patrol WIBP less frequently, since it is on the other side of the peninsula, away from the resort and, as a result, poaching occurs approximately every two weeks during the night. When fishing within the reserves, traditional line and hook fishing is generally used, but when "fishing the line", more extractive net fishing may be employed.

The number of fishermen nearly doubled in Vietnam between 1990 and 2004 from 270,600 to 550,000 and the domestic fishing fleet capacity has increased by factor 6.5 (with an average increase of 2300 small vessels (<45 hp) per year) [27,28]. The most common fished areas are near-shore areas (<50 m depth), constituting 82% of total national marine catch. Results from an assessment of marine fisheries resources in Vietnam showed that the maximum sustainable yield (582,212 tones/year) has been exceeded since 1986 [29]. Fisheries catch from 2008 was more than 2.1 million tones [30], indicating that most near-shore coastal regions of Vietnam are overexploited and fishing pressure is still increasing because of the annual increase of small fishing boats [28,31].

A number of factors have led to overexploitation of near-shore resources (Van Phong Bay included), such as mesh sizes under legal limits, high levels of by-catch and incidental catch of small/juvenile fish, harmful fishing gear such as fixed nets, destructive fishing techniques, and trawling, which has damaged the seabed [28]. Other fishing techniques used in Van Phong Bay, include purse seining, gill net fishing, beach seining, hook and line, cast-net fishing, trap fishing, as well as the illegal and destructive methods: bright light fishing (>2000 W), blast and cyanide fishing, hose and hook fishing and fishing with high volt electricity. The larger vessels fishing outside the channel are selective with their catch, targeting mainly tuna. Some of the smaller vessels target anchovy or squid at night using bright light fishing, but stay within the channel; the remainder is non-selective. Due to overexploitation, more and more fishermen are turning to lobster aquaculture. This is particularly the case during the northeast monsoon season from October to February when fishing is restricted by weather conditions.

3. Community surveys

Two sets of qualitative and quantitative, open and close-ended anonymous questionnaires were completed by the fishermen of Dam Mon in October 2006 and April 2007. In October 2006, 40 questionnaires (translated into Vietnamese) were given to the Chairman of the People's Committee to distribute to the local fishermen. When these questionnaires were returned, it was evident that several sets had been completed in unison with the family, providing near duplicate results. A relatively one-sided positive viewpoint pertaining to the benefit of increasing the local number of protected areas was also apparent. A follow-up, identical, interview-based survey was, therefore, conducted with the aid of two local marine biologists from the Institute of Oceanography in Nha Trang, who acted as translators. The idea was to check the authenticity of the results from the first survey and to examine data from a different angle to improve the legitimacy of the outcomes of the investigation. The interviews were conducted with another set of fishermen in April 2007, but singling out individuals in the village was near impossible, so instead, 10 random fishing families were interviewed at their homes while they were repairing their nets. 40–50 individuals were involved in this survey. Complication with singling out individuals is not surprising considering the traditional Vietnamese social structure, which can be broadly characterised by a closely knitted patriarchal extended family system, where family unity is extremely important [32].

Only fishermen from Dam Mon were surveyed since their village is one of the closest to WIR (1 NM), would be most affected by loss of fishing grounds and would therefore be able to give the most accurate interpretation of the ecology and management of the reserves. Fishermen from the other nearby fishing village (Son Dung; Fig. 1) predominantly fish within the Lach Cua Be channel, which is why these fishermen were not surveyed. Overall, the opinions of approximately 5% of the fishing village were represented.

In these semi-structured surveys, fishermen were requested to complete a demographics section detailing their age, sex and average yearly income; give their opinion of whether they consider the amount of fish to have increased, decreased, or stayed approximately the same in the last 10 years; identify the top 5 reasons why they think fish stocks have decreased, if so specified (11 options were suggested; other reasons could be added by respondent); state whether they think the coral reefs and fish need protection, while given the opportunity to suggest how; state which fishing techniques they use (11 methods suggested) and which species they target. They were then asked to explain why they think WIR had closed off the bay with buoys and to express whether WIR had had an overall positive, negative or inconsequential impact on their lives. Subsequently, they were asked whether the enclosures had had an impact on their lives financially (responding on a 5-point Likert scale from 1 '>20% increase/year' to 5 '>20% decrease/year'). Next, they were requested to comment on potential fishing gains incurred from the protection, by stating whether they consider the number of fish, size and diversity of fish to be from, 1 'much higher/bigger' to 5 'much lower/smaller', within 200 m of the reserve boundary, and to specify if an increase in a particular species had been noticed. The final set of questions enquired whether they themselves, or relatives, ever fish in the reserves (3-point Likert scale from 1 'Yes, often' to 3 'No, never') and, if so, why they fish there; how the number and diversity of fish, number of invertebrates and coral cover in the reserves compare to unprotected areas (responding on a 5-point Likert scale from 1 'much higher' to 5 'much lower'), and if they think it would be a 'good idea' or 'bad idea' if the hotel or government were to close off more coastal areas around Whale Island.

Since we used two different survey techniques, each with a small sample size, and comprising some near duplicate results, detailed statistical analysis was not possible. Instead, we provide qualitative and descriptive analysis, which give some indication of reserve effectiveness and management performance. These data are, however, exceptionally valuable in providing an insight into local communities' attitudes to MPAs and, in particular, to HMMRs, as such information is the first of its kind.

4. Results

The 40 respondents of the first survey represented a balanced mix of genders aged >18 to <65, the majority ranging from 18 to 35

(Table 1). The average fisherman's income totalled VND 9,990,000 per year, or approximately US$ 640 (Apr. 2007 exchange rate: US$ 1 = VND 15,600). Most of the lowest income earners were the older generations >55 and the one boy under 18, earning <VND 5 million per annum. The lowest income recorded was VND 2.5 million (US$ 160/year). The highest earners (max VND 60 million, or US$ 3846 per annum) were between 18 and 25, who target tuna outside the channel. The large group of middle-ranged income earners use a wide range of fishing techniques from hose and hook fishing and trap fishing to trawling. They target shrimps and little lobsters for use in aquaculture, anchovy, squid and Carangidae spp., inside and outside the channel, or indiscriminately any kind of fish, often through cast-net fishing or beach seining (Fig. 2).

The vast majority (95%) had noticed a decrease in the number of fish in the ocean in the last decade, the main reason being attributed to better fishing techniques. Blast fishing was accredited a close second, and overfishing, third place (Fig. 3). These findings coincide with the resort owners' conclusions as to why fish and coral populations had declined, and why they decided to protect their adjacent coastline.

All fishermen suggested coral reef ecosystems should be protected, specifically to protect from blast fishing and to increase the standing stock. They thought that protected zones should be strictly enforced and the local communities educated to understand the value of MPAs (Fig. 3). When asked why they thought WIR had enclosed the bays with buoys, all but two mentioned marine protection; instead these indicated that it was only to attract tourists. In fact, 29% of all fishermen from the first survey also suspected that a reason was to attract more tourists (Fig. 3).

The responses from the fishermen showed an overall positive attitude towards WIR, with 41% boasting an increase in their yearly income (Table 1). Those giving a reason for this suggested that they had secure jobs or could develop other projects related to tourism since the protection (Fig. 3). These fishermen are included in the 80% who fish within 200 m of the reserve and who have noticed an increase in the number, size and species richness of fish within this area, regardless of their fishing techniques. While the majority suggested that coral reef fish in general had increased within 200 m of the reserve, several fishermen also declared an increase in commercially valuable groups of large food fishes, e.g. Serranidae and Carangidae (Fig. 3).

Two fishermen declared a decrease in their yearly income, one of whom admitted to sometimes fishing inside the reserve (the only one to do so), but did not comment on which fishing techniques he uses or the state of the reserve compared with unprotected areas. The second fisherman thought that the size of fish and the species richness was greater within 200 m of the reserve, but explained that the fishermen now had to go further for fishing and expenses are increasing (Fig. 3).

Although only one fisherman admitted to fishing inside the reserves, 68% had an opinion on the number of fish and invertebrates, coral cover and species richness within the reserves compared with unprotected areas. All fishermen who commented on these attributes rated reserve species as being higher or much higher (Table 1). The fishermen were asked what could be done to improve compliance. Their suggestions varied from education and advertising the reserve, by announcements and showing reserve results, to stricter enforcements and more government involvement (Fig. 3). All

Table 1
Breakdown of Dam Mon fishermen's responses to the first questionnaire distributed by the Chairman of the People's Committee (%) and second interview-based questionnaire, expressed in number of families (US$ 1 = VND 15,600 – April 2007).

	Fishermen (%)	No. families		Fishermen (%)	No. families
Sex	*(n = 40)*		*Number of fish within 200 m?*	*(n = 30)*	
Female	52.5		Much higher	40.0	1
Male	47.5		Higher	60.0	
Age	*(n = 37)*		No change		1
<18	2.7		*Size of fish within 200 m?*	*(n = 30)*	
18–25	27.0		Much bigger	46.7	
26–35	29.7		Bigger	46.7	
36–45	18.9		No change	4.7	1
46–55	10.8		*Spp. richness within 200 m?*	*(n = 29)*	
56–65	5.4		Much higher	24.1	
>65	5.4		Higher	75.9	
Yearly income	*(n = 35)*		No change		1
≤5,000,000	22.9	2			
>5,000,000 ≤ 7,500,000	31.4	1			
>7,500,000 ≤ 10,000,000	20.0	2	*Fish inside bay?*	*(n = 36)*	
>10,000,000 ≤ 15,000,000	17.1	1	No, never	97.8	10
>15,000,000	8.6	1	Yes, sometimes	2.2	
No. fish in last decade?	*(n = 40)*		*Been inside buoys?*	*(n = 40)*	
Decreased	95.0	9	Yes	67.5	
No change	5.0	1	No	32.5	10
Do corals need protection?	(n 40)		*Species richness in HMMRs?*	*(n = 20)*	
Yes	100.0	6	Much higher	25.0	
No		3	Higher	75.0	
WIR changed life?	*(n = 39)*		*Number of fish in HMMRs?*	*(n = 26)*	
No change	61.5		Much higher	15.4	
Overall positive	38.5	1	Higher	84.6	
Overall negative		9			
Yearly income changed?	*(n = 39)*		*Number of invertebrates in HMMRs?*	*(n = 25)*	
No change	53.9		Much higher	12.0	
>20% Increase	35.9		Higher	88.0	
>10% Increase	5.1		*Coral cover in HMMRs?*	*(n = 25)*	
>20% Decrease	5.1	8	Much higher	12.0	
>10% Decrease		1	Higher	88.0	
Fish within 200 m?	*(n = 40)*		*Make more MPAs?*	*(n = 37)*	
Yes	80.0	2	Good idea	100.0	2
No	20.0	8	Bad idea		8

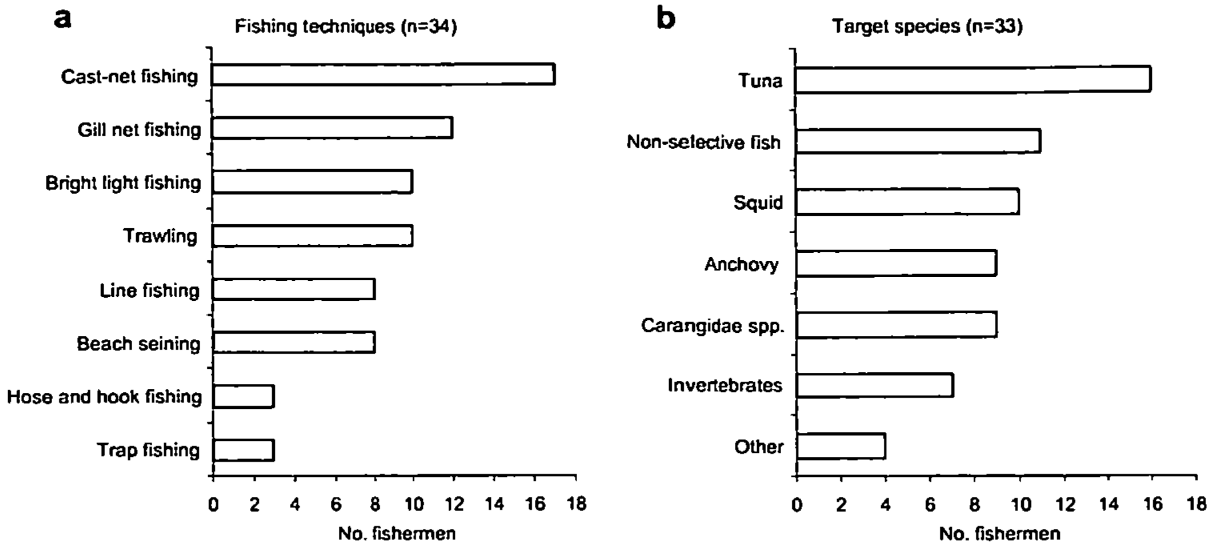

Fig. 2. The fishing techniques (a) and target species (b) of Dam Mon fishermen.

but three, who did not offer an opinion, thought that more reserves around the island would be better (Table 1); eight respondents even suggested protecting a coastal area fringing the whole island. Interestingly, the two who indicated a decrease in yearly salary also recommended more protection.

These eight respondents, however, belong to one of two larger sets of fishermen surveys, whose results were mostly identical, minus the demographics section, suggesting they could have completed the questionnaires in unison with the whole family. These eight have at least one boat large enough to go outside the channel to fish for tuna. Seven of them indicated that their income had increased by >20% because of the reserve, six of them suggesting it was because they had secure jobs. They all thought that coral reef fish abundances had increased within 200 m of the reserve and considered the reserve biota to be higher than unprotected areas, understanding the value of the protected zone. The other group of 7 with similar results, all replied identically to the question: what could the hotel or government do to increase compliance. All suggested more government involvement and for the hotel to announce reserve achievements. They fish for squid, anchovy and little lobsters and consider the reserves to be effectively increasing fish assemblages in and within 200 m of the reserve boundaries. Six of them thought it would be a good idea to increase the number of reserves around Whale Island and one had noticed a financial increase.

The responses of the interviewed families of fishermen differed greatly from those of the other fishermen. Their average yearly income, calculated from the total amount earned by the fishermen of the family, divided by the number of family fishermen, equalled VND 7,400,000 or US$ 474 (73.4% of the average income from the first survey). Most of these fishermen had noticed a decline in the number of fish, attributed to better fishing techniques and overfishing, but only 6 families thought that the coral reef ecosystem needed protection (Table 1). These fishermen, living on the outskirts of Dam Mon, fish with bright lights targeting anchovy (6 families) and squid (4 families); 8 families put equal effort into beach seining, which is non-selective.

Six families concluded that WIR had erected the fishing boundaries to protect the coral reef ecosystem or to increase fish stocks, but seven families figured it was also or only to attract tourists. Only one family thought the efforts of WIR had had a positive impact on them, and all who commented, stated a financial loss since the reserves were established (Table 1). They implied that they had to go further for fishing, which cuts into their profit margin.

Only 2 families fish within 200 m of the reserves, one reporting an increase in stocks; the other had not noticed any significant changes since the protection. All, however, clearly indicated that they do not fish inside the reserves because they are afraid of potential repercussions in the form of fines or gear/vessel confiscations. Several of these fishermen had bitter feelings towards the owners and the reserves and one fisherman thought that the owners had only restricted fishing in order to be able to catch fish for themselves and guests. Only 2 families thought that more protected areas around Whale Island would be a good idea (Table 1).

5. Discussion

It has been the strategy of some governments to relocate whole communities following the establishment of an MPA, to reduce pressure on resources and to increase income potential. Many countries do not have the capital or resources for such actions, however, and the ethical justification is questionable [13]. Community managed MPAs, where local communities can have a voice in reserve location and objectives, is in this sense fairer. When established hotels wish to enclose an area for the sake of conservation, and possibly to attract more tourists, the location is already generally decided: adjacent to the hotel. Therefore, community involvement and acquiescence is extremely important, especially when foreign ownership is concerned [24].

The owners of WIR asked the local staff to confer with their families, and feedback to them if they would have any objections for the bay adjacent to the hotel to be enclosed, and fishing to be prohibited. While all the respondents from the first survey and 6 fishing families from the second survey agreed that coral reefs needed protection, and 100% from the first survey and 2 families from the second, would welcome more protected areas around Whale Island (Table 1), it took a few years upon establishment of the first HMMR to increase compliance to the no-fishing rule to a level of perceived acceptable loss, where only occasionally, hook and line fishermen using bamboo basket boats, did not comply (Michel Galey, resort owner, pers. comm.). 42% of the fishermen

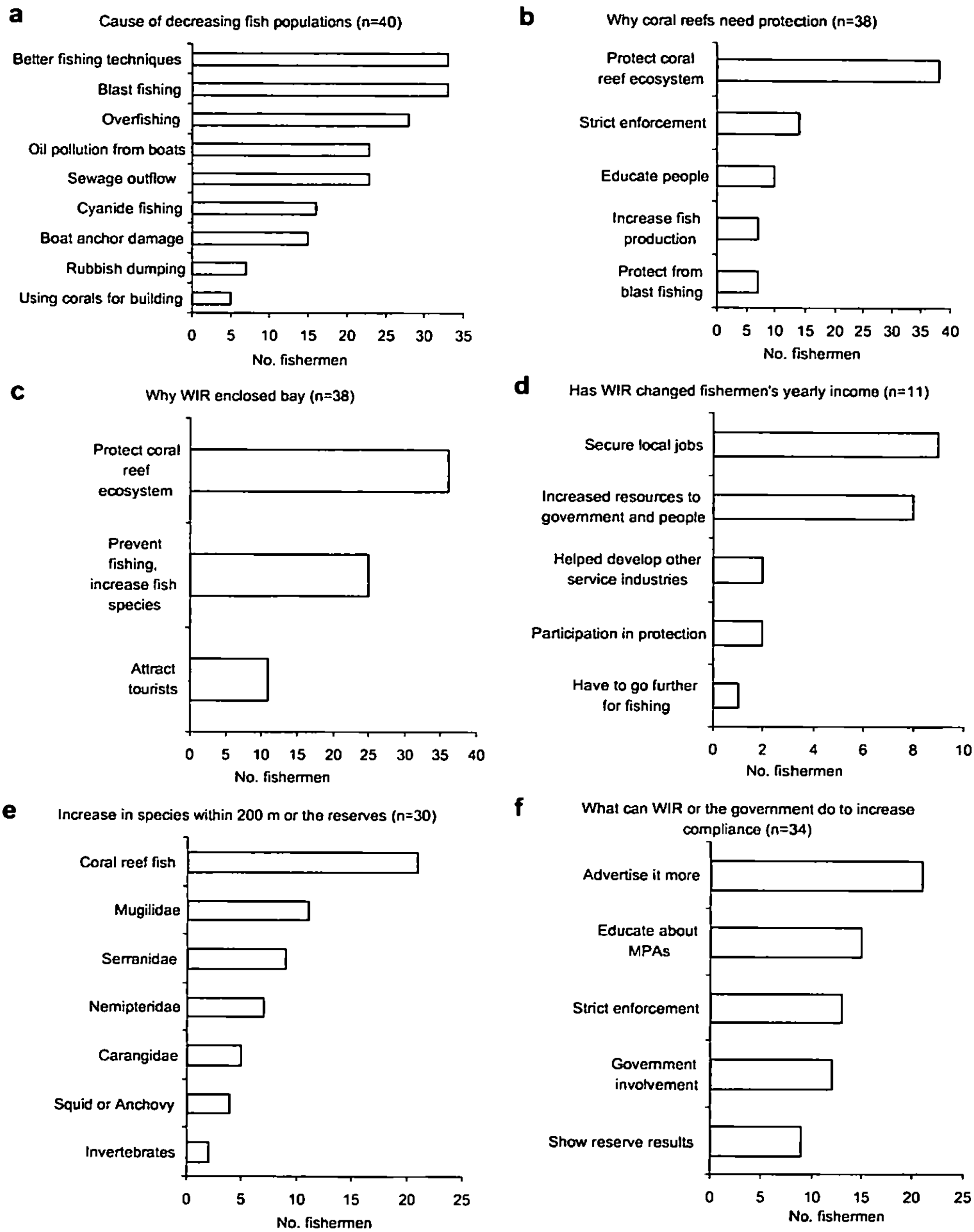

Fig. 3. Dam Mon fishermen's opinions on the cause of decreasing fish populations (a), why coral reefs need protection (b), why Whale Island Resort (WIR) enclosed the bay (c), reasons for a change in yearly income brought on by the establishment of the HMMRs (d), their perceptions of the fish species attributing to spillover (<200 m) (e) and suggestions what WIR and/or government could do to increase compliance (f).

from the first survey suggested that education programs should be established to make people better understand the value of marine reserves (Fig. 3).

Although 95% of fishermen from the first survey thought that WIR had established the reserves to protect the coral reef ecosystem or increase fish stocks, only 6 families from the second survey believed this, and 4 families thought it was purely for tourists' benefit. One family additionally commented that there had been no announcements from the hotel. In a survey conducted with owners of private reserves on land in Costa Rica, it was determined that a sense of conservation ethic was the most powerful motivating force to establishing private reserves, followed by profit [33]. The main concern for the owners of WIR, when the reserves were established was, and is, protecting the coral reef ecosystem, highlighted by the fact that they have not advertised the reserves to tourists. It seems, however, that a more widespread and direct announcement by the hotel when planning the reserves would have been preferred by local fishermen, in order to give them a sense of involvement and to manifest their position as stakeholders, where their opinions and concerns are taken into consideration. More government involvement, education and awareness programs concerning the benefits of marine reserves, as well as regular updates on reserve progress, would also have been appreciated after the reserve was established (Fig. 3). Such regular communications with the adjacent communities would have informed fishermen of the conservation efforts the hotel is undertaking, and provided the opportunity for open debate on how the hotel and local communities could work together to achieve mutual goals.

Fishers' lack of education and knowledge of marine reserves as a method of sustaining habitats and near-shore fisheries in the long-term has been recognized in areas of the Philippines [14]. Once an MPA has been designated, providing more information about regulations and scientific results has shown to increase local stakeholders' feeling of participation, significantly increasing compliance [31]. In a compliance analysis with fishermen in the Galapagos Marine Reserve, boat owners' perception of the legitimacy of regulations was a major influence for compliance [34], suggesting that the adherence to no-poaching regulations for an HMMR would be better accepted with a more notable presence of a respected body, such as the local government. Strict and well-controlled reserve boundaries were also recognized by several fishermen as a necessary action to increase compliance. Aswani et al. [15] interviewed fishermen from communities adjacent to reserves in the Solomon Islands and found that while good enforcement equalled less poaching, the perceptions of MPA effectiveness was also directly correlated with the level of enforcement. The costs of enforcement must, however, be lower than gains attributed to yields from unprotected areas due to spillover [16].

Today, poaching at WIB is very rare. This has led to reduced enforcement. There has not been a need to contact the coast guard in several years, so enforcement is now solely controlled by the security officers/night-time reserve wardens. It is generally sufficient to shine a bright light on fishing boats encroaching on reserve boundaries to deter them from any fishing activities. Sometimes, the quieter and more concealed bamboo basket boats may slip by, but then less extractive hook and line fishing is used. While these occurrences are relatively seldom, and the amount of fish caught is limited by their fishing technique, continued non-compliance could be quite harmful and should not be underestimated. Van Zweiten et al. [35] estimated that basket boat fishing could contribute to one quarter of the total catch of the inshore fishery in Nam Dinh province, Vietnam. However, biological surveys conducted from 2005 to 2007, researching the size of fish, fish density and species richness, still confirm significantly higher fish assemblages within the reserves compared to unprotected areas [21]. Spillover was not researched during these biological surveys, but according to the majority of the fishermen from both surveys who fish within 200 m of the reserve boundaries, the HMMRs are increasing the number, size or species richness of fish and providing spillover of, amongst others, large food fishes (e.g. Serranidae and Carangidae; Fig. 3).

When asked whether they had ever been inside the reserves, 68% of fishermen from the first survey indicated that they had. These suggested that the number of fish and invertebrates, species richness and coral cover was higher in the reserves compared to adjacent unprotected areas. Fishermen from the second survey strongly refuted that they ever cross reserve boundaries, being concerned of potential repercussions (Table 1). Although enforcement is now relatively weak, strong enforcement in the past by the local coast guard has ingrained in them knowledge that the expected loss from detection outweighs possible gains from poaching. This has been described as efficient enforcement [18]. While these fishing families therefore no longer fish within the reserves, a feeling of animosity towards the hotel has grown, which could perhaps have been avoided, had the hotel owners communicated better, described to the fishing community the potential long-term benefits of MPAs and involved local representatives in the decision making process from the start.

Only one fisherman from the first survey actually admitted to sometimes fishing in the reserves, which prompts the question how all the other 26 fishermen from the first survey can maintain that fish and coral assemblages are higher in the reserves compared with unprotected areas. Eight of these fishermen noted that they now have secure jobs, but it is not known whether these secured jobs are positions within WIR. The remainder did not comment, so it is unclear whether all the fishermen had a legitimate reason for knowing the status of coral and fish assemblages in the reserves, if they were just trying to be helpful by answering the question, rather than saying "don't know", or if they were not completely truthful when maintaining they do not fish there. It is understandable that even in anonymous surveys, people do not wish to implicate themselves or family in illegal activities. A more truthful and accurate answer may have been attained by changing the wording of the compliance question to "whether they know of *other* people who fish within the reserves", as was done by Cinner et al. [36] to assess the compliance of a closure at Ahus Island, Papua New Guinea.

Quite a large number of fishermen from the first survey stated that their yearly income had increased thanks to the hotel (41%) and over half of these suggested that it was because of secured jobs or other related service industries (Fig. 3). Members of these fishing families could have positions with the hotel, they could be delivering resources to the hotel, or they could have established other services credited to the increasing reputation of the hotel and the resulting tourism growth. They could also simply be better off now, due to a constant supply of spillover of fish from the reserves. Unfortunately, without more detailed comments, this is not possible to determine. All fishermen from the second survey claimed a decrease in income since reserve inauguration (Table 1). Half the fishing families commented, and these blame the hotel for their decreased catches, suggesting that the number of available fishing grounds have been stripped away from them. One family argued that, where they once had 5 beaches to fish by beach seining, they now only have 3. Since their fishing vessels are not large, their possible fishing grounds are limited in distance.

It has been suggested that larger marine reserves may be better for biological reasons, but that smaller no-take areas are generally better accepted by local communities as they do not significantly affect their socioeconomic welfare [37]. While theoretically true, local fishing techniques must be taken into account when establishing HMMRs. The loss of two beaches out of 5 seriously impinges on their ability to secure resources for survival.

Several families suggested that the hotel or government could give financial support to invest in lobster aquaculture, or better boats and equipment, in order for them to be able to extend their fishing area. At least six families out of both surveys partake in lobster farming. The hotel or government could provide financial aid to support lobster aquaculture, but consequences could be dire if additional funds are not invested in quality feed. Most fishermen currently provide trash fish, mixed with low value crustaceans, increasing the likelihood of infection. This results in copious amounts of antibiotics being used, which, in combination, could seriously increase nutrification and harm the environment, especially in areas of low water circulation [38].

Open access fishing has been depicted as a last resort for survival in times of economic crisis [39], but when overfishing has been the constant for a long time, even fishing may not be enough for survival. The bionomic equilibrium is reached when a sustainable human population is surpassed, inducing overfishing, and fishing efforts have reduced the fish population to a level at which catch rates are barely sufficient to cover the costs of fishing [18]. It seems that this equilibrium could be near, since 23% of the fishermen from the first survey and 2 fishing families earn less than the international poverty line of US$ 1 (VND 15,600) per day ([40]; Table 1). Half of these are, however, the very old or the very young, who will be taken care of in their large, closely knitted, extended families.

Unlike many developed countries, the families of developing countries are often quite large, often including the extended family that live and work together to support all members. For this reason, it was difficult to get individual fishermen responses to the surveys conducted and why it is quite probable that 15 responses from the first survey can be traced back to two families. For the second survey, it proved extremely difficult to interview one fisherman at a time, since everyone wanted to listen and hear what the white foreigner wanted in their small village. This is why the collective opinions of all members of the family (40–50 individuals) were taken into account. A possible method to improve the accuracy of the results of this study would involve questionnaires being distributed to each fisherman as they were returning with their catch, with translators on hand to aid the illiterates. This may have increased the number of individual responses and avoided respected family elders influencing younger family members' responses. In Vietnam, ancestor worship highly influences the culture and mentality of the people. Children are taught from a young age that they owe everything to their parents and ancestors [41]. As a result, younger generations have profound respect for their parents and elders, suggesting they may be more likely swayed by their opinions in their presence. This inevitably biases such family group results.

While 9 out of 10 families implied that WIR had had an overall negative effect on their lives, 39% from the first survey thought the opposite (Table 1). The reasons for these differences could be manifold. The beach seining fishing technique also used by several of the families interviewed decreases their potential to catch enough fish, since two of five beaches have been occupied by WIR. Also, as a result of this destructive, non-selective catch method, the hotel does not buy fish from them for guests. The opposite may also be true for fishermen from the first survey, since more of them have larger boats, enabling them to fish outside the channel, where they can target tuna and other larger predatory fish, which the hotel will more readily purchase (Fig. 2). These fishermen may consequently not be as dependent on near-shore fishing as the poorer fishermen from the second survey, suggesting they may not have had any difficulties with the local coast guard in the first years after the reserve was established, unlike some of the fishing families, who may therefore be harbouring ill feelings towards the hotel owners.

More positive and supporting responses from the fishermen of the first survey with regards to the HMMRs and the question whether they would welcome more reserves to the area may also have been influenced by the Chairman of the People's Committee. He may have distributed the questionnaires to friends or families he knew, perhaps even to people who work for, or who supply the hotel with their catch (potentially explaining the comments from some fishermen, explaining they have secure jobs: Fig. 3), or who may well be 'wealthier' families, owning larger vessels and who, are therefore, less near-shore dependent. He will perhaps also have told them what he knows about the hotel, its reserves and the research being conducted, which would greatly influence these fishermen's attitudes and responses.

In account of such uncertainty, it is important to bear in mind possible biases to certain responses from the first surveyed fishermen and/or to consider a misrepresentation of the opinions of the larger community. Albeit, the results do suggest positive attitudes towards the HMMRs and towards establishing more protected areas in a subgroup of the community, but without verifying the perceptions of a larger population, it may be too soon to confirm the effectiveness of HMMRs from a socioeconomic point of view.

6. Conclusion

The majority of the local fishermen have noticed a decrease in fish populations over the last decade. They recognize the need to protect coral reef ecosystems, especially in today's situation where better fishing techniques are available; population growth has led to overfishing, and where a remaining destructive minority still use blast fishing. A large proportion of fishermen have detected spillover of fish from the reserve, including commercially valuable groups of large food fishes; and previous biological surveys confirm significantly higher fish stocks within the protection [21]. Moreover, in a survey conducted with 211 WIR guests, Svensson et al. [22] found that 97.5% support HMMRs and 86.3% would be willing to pay extra to stay at such hotels. These findings suggest that this HMMR has achieved its ecological objectives and has the guests' support. A follow-up study to confirm fishers' perceptions of spillover, however, would be prudent, since currently, the social and economic benefits to local fishermen are ambivalent, and depend mainly on the target fishery. More direct and widespread communication, involvement, education and financial support from the hotel could make this HMMR truly effectively managed. By paying greater attention to developing and maintaining a mutualistic relationship with affected communities, HMMRs could realize a great potential as an added alternative to traditionally managed MPAs, especially if the government would show a greater presence by aiding in surveillance, monitoring and developing appropriate management and policy frameworks, thereby confirming the legitimacy of the HMMRs and substantiating its support for them as an important marine conservation tool. A network of hundreds to thousands of such HMMRs lining coastal tropical countries could have a cumulative positive effect on fish and coral growth by providing refugia at various distances for adult, larval and propagule dispersal and settlement [42,43].

These community surveys provide first indications of the strengths and weaknesses of the management of an HMMR. However, an individual, singular, interview-based survey design, involving a larger sample size would give an improved understanding of the management effectiveness of the HMMR. Future studies of this kind could be used to help gauge management performance and reserve effectiveness for a vast number of community and government managed MPAs worldwide.

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