

A private management approach to coral reef conservation in Sabah, Malaysia

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Received: 12 February 2007 / Accepted: 23 October 2007
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Abstract Many marine protected areas (MPAs), particularly in developing countries, have failed because of a lack of enforcement and monitoring due to limited public funds for conservation. Private investment and management in MPAs offers a potential solution, and has been applied with initial positive results at the Sugud Islands Marine Conservation Area (SIMCA) in Sabah, Malaysia. Conservation fees charged to visitors to Lankayan Island Dive Resort within the SIMCA have generated a sustainable source of financing to meet the majority of management costs for the conservation area, which is separately managed by a private organization called Reef Guardian. The availability of adequate funds has enabled Reef Guardian to invest in personnel training and surveillance technology to enforce the rules and regulations of the conservation area. In collaboration with government enforcement agencies, Reef Guardian has reduced threats such as illegal fishing and turtle egg poaching. As a result, there is a comparatively high abundance of commercially important fish, and turtle nestings at Lankayan Island have increased. Private management can be effective in conserving biodiversity in MPAs, and may well succeed regionally in suitable locations.

Keywords Coral reefs · Enforcement · Malaysia · Marine protected area · Private management · Sugud Islands Marine Conservation Area · Sabah

Introduction

Coral reefs in Southeast Asia are increasingly threatened by overfishing, coastal development, and climate change (Burke et al. 2002). It is suggested that more than half of the

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world's coral reefs may be lost in the next 30 years if current degradation continues unabated (Wilkinson 2000). The loss of coral reefs in Southeast Asia, which accounts for 32% of coral reefs globally, is devastating for the region's marine biodiversity, which is among the richest in the world (Allen and Werner 2002). Marine protected areas (MPAs) are increasingly being used for conservation purposes, especially in Southeast Asia, where in 2002 there were over 630 declared and 185 proposed MPAs (Tun et al. 2004). Yet, many MPAs are not successful in protecting marine life, a failure which can often be traced to a lack of adequate financing and poor regulatory enforcement (Lundquist and Granek 2005). In this paper we examine private management as a means of overcoming management failure in MPAs, using the Sugud Islands Marine Conservation Area (SIMCA) in north Sabah, Malaysia as our case study. We will discuss the advantages and shortcomings of private management in operating a MPA to meet marine conservation objectives.

Background

Marine protected areas

The World Conservation Union (IUCN) defines six types of MPAs according to their objectives, which range from scientific research, ecosystem protection and recreation, to sustainable use of natural ecosystems. Clearly stated MPA objectives are necessary as they determine how the MPA will be managed and monitored for success in the future. For example, strict no-take MPAs exclude all types of resource extraction (e.g. Tubbataha Reef National Marine Park), while multiple use MPAs such as Bunaken National Marine Park or the Great Barrier Reef Marine Park accommodate no-take areas as well as fishing and recreation zones.

The number of proposed or newly designated MPAs has been increasing in developing countries (McClanahan 1999). Over the past decade, approximately 40 new MPAs that include coral reefs have been created worldwide (Mora et al. 2006). However, many MPAs are not well managed, especially in the Indo-Pacific, where coral and marine diversity is the highest. Forty-six percent of declared MPAs in Southeast Asia have little to no management, and only 10–20% can be considered to be effectively managed (Tun et al. 2004). A major factor behind this poor record is insufficient long term funding, which often hampers enforcement and surveillance capacity (Evans and Russ 2004; Lundquist and Granek 2005).

Even effectively managed MPAs that achieve conservation targets may be hindered if they do not address social issues. MPAs, especially those with communities living within the protected area, have to be consistent with the goals and interests of local residents in order to achieve overall success (Mascia et al. 2003; Christie 2004). This may be achieved by engaging local communities or stakeholders in participatory management and by fairly managing user access to MPA resources (Mascia et al. 2003).

Enforcement in MPAs

User compliance with protected area regulations is crucial for the success of MPAs (Alder et al. 2002). Enforcement of MPA regulations can contribute to ecological benefits (Walmsley and White 2003; Maliao et al. 2004), while low levels of surveillance and enforcement can potentially lead to undermining the integrity of the protected area (Gribble and Robertson 1998). In parts of Southeast Asia, community based enforcement, which relies on volunteers and minimum investment in enforcement tools, is applied. However,

personal conflicts over the sharing of responsibility have led to the breakdown of some community enforced marine reserves (Christie 2004).

In comparison, well funded MPAs are able to invest in surveillance technology that boosts enforcement capabilities. For example, in 2000 the Great Barrier Reef Authority spent one-third of its annual budget (approximately AU\$ 2.8 million) on enforcement alone (MPA News 2000). Attaining a source of reliable, long term financing to support enforcement operations is therefore a key to the success of MPAs (McClanahan 1999).

Education plays an important role in improving compliance behaviour by raising awareness and encouraging user acceptance (Sutinen and Kuperan 1999). In some MPAs education has led to higher user compliance (Alder 1999; Causey 2002). However, not all users respond to education, in which case conventional deterrence is used (Causey 2002). It is also not conclusive whether education is more cost effective than enforcement programmes (Alder 1996). Both strategies thus have their own place in encouraging MPA compliance, and complement each other when implemented simultaneously.

Funding MPAs

Even though costs for managing MPAs are high (MPA News 2003), public funding for protected areas in many countries is declining (World Commission on Protected Areas 2000), particularly in developing countries where other public services often have priority in the state or national budget (Kelleher 1999). The lack of sustainable financing results in many 'paper parks' (McClanahan 1999; Lundquist and Granek 2005). Donor funding is an alternative, but these are usually provided only on a short term basis (McClanahan 1999), and do not provide the critical long term funds necessary to support the protected area's ongoing operations (Depondt and Green 2006; Subade 2007). In fact, in a worldwide survey of MPAs, only 16% of respondents reported that current levels of funding were adequate for effective conservation (Balmford et al. 2004). Other financing options therefore have to be explored.

Private investment in MPAs is an alternative to traditional sources of funding which government agencies and donor dependent organizations rely on. Having control of their own income stream allows private organizations more flexibility in managing the MPA, and also enables them to channel more time and effort to conservation duties, as fund raising is not usually a major component of operations. In addition, private sector stakeholders usually have monetary incentives to protect the integrity of their environmental resources, so they tend to be more motivated and adept than governments at handling the economics of running a protected area (Riedmiller 1999; Wilkinson et al. 2006).

Private sector involvement in protected areas

The private sector [for profit and non-profit companies, non-governmental organizations (NGOs), communities or individuals] can participate in protected area management in several ways. The establishment of private terrestrial sanctuaries is fairly extensive in parts of east and southern Africa, where they make a significant contribution to biodiversity conservation (Watkins et al. 1996). Alternatively, private entities may buy or lease areas of special biodiversity value with the intent of managing it for conservation purposes. This strategy has been used by NGOs internationally to buy and protect a variety of unique habitats (The Nature Conservancy, <http://www.nature.org/pressroom/press/press1126.html>. Cited 15 August 2007).

There are a variety of management approaches for MPAs, including government funded and managed parks like the Great Barrier Reef Marine Park, or community managed MPAs

like those found in the Philippines. Collaborative management involves governments appointing an entity to take partial or complete responsibility for managing a MPA. The Tubataha Reef Marine Park and Bunaken National Marine Park are examples of such an approach. Alternatively, governments may contract out the day to day management of a MPA to a private body. For example, the right to manage Chumbe Island Coral Park (CICP) in Tanzania is granted to a private entity through a series of agreements with local governments. Successful private management of the CICP has made its coral reefs one of the best in East Africa (Riedmiller 1999). Private stewardship can thus be beneficial for coral reef ecosystems (Colwell 1999), and this is the form of management that we will focus on in this paper.

Marine park management in Sabah

The state government of Sabah has jurisdiction over coastal waters as well as terrestrial portions of marine parks (marine park and MPA are synonymous in this paper). The four state marine parks in Sabah are managed under the jurisdiction of Sabah Parks, a unit within the Ministry of Tourism, Culture and Environment. Revenue for park management is generated by charging a conservation fee of RM 5 (around US\$ 1.40)¹ to all park visitors, as well as from revenues generated from the sales and services of private companies operating in marine parks. Park fees collected by Sabah Parks are deposited in a Parks Fund that is managed by the Sabah Parks Board of Trustees. In contrast to some other national and state parks in Malaysia where park fees are directed to the state government for discretionary use (Ministry of Natural Resources and the Environment 2006), money in this fund goes directly to the Parks Fund for financing park conservation and operational activities.

The Malaysian marine police are responsible for enforcing the ban on destructive fishing methods such as the use of dynamite, which is illegal under the Malaysian Fisheries Act. However, lack of funds and personnel has hampered enforcement (and hence the success) of marine parks in parts of Sabah (Pilcher and Cabanban 2000). Consequently, illegal fishing using dynamite and cyanide remains common throughout Sabah.

Study site

The SIMCA is located about 80 km northwest of the mainland town of Sandakan in north-eastern Sabah, Malaysia. It covers an area of approximately 467 km² in the Sulu Sea, and includes the three islands of Lankayan, Billean, and Tegapil (Fig. 1). SIMCA was officially established in 2001 as a Category II conservation area under the IUCN Protected Area Management Category. This classification designates that the area is protected and managed specifically to preserve natural conditions and to provide for recreation opportunities; therefore no fishing or any other extractive activities are allowed.

SIMCA is situated in the Coral Triangle, which is the epicenter of marine biodiversity (Allen and Werner 2002). More than 400 species of fish and 200 species of coral have been recorded, and SIMCA's islands are also frequented nesting grounds for endangered green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles.

The islands of SIMCA are remote and far from populated towns. No island communities exist in the vicinity of SIMCA, and the surrounding waters are not known to be traditional fishing grounds. However, the SIMCA area is frequented by fishers from Sandakan, Kudat,

¹ All currency conversions to US dollars are based on August 2007 exchange rate of US\$ 1 = RM 3.5.

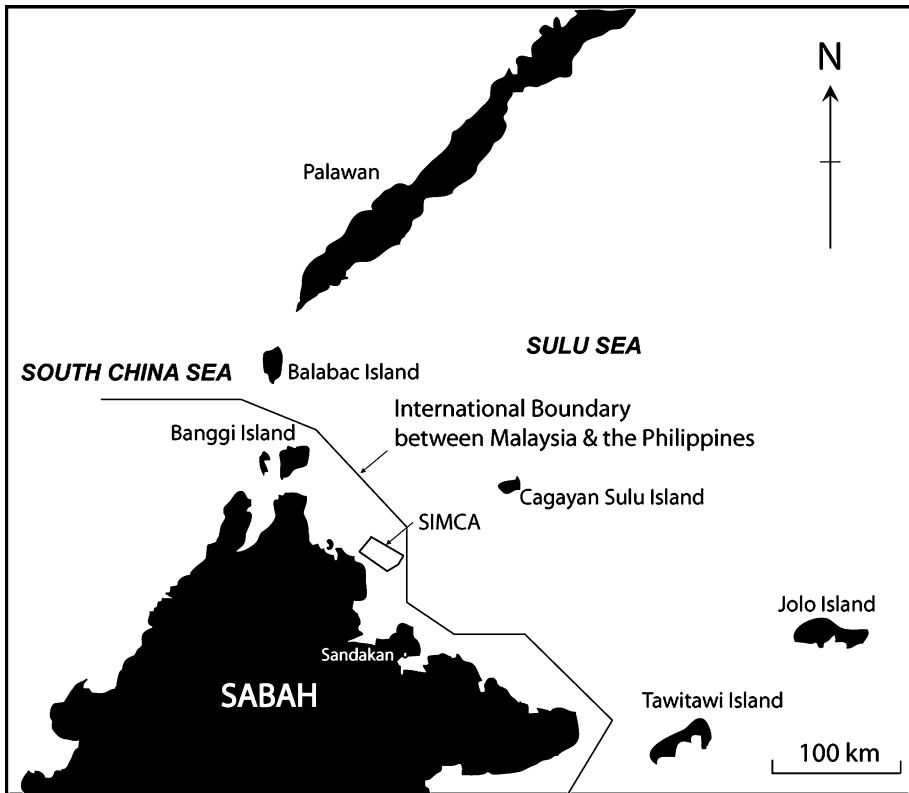


Fig. 1 Map of Sabah, showing SIMCA off the northeastern coast

and the Philippines. The area is fished by artisanal and commercial fishers, the latter including small or medium net and trawling vessels. Artisanal fishers use hook and line, gillnet, spear, and traps, as well as destructive methods like explosives and cyanide. Before the creation of SIMCA, blast fishing was a constant problem, and turtle eggs were poached on a regular basis (H.I. bin Samain, pers comm. 2006). Blast fishing continues to occur in the vicinity of SIMCA.

Lankayan Island is the only developed island within SIMCA. The 0.05 km² island is the site of the Lankayan Island Dive Resort (LIDR), which is the only structure on the otherwise uninhabited island. Lankayan is renowned for its diverse marine life and attracts mainly dive tourists. Prior to the development of the resort, a single fishing family resided on Lankayan. This family was consulted and subsequently approved of the development of LIDR, and later, of SIMCA.

Private sector management of SIMCA

Creation of a privately managed MPA

The formation of SIMCA was initiated by owners of the LIDR as a means of controlling illegal and destructive fishing in the vicinity of Lankayan Island, and for protecting the

environmental integrity of the island. Prior to the gazettelement of SIMCA, LIDR staff used to informally protect the island's reefs. Fishing vessels that approached too closely to dive sites and that were suspected of using illegal fishing techniques were approached by a team of LIDR staff and told to leave.

In 2001, SIMCA was declared under the provisions of the Sabah Wildlife Conservation Enactment 1997. In May 2003, Reef Guardian was officially appointed as the management company responsible for conservation activities within SIMCA, to be undertaken in collaboration with the Sabah Wildlife Department (SWD). The SWD is involved only in enforcement operations: SWD staff train and certify Reef Guardian staff as Honorary Wildlife Wardens, and occasionally participate in sea patrols to enforce SIMCA boundaries. The SWD does not contribute financially to Reef Guardian, nor does Reef Guardian fund any aspect of SWD's activities. Both parties maintain dialogue through meetings and special workshops.

Reef Guardian: organizational structure and operating resources

Reef Guardian is a private, non-profit company that is wholly owned by a Director of Pulau Sipadan Resort, which is the parent company of Lankayan Island Dive Resort, a multi-sector business operator that is also the parent company of LIDR. The two operations are independent of each other, thereby enabling Reef Guardian to focus solely on managing SIMCA. It contrasts with typical resort stewardship where conservation activities normally fall within resort operations.

Reef Guardian leases the islands of Lankayan, Billean, and Tegapil from the SWD for a period of 30 years for a fee of RM 60,000 (US\$ 17,200) per year. Reef Guardian generates revenue by charging a conservation fee of RM 20 (US\$ 5.70) per visitor per night. This fee is used entirely to fund Reef Guardian's management and conservation programmes. As well, LIDR subleases Lankayan Island from Reef Guardian for RM 35,000 (US\$10,000) annually. Additionally, Reef Guardian received an 18-month conservation grant worth US\$20,000 in 2006.

Annual operating costs for Reef Guardian's conservation work in SIMCA averaged RM350,000 (US\$ 100,600) from 2004 to 2006. In 2006 the cost of running SIMCA was US\$ 3.00 per ha, compared to a median of US\$ 7.80 per ha in 83 sampled MPAs throughout the world (Balmford et al. 2004). The largest component of expenditures was for salaries and professional fees, followed by depreciation and direct operation costs (e.g. petrol, research materials, equipment maintenance) (Fig. 2).

In 2004, the first year of operation, Reef Guardian collected RM 94,280 (US\$ 26,900) in conservation and user fees, while operation costs were RM 135,000 (US\$ 38,570) (Lee 2005). Conservation and user fees thus covered 70% of Reef Guardian's costs. In 2006, SIMCA generated revenues of US\$ 1.47 per ha, which is higher than several other more established MPAs in the region (Table 1). Revenues were enough to cover 50% of costs, with conservation and user fees covering about 35% and lease income covering 15% of costs. Additional funds to balance expenses are subsidized annually by private investors, which include the owners of LIDR.

Reef Guardian: staff and conservation activities

Reef Guardian is responsible for monitoring and enforcing regulations, and promoting best practices in each of its three main areas of activities: marine conservation, environmental conservation, and MPA enforcement. The Reef Guardian team of ten staff is stationed permanently on Lankayan Island and is led by a marine biologist. Team members are trained

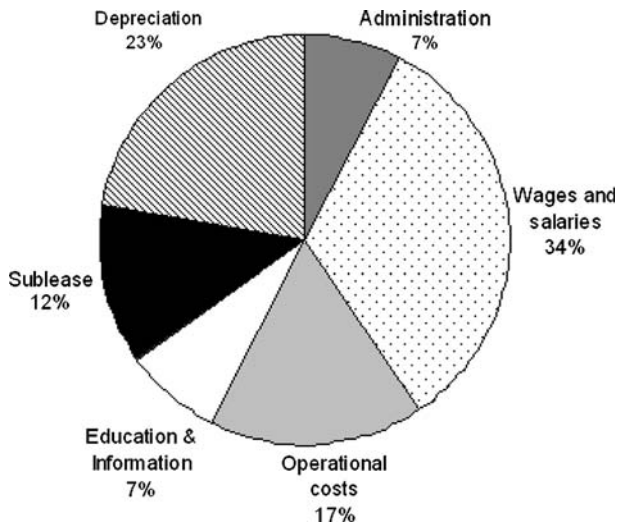


Fig. 2 Breakdown of 2006 SIMCA management expenditures

Table 1 Comparison of SIMCA revenues and costs (reporting year) with other Marine Parks (MPs)

MPA	Revenue per hectare (US\$/ha)	Cost per hectare (US\$/ha)	% cost covered by revenue
SIMCA (2006) ^a	1.47	3.00	50
Tubbataha Reef National MP (2004) ^b	1.16	3.80	31
Great Barrier Reef MP (2006) ^c	0.94	0.95	100
Bunaken National MP (2002) ^d	1.24	1.38	100

^a Source: Reef Guardian Annual Financial Report 2006

^b Source: Subade (2007)

^c Source: Great Barrier Reef Marine Park Authority Annual Financial Report 2006

^d Source: The North Sulawesi Watersports Association. Available at http://www.divenorthsulawesi.com/nrm_news15.html. Cited 12 Aug 2007

for undertaking multiple tasks. The marine biologist designs and implements scientific research and monitoring programmes, is responsible for staff administration, and scientific and public communications. Other staff include: (1) enforcement officers, who carry out sea patrols of SIMCA boundaries. Currently, four staff are certified Honorary Wildlife Wardens who are trained in enforcement and chain of custody procedures, and wildlife and endangered species management. They are granted powers of inspection, search, seizure, and arrest by the SWD; (2) environment officers, who carry out water quality sampling twice a week and maintain the hydroponics treatment system; (3) radar operators, who man the radar surveillance system; (4) research and monitoring team members, who carry out underwater visual surveys of fish, invertebrate, and coral abundance, and Crown-of-thorns starfish removals; (5) turtle patrol officers, who patrol Lankayan island nightly for turtle nestings, transfer turtle eggs to the hatchery, and control tourist activity during nesting and hatchling release.

In the following section we describe various programmes Reef Guardian has implemented and some preliminary monitoring results from these programmes. The success of

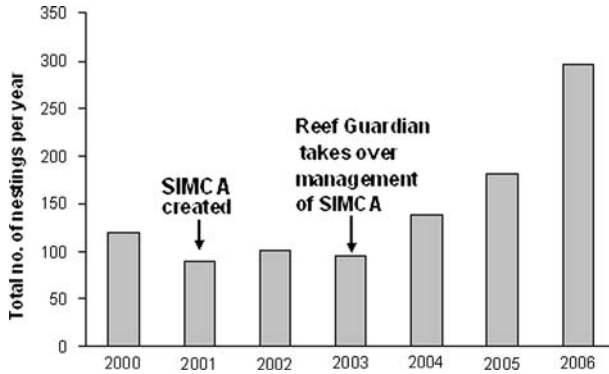


Fig. 3 Annual sea turtle nestings on Lankayan Island for 2000–2006

these programmes is measured by the extent to which they fulfill Reef Guardian's management objective of ecosystem protection. The criteria for success in each programme which we will present are: (a) Marine conservation programme: (1) the number of turtle nestings increases; (2) turtle egg survivorship improves; (3) abundance of monitored fish species improves; (4) coral cover improves; and (5) reef sites are free of Crown-of-thorns. (b) Environmental conservation programme: (1) the concentration of nitrates and phosphates in discharged wastewater is maintained at a level within the range of Malaysia's interim water quality standards. (c) MPA enforcement programme: (1) decrease in fishing pressure within SIMCA; and (2) reduction in the number of repeat offenders.

Marine conservation

The marine conservation programme includes turtle conservation, marine biological assessments, and Crown-of-thorns starfish (*Acanthaster planci*) monitoring and clean-ups. Reef Guardian staff conduct nightly turtle patrols to detect nesting females, and remove newly laid turtle eggs to an on-site hatchery where they are incubated until hatching. Reef Guardian staff started conducting underwater visual censuses of fish, invertebrates, and coral cover at six sites in 2006. The line intersect transect method (English et al. 1997) is used to survey the abundance of indicator fish species such as groupers, snappers, fusiliers, angel-fish and butterflyfish. Coral cover and benthic life are recorded along a 20 m transect and 2.5 m to either side of the transect.

Since Reef Guardian took over LIDR's turtle monitoring duties in 2004, the total number of recorded nestings for both green and hawksbill turtles has increased steadily (Fig. 3). Consequently, the programme has released progressively more hatchlings, increasing from 5,121 hatchlings in 2004, to 11,667 in 2005, and 20,403 in 2006. The mean number of annual turtle nestings was higher after Reef Guardian assumed management of SIMCA [205 ± 82 (SD) vs. 101 ± 13 (SD)], although the increase was not significant (Student's *t*-test, $t = 2.18$, $p = 0.157$, not significant).

Diversity and abundance of commercially important fish within SIMCA is high: a scientific study showed that a total of 21 grouper species was found in Lankayan's reefs, with a maximum of nine species at one site alone. There was at least one grouper larger than 30 cm per 100 m² recorded at each fish transect, and only three out of 44 surveyed sites lacked the indicator fish species that characterize a healthy reef fish community (Lee 2005).

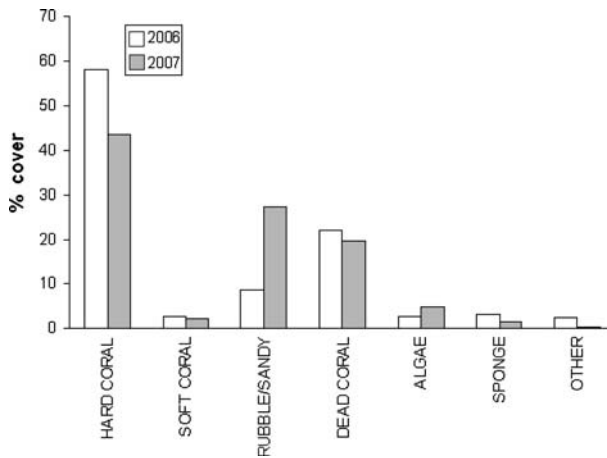
Table 2 Comparison of fish abundance in no-take MPAs according to management type

MPA	Management	Survey year	Year established	Fish abundance (Mean no. of individuals/250 m ²)				
				Groupers	Snapper	Butterflyfish	Angelfish	Fusilier
SIMCA ^a	Private	2007	2001	8.9	62.9	8.8	3.9	172.9
Tubbataha ^b	Collaborative	2000	1988	8.5	5.5	22.0	16.1	29.0
Pulau Payar ^c	Government	2002	1985	10.4	6.6	27.7	2.4	162.9

^a Reef Guardian unpublished data

^b Tubbataha Reef National Marine Park, Philippines. Source: White and Ovenden (undated). Note: original data presented as density per 500 m²

^c Pulau Payar Marine Park, Malaysia. Source: Andersson (2002). Note: original data presented as total fish abundance at all survey sites

**Fig. 4** Average percentage substrate cover across sites for 2006 and 2007

The mean abundance of commercially important groupers and snappers is comparable to that recorded in MPAs under government and collaborative management (Table 2). Furthermore, the mean abundance of groupers in SIMCA is significantly higher than that recorded at Pulau Banggi (1.9 groupers per 250 m², Tanzil and Chou 2004), an actively fished coral reef area in north Sabah (Student's *t*-test, $t = -5.15$, $df = 35$, $p < 0.001$).

Percentage of dead coral cover decreased slightly from 22% in 2006 to 20% in 2007 (Fig. 4). However, hard coral cover also decreased from 58% in 2006 to 48% in 2007, while the proportion of algae and rubble/sand increased (Fig. 4). When compared to MPAs under different management approaches, SIMCA has higher hard coral cover, but also higher dead coral cover (Table 3).

Reef Guardian initiated a Crown-of-thorns starfish clean-up programme in 2005, and collected and disposed of a total of 13,752 starfish that year. Reef Guardian staff now conduct monthly Crown-of-thorns removal operations at infested reefs, and Crown-of-thorns population and size composition are carefully monitored to control the spread of these coral eating predators.

Table 3 Comparison of substrate cover in no-take MPAs according to management type

MPA	Management	Survey year	Year established	Substrate cover (%)			
				Hard coral	Dead coral	Abiotic	Other ^d
SIMCA ^a	Private	2007	2001	41.8	19.9	30.9	7.4
Tubbataha ^b	Collaborative	2000	1988	25.9	11.9	58.8	3.5
Pulau Payar ^c	Government	2005	1985	23.0	0.8	41.2	34.8

^a Reef Guardian unpublished data

^b Tubbataha Reef National Marine Park, Philippines. Source: White and Ovenden (undated). Note: data presented are an average of deep and shallow transects

^c Pulau Payar Marine Park, Malaysia. Source: Comley et al. (2005). Note: data presented are averaged across five survey sites

^d Other substrate includes soft coral and algae

Table 4 Nitrate (NO₃-N) and phosphate (PO₄) concentrations (mg L⁻¹) from Reef Guardian's hydroponics treatment system

Sampling date	NO ₃ -N	PO ₄
May 2005	0.07	0.06
October 2005	0.21	0.1
April 2006	0.15	0.06
September 2006	0.05	n/a

Environmental conservation

Environmental conservation consists of water quality monitoring, monitoring of a hydroponics waste treatment system, and beach clean-ups. Reef Guardian staff conduct weekly water quality testing around Lankayan, Billean, and Tegapil Islands, during which they record and monitor salinity, temperature, pH, conductivity, and vertical visibility.

All grey and black water from LIDR used to be held in a septic tank before being discharged into the surrounding jungle. In 2004, a hydroponics treatment system to treat waste water was installed on the island. This system uses biological filtration to convert ammonia from sewage discharge to nitrate, which is then taken up by hydroponics plants. Discharge from the hydroponics is channeled to a collection tank that is about 10 m below ground, and located at the edge of the jungle. At this point, effluent continues to be filtered through the sand and utilized by the surrounding vegetation. Reef Guardian monitors the system regularly to assess pH and nutrient (nitrate and phosphate) content of discharged wastewater. Nitrate and phosphate concentration levels are consistently within the limits adopted by the interim national water quality standards for Malaysia, set at 5–7 mg L⁻¹ for nitrate and 0.1–0.2 mg L⁻¹ for phosphate (Table 4).

Reef Guardian mitigates excessive impacts on the marine environment by regulating the maximum allowable number of guests, set at 60 per day, to LIDR, and also by regularly clearing the beach of washed up garbage and debris. Reef Guardian's environmental protection performance is evaluated by a bi-annual environmental compliance assessment. An environmental consulting firm evaluates waste management, water quality, and general terrestrial development within SIMCA according to standards of the national Environmental Protection Department.

MPA enforcement

Reef Guardian's MPA enforcement team carries out sea patrols to control the intrusion of fishing vessels in SIMCA. Sea patrols are carried out by four to five enforcement officers, at least two of which are Honorary Wildlife Wardens. Sea patrols occur both during the day and night and are supported by a land based team that monitors boat traffic across SIMCA using a radar tracking system. The radar system is manned between 8 and 3 am daily, weather permitting (rain and cloud cover disrupt the radar system), and the number of boats detected within SIMCA is recorded on a half hour basis. Patrols are not carried out according to a predictable schedule, but rather on a responsive basis, as and when needed (i.e. when the radar detects a high volume of suspected fishing vessels). The enforcement team is equipped with two high speed motorboats with navigation and communication devices. Reef Guardian implemented its sea patrol enforcement programme in 2004, while radar monitoring commenced in September 2005.

Fishing vessels found within SIMCA boundaries are stopped by the Honorary Wildlife Wardens, who board the vessel to inspect catches and record the boat registration number and crew's identities. Reef Guardian enforcement officers are not armed² and do not employ heavy handed deterrence techniques; rather, Reef Guardian carries out a 'fisher interpretive programme', whereby first time offenders are informed about SIMCA's boundaries and given a pamphlet with details of the conservation area's objectives and regulations. No resistance or violence has been encountered during sea patrols. Vessels found fishing within SIMCA are issued three warnings, after which Reef Guardian can legally detain the boat and crew, then escort them to marine police headquarters at Sandakan.

Reef Guardian's enforcement team stopped an average of 3.7 illegal fishing vessels per patrol in 2004. This decreased to an average of 1.9, 1.3, and 0.9 in 2005, 2006, and 2007 (Note: Jan to July 2007), respectively. The proportion of fishing vessels stopped that were repeat offenders decreased slightly from 15% in 2005 to 13% in 2006, and 10% in 2007. A special enforcement operation conducted with the SWD in 2005 resulted in the prosecution of three fishing vessels that were trawling within SIMCA. Two operations conducted with the marine police in 2006 resulted in the prosecution of three fishing vessels using dynamite, and another three trawlers fishing illegally within SIMCA. The dynamite fishers were subsequently fined and their vessel was confiscated.

Education

In May 2007 Reef Guardian conducted its first educational activity to spread awareness of the presence and function of SIMCA. Local secondary school students were invited to participate in a 2 day Adopt-a-Reef event at Lankayan Island, during which they learnt about marine life and participated in activities like snorkeling and viewing turtle hatchlings. Future success of this programme can be assessed by the degree of new knowledge participants gain, as well as how participants' attitudes towards conservation evolve.

² Government enforcement agents (Police Field Force and Marine Police) who occasionally accompany Reef Guardian sea patrols are armed.

Discussion

Effectiveness of Reef Guardian's conservation management

Overall, Reef Guardian's management has had a positive effect in some areas of marine conservation in SIMCA. Notably, the mean number of turtle nestings has doubled (although not statistically significant) from a mean of 101 to 205 since Reef Guardian started managing turtle conservation activities in 2004. This is likely a result of Reef Guardian's turtle awareness campaign and nightly turtle patrols which have practically eliminated turtle poaching on Lankayan.

To date, only two consecutive years of fish abundance data exists for SIMCA, which is not nearly long enough to detect significant trends. Although rapid changes in fish abundance (1–3 years) have been documented (Halpern and Warner 2002), a more appropriate indication of conservation effectiveness in this case is a comparison with other sites (Table 2). Reef Guardian's active enforcement of SIMCA since 2005, and LIDR's informal protection before that, has sufficiently reduced fishing pressure such that fish stock levels within SIMCA are comparatively healthy. In particular, the mean abundance of commercially important groupers in SIMCA is significantly higher than that recorded at Pulau Banggi, an important reef fishing ground (Teh et al. 2007). Meanwhile, the abundance of groupers and snappers is comparable to that at MPAs under government and collaborative management (Table 2).

Based on criteria developed by ASEAN-Australia Living Coastal Resources Project (Chou et al. 1994), average coral cover across all sites in SIMCA fall under the 'Good' and 'Fair' category in 2006 and 2007, respectively. In addition, live coral cover within SIMCA appears to be comparable to those at other MPAs (Table 3), although dead coral cover is also higher. This may be attributed to severe storms that hit the island in the beginning of 2007, which caused extensive damage to corals as well as invertebrates. As with fish abundance, the continuation of reef monitoring will provide the time series data necessary to better assess the effect of Reef Guardian management on marine conservation in the long term.

The ability of Reef Guardian to carry out its various conservation activities effectively and on a frequent basis is facilitated by several key factors discussed below:

(a) *Sustainable financing through tourism*: Dive tourism is considered a valuable tool in enabling MPAs to achieve self-financing status (Gallagher-Freymuth 2001; Depondt and Green 2006). The LIDR receives a steady stream of visitors, ranging from 9,535 visitor nights in 2004, to 8,421 in 2005 and 8,875 in 2006. Conservation fees collected from these guests covered a substantial portion of Reef Guardian's annual operating costs (Lee 2005). However, the percentage contribution of conservation fees to Reef Guardian revenues has dropped in the last 2 years, in part due to acquisitions of new equipment and new staff. These initial costs are expected to decrease in the future. At the same time, Reef Guardian can increase conservation contributions by charging higher fees, or by implementing new user fees for cameras and/or videography equipment, and activity specific charges.

Dependence on visitor fees as the main source of income has led to financial difficulties for other MPAs (e.g. Erdmann et al. 2004; Tongson and Dygico 2004), and over-reliance on tourism revenues could expose Reef Guardian to the threats of a volatile tourism industry. Reef Guardian mitigates financial risk by maintaining a resilient financial structure that is not entirely dependent on tourism. It also obtains funds from a conservation grant, and is subsidized by the parent company's diversified business portfolio.

(b) *Separation of dive resort and conservation management*: Being a distinct body from LIDR enables Reef Guardian to exercise objective judgement in implementing conservation interests in accordance with SIMCA's goals. For example, Reef Guardian ended LIDR's practice of feeding juvenile black tipped reef sharks although it was popular with guests, as feeding marine life has been observed to alter their natural behaviour (Shackley 1998). In addition, Reef Guardian replaced the resort's jetty and boardwalk lights with dimmer bulbs to reduce light disturbance to sea turtles. Reef Guardian is also obliged to maintain environmental standards according to measures enforced by the Department of Environment. Reef Guardian's license to manage SIMCA can be revoked by the state government if bi-annual environmental inspections fall below defined standards. Reef Guardian's accountability to the state government thus acts as a check against situations where conservation objectives may be compromised for business interests.

(c) *Operating resources*: SIMCA's revenues are comparatively higher than some MPAs that are publicly funded and managed, but operating costs are up to two to three times higher as well (Table 1). The high cost to revenue ratio for SIMCA can be attributed to initial set up costs, and the fact that private subsidies were not considered as income, whereas other MPAs treat government subsidies and payments as part of income.

A benefit of Reef Guardian's private ownership is that all conservation fees collected from visitors to SIMCA are channeled directly back to finance the conservation and management of SIMCA. While there are exceptions (e.g. Sabah Parks Trust Fund, Great Barrier Reef Marine Park's Environmental Management Charge), very often conservation fees collected by government agencies are remitted to other departments and are not fully reinvested in conservation (Wilkinson et al. 2006). For example, Bunaken National Marine Park receives only 80% of revenues for Park management, with the remainder being remitted to the central government. In Apo Island, an economic analysis revealed that only 3% of gross revenues derived from park fees and donations were reinvested in MPA protection, maintenance, and management (Cadiz and Calumpong 2000).

Being a private organization, Reef Guardian is able to secure and dedicate all their resources towards marine conservation activities because that is their primary management objective. In contrast, many governments, especially in Southeast Asia, do not have dedicated departments to manage MPAs, and inter-departmental conflicts over funding and competing interests often can arise (Wilkinson et al. 2006). Reef Guardian's streamlined management enables it to respond quickly to MPA issues, for example, in raising financial or human resources to meet unforeseen staffing or equipment needs. On the other hand, government agencies are usually governed by annual budgets and departmental procedures that may not have the flexibility to accommodate unanticipated expenses.

(d) *Collaboration with government agencies*: Reef Guardian has strengthened its credibility and authority for enforcing SIMCA through collaboration with state and federal enforcement agencies such as the SWD, Malaysian marine police, and Malaysian police field force. In contrast, resorts that take de facto ownership over nearby reefs and unilaterally enforce them may find that they have limited legal powers to do so. Reef Guardian's collaborative enforcement efforts appear to have increased fishers' awareness about SIMCA's no-fishing regulations, as indicated by the lower frequency of illegal fishing boats stopped within SIMCA. Nevertheless, the persistence of offenders that repeatedly enter SIMCA suggests that obtaining compliance from all fishers is still an issue to be dealt with.

Gaps in Reef Guardian's management

While initial findings suggest that the primary objective of conserving biodiversity is being addressed well in SIMCA, a gap in management remains that fishers as a group were overlooked during formation of the protected area. Strong support from local fishing communities is a key factor in successful MPA implementation (Russ and Alcalá 1999). In fact, alienation of fishing communities from marine parks has led to violent confrontations between fishers and enforcement officials in the past, for example in the Komodo National Park in Indonesia (Gustave 2005).

Although there were no local fishing communities within SIMCA, fishers from Sandakan (80 km south of Lankayan) and as far away as Pulau Banggi (approximately 120 km northwest of Lankayan) used to travel to fish in SIMCA waters. The loss of SIMCA as a fishing ground has economic consequences for the Pulau Banggi fishers, as they used to get higher than average catches in SIMCA (K. bin Indani and J. bin Misain, pers comm. 2007). Even though marine reserves can potentially benefit fishers through increased fisheries yield (Russ et al. 2004), fishers in SIMCA were likely not aware of these benefits as they were not consulted during the formation of SIMCA, and this is an oversight of SIMCA management.

Applicability to other locations

It is not realistic to expect Reef Guardian's model of private management to succeed in every MPA. There are several unique features of SIMCA which we feel have contributed to its success. Firstly, there was only one fishing family living on Lankayan Island prior to the establishment of LIDR and SIMCA. This family was consulted and agreed to the development of the resort as well as of SIMCA, therefore social conflicts, which have hindered the success of other MPAs (Christie 2004), were not an issue.

On islands with sizable local fishing communities, the potential for private ownership or management of marine resources to raise concerns over economic and social equity has to be considered. For example, plans to turn over the management of Komodo National Park to a private company were opposed by some local communities who said they were not consulted and who did not think they would benefit from proposed eco-tourism activities (Down to Earth, <http://dte.gn.apc.org/57Kom.htm>. Cited 15 August 2007). On the other hand, Chumbe Island Coral Park's private management model engaged local communities in the planning process to build strong relationships and stakeholder buy-in. Private management of inhabited islands can work as long as local communities express support and acceptance of the private company's activities.

Secondly, Lankayan Island has an established reputation as a premier dive destination, thus Reef Guardian can generally rely on conservation fees generated from a steady stream of visitors. SIMCA is also unique in that the director of a dive resort took the initiative to privately fund and form a separate organization to manage the conservation area. Although many dive resorts may conduct informal protection of their surrounding coral reefs, few have taken the steps to institutionalize and formalize conservation management, thus strengthening the conservation mandate, in the way Reef Guardian has. We do not imply that the circumstances mentioned above are mandatory for successful private management of MPAs, but rather, that their absence might give rise to social or funding issues that managers should be aware of.

Concluding remarks

Private investment and management in MPAs offers an alternative approach that can address the problems of sustainable funding and enforcement that so often hamper MPA success. Reef Guardian's management of SIMCA has contributed to initial positive results in marine conservation and enforcement of illegal fishing activity.

Tourism can be a valuable financial resource for MPAs, and dive resorts that engage in conservation should consider separating business from conservation to avoid potential conflicts between differing interests. Within the context of large networks of MPAs being developed in Southeast Asia (e.g. the Sulu Sulawesi Seascape), implementation of private management in select pockets can ease administrative pressure off the central MPA management agency and broaden research and monitoring capacities. In particular, the following situations can enhance the likelihood of success for privately managed MPAs:

- (1) Availability of long term funding, the bulk of which originates from private sources.
- (2) Diverse and healthy coral reefs for tourism.
- (3) Partnership with local regulatory agencies for technical and enforcement support.
- (4) Buy-in and support from local inhabitants to minimize the potential for social conflict.

Acknowledgements We thank Leony Sikim and Reef Guardian staff for data collection and preparation. Comments from two anonymous reviewers greatly improved the original manuscript.

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