A Decade of Reef Check Monitoring:
Indonesian Coral Reefs, Condition and Trends

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The Indonesian Reef Check Network

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Executive Summary

Reef Check is a coral reef monitoring method which has now been used for a decade in Indonesia. From this first decade of RC surveys in Indonesia from 1997-2006, we can say that overall the hard coral cover (Hard Coral) which is used as an indicator of coral reef health is in the Average category (26-50%), with a downwards trend. The percentage live cover varies from 40.90% to 56.96% with the highest percentage recorded in 2000 and the lowest in 1999. Conversely, the non-living (abiotic) cover was lowest in 2000 and highest in 1999.

Butterfly fish are one of the indicators used to assess the pressure from collection for the marine aquarium trade, and there is a slight downward trend in the annual average abundance. Whereas for fish used as indicators of the live reef fish trade and overfishing the figures indicate very heavy fishing pressure, indeed for Barramundi Cod and Humphead Wrasse the figures per transect per year vary from none to one.

Invertebrate data are used to describe four aspects; collection for the marine aquarium trade, overfishing, over harvesting and coral predator population explosions. The abundance of organisms used as indicators of the marine aquarium trade tended to increase, whereas the abundance of organisms used as indicators of overfishing and over harvesting show a significant downward trend. The crow of thorns starfish (COTS) *Acanthaster plancii* which is an indicator of coral predation was recorded at minimal population levels.

Overall, the impacts which cause mechanical damage to coral reefs and the level of trash didn't show any clear increasing or decreasing trend. The majority of coral damage was not very serious (level 1) and on average the highest level of damage was caused by anchoring and other boating activities, whereas trash was also at the same level (level 1) and the majority of impacts were classified as "other".

In conclusion, we are aware that the pressure on our coral reefs is increasing in line with development and resource use across Indonesia. If we are to preserve our coral reefs and their resources which should benefit us all, now and in the future, it is imperative that we build partnerships and each play our part in the wise management of this valuable ecosystem.

Best regards,

Abdullah Habibi
Data Officer, Indonesian Reef Check Network (JKRI)

Contents

1 Introduction

Indonesia is situated in the centre of coral diversity (Veron, 2000), which is often referred to as the Coral Triangle. Indonesian coral reefs are estimated to cover around 51.000 km² or around 18% of the global coral reef area, and around 60% of coral species are found in this country. Sadly, environmentally damaging fishing practices (such as the use of cyanide and explosives), overfishing, sedimentation, waste disposal (Burke *et al.*., 2002), and coral bleaching (Hughes *et al.,* 2003) have been identified as the major threats to this ecosystem.

Over 80% of the Indonesian population lives in the coastal zone, so that the degradation does not only impact the coral reefs themselves but also has a significant impact on the coastal communities who rely on this ecosystem for their livelihoods (Burke et al.., 2002). The Reefs at Risk in Southeast Asia report (Burke et al.., 2002) stated that during the past 50 years, the proportion of coral reefs in declining condition has increased from 10% to 50%. If this destruction is allowed to continue, it is estimated that the economic losses will be around 2.6 billion US $ over a period of 20 years. This is a very low value if compared to the estimated value of over 1.6 billion US $ per year if the coral reef ecosystem is maintained in a healthy condition (Cesar et al.. 1997).

Coral reef management in Indonesia to date has been hindered by a lack of data. In the past, coral reef data has tended to focus on a particular area, and relatively comprehensive data have tended to come from one-off surveys with no further or ongoing data collection. Comprehensive and on-going data collection is very much needed in order to identify trends in the coral reef ecosystem so that best management practices can be developed to ensure it's long-term conservation.

Reef Check is based on coral reef education, research and conservation, and is one practical solution which can be applied in Indonesia. This method was made known world-wide in 1997 by Gregor Hodgson, and was applied for the first time in Indonesia in the Karimunjawa National Park in the same year[1]. Since then, Reef Check has expanded substantially, in terms of the number of volunteers, organisations involved, Provinces covered and data collection sites. The Indonesian Reef Check Network, Jaringan Kerja Reef Check Indonesia (JKRI) was founded in 2001 in order to facilitate communication between the Reef Check survey organisers in different districts. In addition, ever since it's founding year JKRI as developed as a forum making a worthwhile contribution to awareness raising, monitoring and management activities for Indonesian coral reefs.

In a decade of Reef Check coral reef monitoring in Indonesia, 72 km of transect lines have been surveyed. This is almost twice the total length of West Java Province!

2
Method Survey

Reef Check surveys are carried out at 2 depths, a shallow transect (2–6 m depth) and a medium depth transect (over 6 m and up to 12 m) taking into account the tidal range. At each depth, 4 segments each 20 m in length are placed and surveyed as 1 transect. All segments must follow the depth contour, and each segment must be separated from the next by a gap of 5 m at least, this is to enable statistical analysis as each segment can be considered to be an independent sample. The minimum distance between the start and end of the transect is 20 + 5 + 20 + 5 + 20 + 5 + 20 = 95 m.

There are 4 types of data which are recorded on the Reef Check data sheets, from 3 types of survey which are all carried out along the same transect line.

1. Site description

   Legends, observations, history and other data should be recorded on the Site Description Sheet. This data is important for the interpretation of field data. The Site Description Definitions and Field Guide contains a list of specific criteria for guidance in filling out the Site Description Sheet correctly.

2. Fish Belt Transect

   A segment 5 m wide (centres on the transect line) and 20 m wide is used to survey fish species which are targeted by fishermen, the marine aquarium trade, and others. This survey must be carried out first, and there are 9 survey target species.

Table 1. Indicator fish names and ecosystem functions

Common name	Latin name	Indicators
Butterflyfish (All species)	Chaetodontidae	Overfishing Aquarium Trade
Kerapu (> 30 cm)	Serranidae	Overfishing Aquarium Trade
Grunts/Sweetlips/Margates	Haemulidae	Overfishing
Moray Eel (All species)	Muraenidae	Overfishing
Parrotfish(> 20 cm)	Scaridae	Overfishing
Snapper	Lutjanidae	Overfishing
Barramundi Cod	*Cromileptes altivelis*	Overfishing Live Reef Fish Food Trade *Spearfishing*
Bumphead Parrotfish	*Bolbometopon muricatum*	Overfishing
Humphead (Napolean) Wrasse	*Cheilinus undulatus*	Overfishing Live Reef Fish Food Trade

3. Invertebrate Belt Transect

As for the fish transect, a segment 20 m long and 5 m wide is used to survey invertebrates which are targeted for consumption or the marine aquarium trade.

Table 2. Name and indicator function of invertebrates

Common name	Latin name	Indicator
Banded Coral Shrimp	*Stenopus hispidus*	Aquarium Trade
Lobster (All species)	Malacostraca	Overfishing
Long spine Sea Urchin	Diadema spp.	Overfishing
Pencil Urchin	Eucidaris spp.	Curio Sales
Sea Egg/Collector Urchin	Tripneustes spp.	Overfishing
Triton	Charonia spp.	Curio sales
Crown-of-thorns Starfish	*Acanthaster plancii*	Population explosion
Teripang (2 spesies)		*Beche-de-mer* fishery
> Prickly Redfish	> *Thelenota ananas*	
> Greenfish	> *Stichopus hloronotus*	
Kima raksasa (provide size/species)	Tridacna spp	Over-harvesting

4. Substrate Line Transect

Using the same transect line as for the fish and invertebrate transects, the reef substrate category is recorded at intervals of 0.5 m.

Table 3. Line transect codes and their meaning

Code	Meaning
HC	*Hard coral*
HCB	*Hard Coral bleaching*
SC	*Soft coral*
RKC	*Recently killed coral*
NIA	*Nutrient Indicator Algae*
SP	*Sponge*
RC	*Rock*
RB	*Rubble*
SD	*Sand*
SI	*Silt/clay*
OT	*Other*

Data Analysis

Reef Check data was supplied by local Reef Check survey teams, however 1997 data and some data not recorded in the JKRI database was obtained from Reef Check Headquarters in the USA. Reef Check surveying was only carried out at one site in Indonesia in 1998 so that 1998 data has not been used.

The percentages are calculated for Reef Check survey data from each site. These percentages are then used to calculate means and the national averages using all data from each site for a given year. In order to ensure the accuracy of the percentage data at national level, data are examined to determine key sites as references based on the continuity of data from these sites. This is done because not all Reef Check organisers carry out repeat surveys (monitoring) on a regular basis at the same sites. The criteria for data selection are at least 5 repeats of data collection at the same site for the line transect and 3 repeats at the same site for belt transect data. If national data results differ significantly from key site data, then comparisons will be drawn between the national data and the data from key sites. In order to make the coral reef condition data easier to understand, the percentage of live hard coral cover (HC) from the substrate line transect is used as the key indicator. The coral condition categories used are Poor (0-25%), Average (26-50%), Good (51-75%) and Very Good (76-100%).

Analysis of the fish and invertebrate data is somewhat different from substrate data analysis. Data from individual sites are amalgamated at the provincial level, to obtain an average per transect value. The resulting data are used to calculate average per transect densities, resulting in a figure for number of individuals/transect at the national level, after comparison with data from the key sites.

The estimated severity of impacts on coral reefs and levels of trash are divided into the following categories: None, Low, Medium and High. The mean category per transect is calculated and the average value taken to evaluate the overall level or threat category of pressures on the coral reef ecosystem over the decade.

The first use of Reef Check in Indonesia was in 1997 at 1[2] site with 7 volunteers taking part. By late 2006 Reef Check monitoring had been carried out at 61 sites in 19 provinces with 1,442 volunteers and 100 organisations taking part

3
Survey Results

A decade (1997-2006) of Reef Check data collection gives a clear picture of the condition of Indonesian coral reefs. A brief summary is given below, with national scale information being presented for each type of data collected.

Survey Sites

Site selection is an important factor in determining the success of Reef Check. One of the Reef Check goals is to find out the level of human impact on coral reefs. To achieve this goal, teams which only able to undertake surveys at one site should select the best site available, in terms of having the minimum possible level of impact from human activities, fishing, pollution and so-on. The site should have a high level of coral cover, with dense fish and invertebrate populations. Over the decade, Reef Check surveying was carried out in 19 provinces spread out across Indonesia (Figure 1). Data collection was not continuously undertaken at given sites; out of a total of 61 survey sites, only 21 sites were selected as key sites with ongoing monitoring data, where data had been collected on at least 3 occasions. These key sites are spread out across all regions of Indonesia; Bali (Garden Eel), Central Java (Menjangan Besar, Menjangan Kecil, Geleang, Burung, Menyawakan, Cemara Besar, Tanjung Gelam and Cemara Kecil), Riau (Barracuda point, Lagoi Berakit, Mayangsari Bay and Sumpat), South Sulawesi (Lekuan 3), Central Sulawesi (Pasoso 1, Pasoso 2, Pasoso 3 and Tawaeli Talise) as well as Southeast Sulawesi (Hoga Island Buoy 2, Hoga Island Buoy 4 and Kaledupa Spur).

Figure 1. Reef Check data collection sites in Indonesia (symbol Δ)

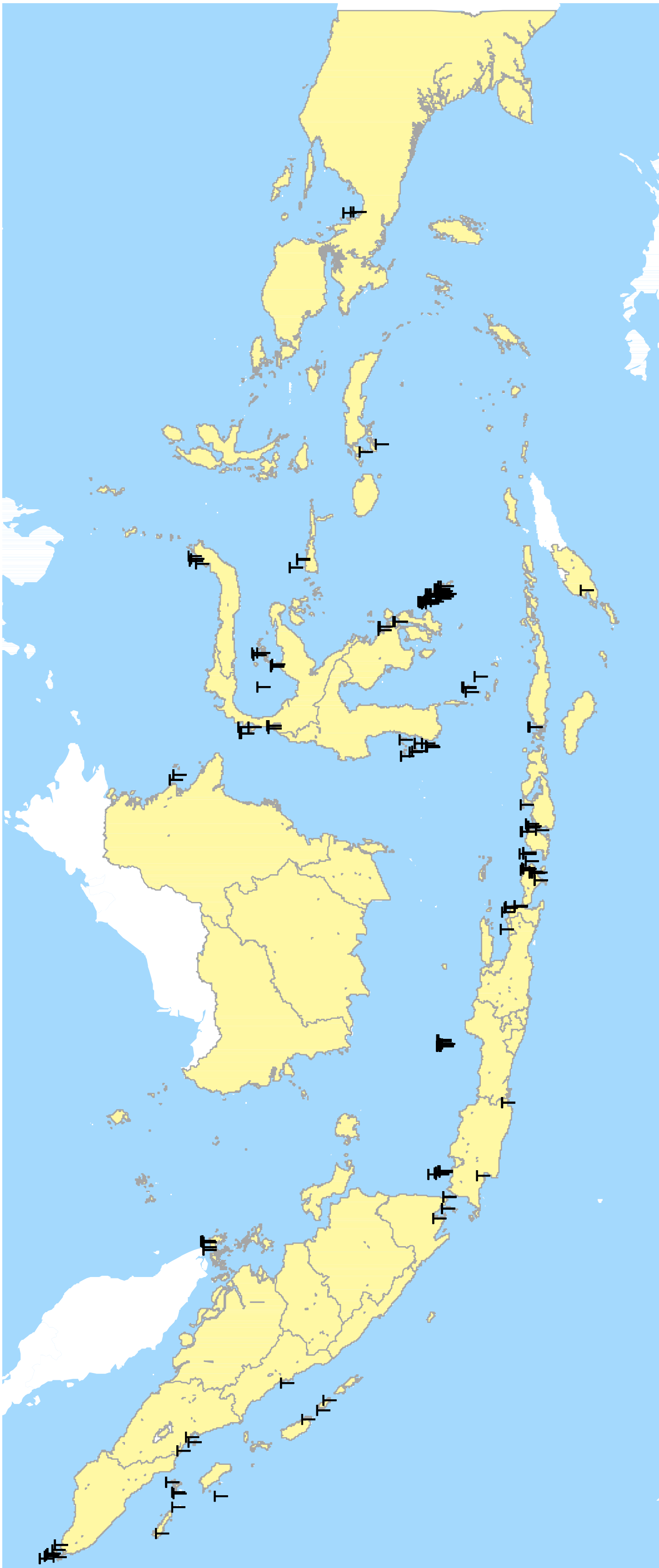


Table 4. Number of Reef Check monitoring sites per province per year

Province	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
Bali	8	0	24	0	38	48	26	0	0	4	148
DKI Jakarta	8	0	27	8	24	32	0	0	0	0	99
West Java	0	0	0	0	4	0	24	0	0	0	28
Central Java	48	0	42	40	72	96	48	32	40	40	458
East Java	0	0	0	0	8	32	0	0	40	20	100
East Kalimantan	32	0	0	0	16	0	0	0	0	0	48
Kepulauan Riau	24	8	0	0	16	16	31	32	15	0	142
Lampung	8	0	0	0	0	16	0	0	0	0	24
Maluku	16	0	0	0	0	0	0	0	0	0	16
Nanggroe Aceh Darussalam	0	0	0	0	4	0	16	24	97	0	141
West Nusa Tenggara	0	0	0	13	0	0	86	0	0	0	99
East Nusa Tenggara	16	0	0	15	0	0	0	0	0	0	31
Papua	24	0	0	0	0	0	0	0	0	0	24
South Sulawesi	16	0	12	28	46	0	24	0	28	4	158
Central Sulawesi	0	0	32	0	56	196	118	24	0	8	434
Southeast Sulawesi	8	0	0	88	157	0	212	140	144	0	749
North Sulawesi	0	0	0	4	8	36	0	0	0	0	48
West Sumatra	0	0	0	8	8	8	0	0	12	0	36
North Sumatra	0	0	0	0	4	8	12	48	0	0	72
Total	208	8	137	204	461	488	597	300	376	76	2855

Reef Check survey sites in these 19 Indonesian provinces include sites within and outside of Marine Protected Areas. For the purposes of this report, Marine Protected Areas are defined as coastal and marine areas which are managed by government authorities or by local communities. The following Table gives the total number and the percentage of Reef Check surveys which were carried out within Marine Protected Areas.

Table 5. Number and percentage of marine protected areas surveyed using Reef Check

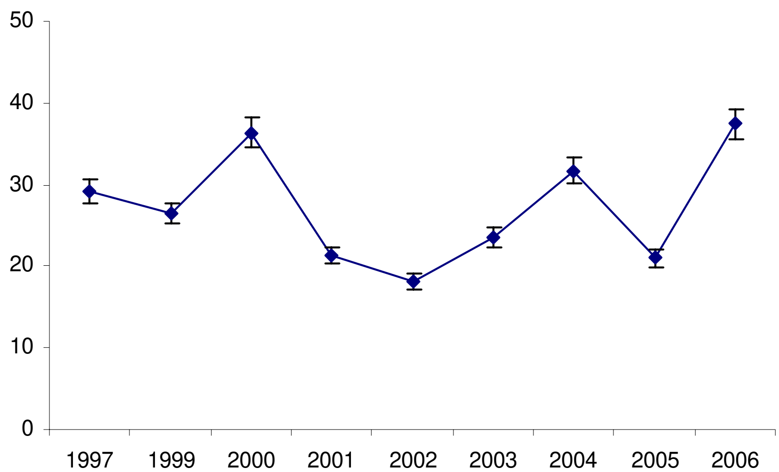
Year	**Marine Protected Area**	
	Number	**Percentage**
1997	120	57.7
1998	0	0.0
1999	98	71.5
2000	72	35.3
2001	230	49.9
2002	288	59.0
2003	290	48.6
2004	116	38.7
2005	127	33.8
2006	40	52.6

Fish

Fish transect data is used here to give a picture of three issues: collection for the marine aquarium trade, the live reef fish trade and overfishing.

Collection for the marine aquarium trade

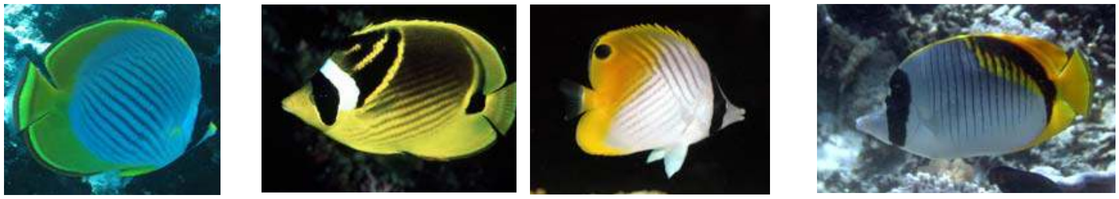
Figure 2. Average numbers of Butterfly fish per transect



Butterfly fish are an indicator for fish which are collected for sale in the marine aquarium trade. Butterfly fish were the most frequently observed fish indicator with the highest number recorded at all sites. Although the numbers recorded tended to fluctuate over the decade, overall the numbers are still relatively high with a minimum average value of 18 fish per transect in 2002.

The greatest threats to the Indonesian butterfly fish population come from the side-effects of bomb fishing and exploitation for the marine aquarium trade. Most Reef Check data was collected at popular dive sites or in protected areas, so that both these threats tended to be minimised and relatively high numbers of fish were recorded.

Further surveys are required, especially at sites outside such areas in order to obtain a more complete picture of the butterfly fish population across Indonesia.



Some of the Butterfly fish recorded during Reef Check surveys (reefcheck.or.id and reefcheck.org)

The Live Reef Fish Trade

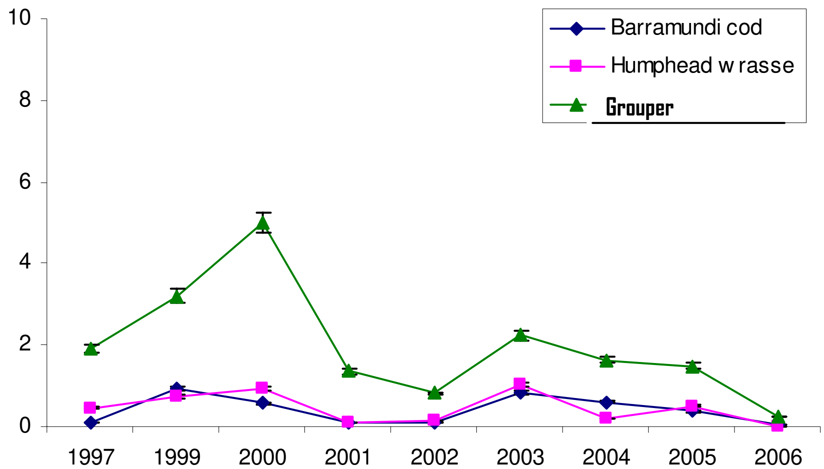


Figure 3. Average numbers per transect of Barramundi cod, Humphead wrasse and Grouper

Live reef fish species (Barramundi Cod/mouse grouper, Humphead Wrasse and Grouper) are examples of indicator fish with high economic value which are traded alive. Grouper are caught to fulfil demand from the export market with prices ranging 7-14 US $/kg in 2003 (Pet-Soede et al., 2004). The high demand for live reef fish and the profitable prices paid have led may fishermen to use capture methods which are environmentally damaging (Johannes and Riepen 1995).

The numbers recorded for these three fish species were low with a downward trend. During the past 10 years, the average number of Grouper recorded has been below 6. The condition of the Humphead Wrasse (listed in Appendix II of CITES, the Convention on International Trade in Endangered Species) and Barramundi Cod is more extreme with average values of zero to one fish per transect per year.

Overfishing

The majority of Overfishing indicator fish also exhibit a downwards trend in average numbers/transect, although Snappers seem to be somewhat more abundant than the other species. The graphic representations of data for Haemulidae (sweetlips), Parrotfish and Bumphead parrotfish show a steep decline. Average numbers of Parrotfish fell from 13 fish/transect in 2000 to only 3 fish. There was a drastic decline in Bumphead parrot numbers with zero fish sighted in 2006, whereas the maximum number recorded was in 2000 with 6 fish/transect.

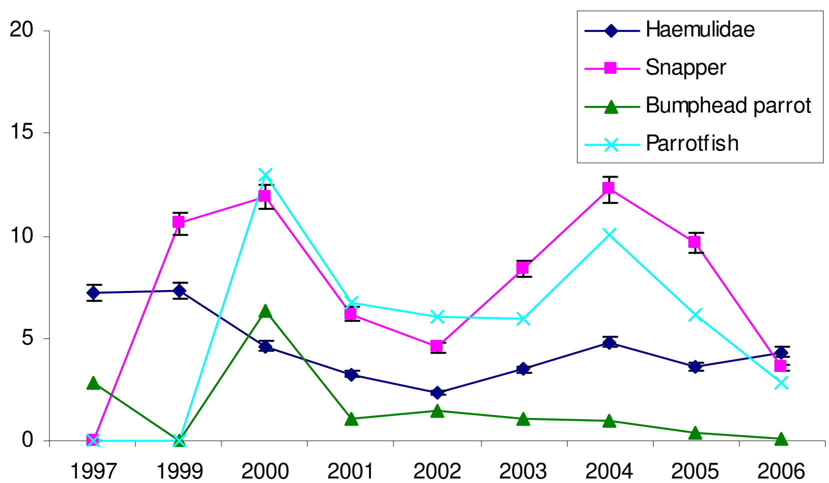


Figure 4. Average per transect numbers of Haemulidae, Snapper, Bumphead parrotfish and Parrotfish .

Moray Eels, Manta Rays and Sharks are rare animals which must be recorded whenever sighted during the survey. However, during this decade no individuals of these species were encountered within the transect boundaries by Reef Check volunteers.

Facts about overfishing

Three quarters of world fisheries are already overfished or are already experiencing reduced catches (FAO Fisheries Department, 2002).

Most Indonesian waters are already overfished. Nearly half of the Fisheries Management Areas (Wilayah Pengelolaan Perikanan, WPP) in Indonesia are severely overfished in terms of the reef fish and lobster fisheries, whereas Penaeid shrimp have been overfished in over half of the Indonesian WPP (PRPT-BRKP and PPPO-LIPI, 2002). This condition is further worsened by the continued use of the catch per unit effort (CPUE) and Maximum Sustainable Yield (MSY) models which pose a high risk to the sustainability and long-term profitability of Indonesian fisheries (Mous et al.., 2005).

Efforts to reduce or mitigate overfishing include the use of the ecosystem management approach, where marine protected areas play an important role in fisheries sustainability (Mous et al.., 2005).

Invertebrates

Invertebrate data is used here to give a picture of the conditions related to four issues: collection for the marine aquarium trade, overfishing, over-harvesting and coral predator population explosions.

Collection for the aquarium trade

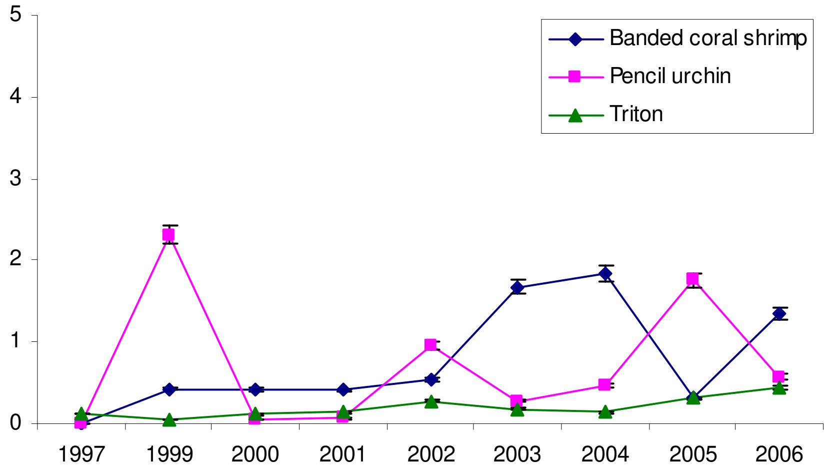


Figure 5. Average per transect numbers of Banded Coral Shrimp, Pencil Urchin and Triton

Numbers of Banded coral shrimp and Pencil urchins which are much sought after for the marine aquarium trade are very low (0-2 /transect) but exhibit a slight increasing trend whereas Triton were only found in extremely low numbers (0-1 /transect).

Invertebrates collected for the marine aquarium trade: Banded Coral Shrimp, Pencil Urchin and Triton (reefcheck.org)

Overfishing

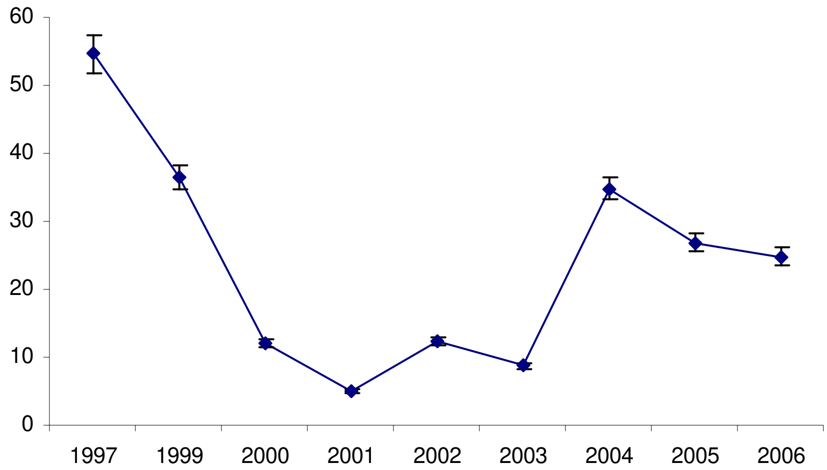


Figure 6. Average numbers of Diadema urchin per transect

The numbers of Diadema urchins recorded fell from 1997-2001 then increased again up to 2004, however in 2005 fell once more to around 24.9 urchins/transect.

Figure 7. Average numbers of Lobster and Collector urchin per transect

The average number of lobster per transect exhibited an overall downward trend, with values ranging from 1.5-0.2 lobster/transect, whereas Collector urchins were only recorded in the past two years and average numbers were below one urchin/transect. The fall in the number of lobsters reflects the growing pressure on these species, with significant levels of overfishing especially since the year 2000.

Over-harvesting

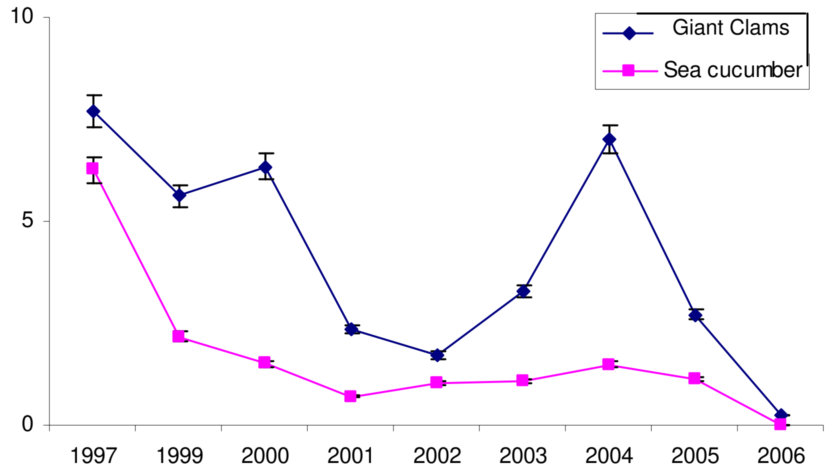


Figure 8. Average numbers of Giant clams and Sea cucumbers per transect

The average number of Giant clams as an indicator of over-harvesting declined from 7.7 clams/transect in 1997 to only 0.3 clams/transect in 2006. Whereas the number of Sea cucumbers (Teripang) per transect fell sharply (6.3 to 0.0 per transect) in the past 10 years, showing that the pressure on these animals is increasingly severe.

Population explosions

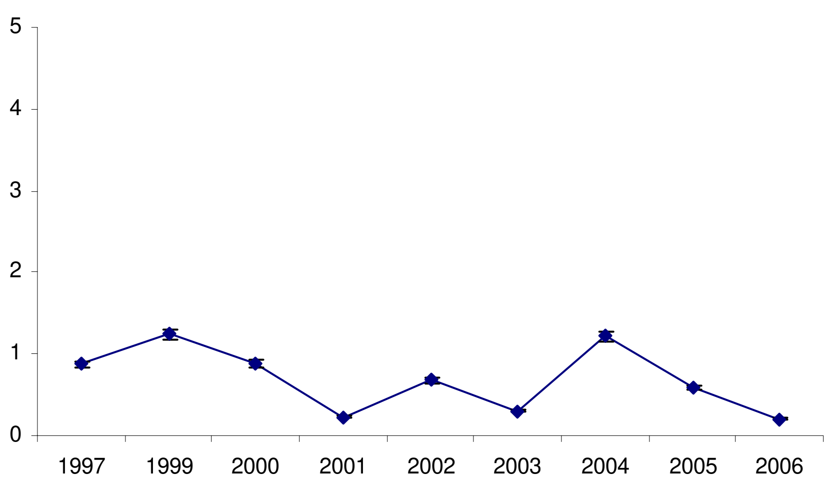


Figure 9. Average numbers of CoTS per transect

In the past 10 years, the average number of CoTs per transect has been quite low (1.2-0.2 CoTs/transect). This is below the number constituting a population explosion which can cause severe damage to coral reefs (AIMS 1997).

Substrate

During this monitoring period, the dominant substrate category has been HC (Hard Coral). This was followed by RB, RC and RKC. Whereas HCB is a substrate category which was never recorded. This is probably because the HCB indicator was only introduced in 2004, and there have been no significant mass bleaching events recorded in Indonesia since 1998. During the period 1998-2006 only three relatively mild bleaching events were recorded in Indonesia: slight bleaching in TNBB (only for the coral species *Seriotopora hystrix*) during 2003, localised bleaching on the reefs around the Ngurah Rai Airport in Bali (April 2005), and medium-severity bleaching at several spots in the Kepulauan Karimunjawa in December 2006.

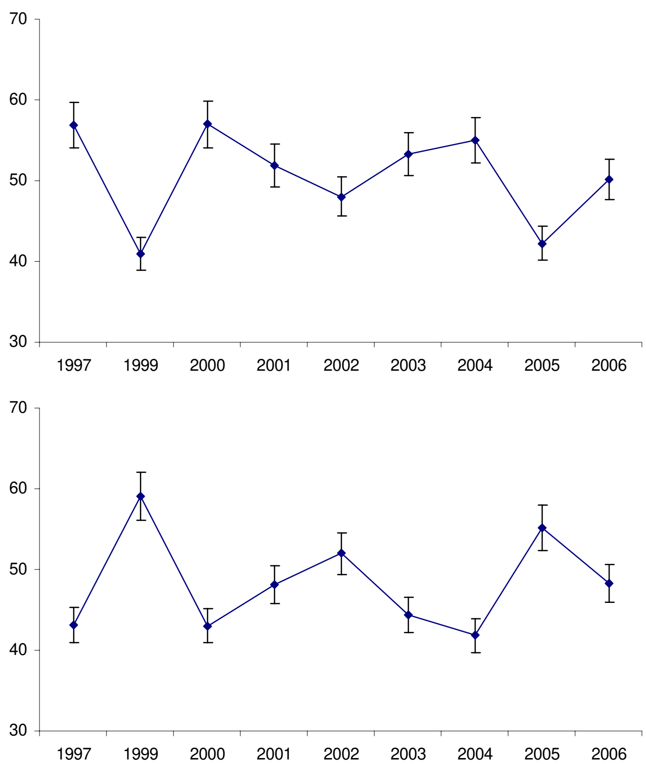


Figure 10. Percentages of Live cover (above) and Non-living (abiotic) cover (below)

The percentage of live cover or living reef organisms (FS/NIA+HC+OT+SC+SP) at the national level declined over this decade, with percentages varying from 40.90% to 56.96%, figures which were recorded in 1999 and 2000 respectively. Because the non-living cover or dead/abiotic reef cover (RB+RC+RKC+SD+SI+HCB) forms the remainder of the reef cover, when the live cover percentage falls then the non-living cover automatically increases.

The overall national trend of declining live cover was reversed for the key sites, where there was a rising trend in live cover. This increase in live cover at the key sites was probably due to the fact that most of these key survey sites were within Protected Areas, so that they were better protected from threats which can cause degradation of the coral reef ecosystem. This was supported by data showing declining trends in unprotected areas. (continuation of the comparison between protected and unprotected areas).

The mass bleaching event in 1998 played a significant role in reducing the overall coral health of Indonesian coral reefs (Burke, et al.., 2002). For example, in that year bleaching of up to 19.5% was recorded on the western side of Menyawakan Island in Karimunjawa, with the percentage of bleached hard coral ranging from 5-19.5% (Razak 1998). In the years following the coral deaths (from bleaching), a trend towards recovery was also recorded at this site. The Figure below shows the pattern of recovery at Cemara Kecil and Menyawakan Islands, two neighbouring sites.

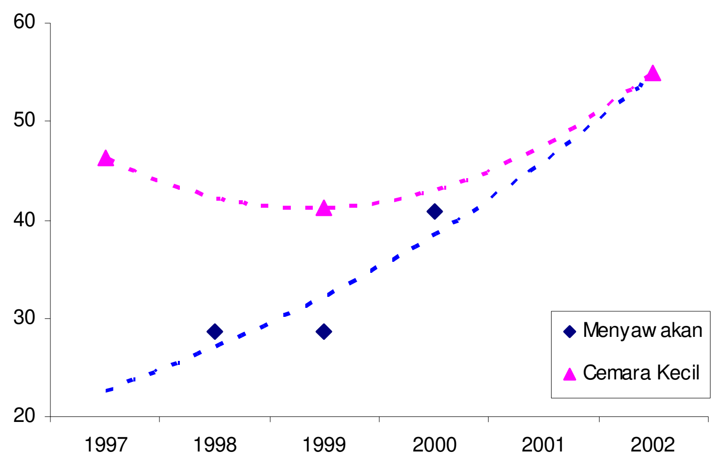


Figure 11. Trends of coral reef recovery in Kepulauan Karimunjawa. (result of data analysis, 1998 data from Razak 1998)

The overall condition of Indonesian coral reefs over this decade has been in the Average category. The HC percentage cover as an indicator of coral reef condition varied, however in spite of fluctuations there was an overall trend towards increasing decline, with the HC component tending to be balanced by increases in the percentage cover of RB, RC and RKC. Data from all provinces throughout the survey period showed a majority of coral reefs with HC cover in the range 26-50%. Three coral reef condition categories were recorded, which were Good, Average and Poor, for 8.1%; 73.3% and 18.6% respectively of the sites surveyed.

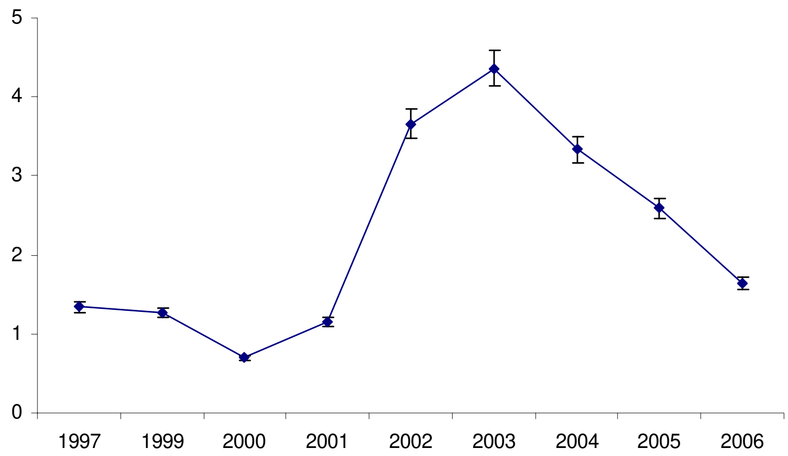


Figure 12. Percentage of cover by NIA

Although values tended to be below 5% with a downward trend after 2003, the presence of NIA is an indication of the increasing nutrient load in our seas, caused by run-off as well as the disposal of domestic waste. These nutrients promote the growth of algae which compete with corals and interfere with coral reproduction (Bryant, et al.., 1998).

An example of Nutrient Indicator Algae recorded during a Reef Check survey (reefcheck.org)

Impacts

Overall, the coral damage and Trash indicators did not show any significant upwards or downwards trends.

The majority of observed recent damage was relatively slight (level 1) and on average the most frequently encountered source of damage was anchoring and activities related to the use of boats, followed by "other" causes of damage. Out of the total damage, the greatest contribution came from damage caused by "other" sources (storms, destructive fishing practices such as the use of fish traps and hookah diving).

Table 5. Average level of recent coral damage per transect per year

Year	Cause of Coral Damage											
	Boats/Anchoring				Dynamite/Bomb Fishing				Others			
Level	0	1	2	3	0	1	2	3	0	1	2	3
1997	0,0	1,2	0,4	0,2	0,0	0,0	0,1	0,9	0,0	0,0	0,0	0,0
1999	0,0	0,5	0,3	0,1	0,0	0,5	0,8	0,4	0,0	0,4	0,3	0,4
2000	0,0	0,6	0,4	0,1	0,0	0,5	0,3	0,5	0,0	1,2	0,5	0,5
2001	0,0	0,5	0,2	0,0	0,0	0,3	0,1	0,1	0,0	0,1	0,2	0,2
2002	0,0	0,3	0,3	0,2	0,0	0,2	0,2	0,2	0,0	0,4	0,5	0,3
2003	0,0	0,6	0,3	0,2	0,0	0,3	0,1	0,1	0,0	0,7	0,2	0,2
2004	0,0	0,7	0,4	0,0	0,0	0,5	0,4	0,0	0,0	0,5	0,4	0,1
2005	0,0	0,5	0,2	0,2	0,0	0,4	0,2	0,1	0,0	0,7	0,5	0,7
2006	0,0	0,6	0,5	0,3	0,0	1,2	0,1	0,1	0,0	1,0	0,7	0,1
Average	0,0	0,6	0,3	0,1	0,0	0,4	0,3	0,3	0,0	0,5	0,4	0,3

Indiscriminate anchoring can damage coral reefs (reefcheck.org)

The majority of Trash impacts on coral reefs were not very high (level 1) and did not exhibit any clear upward or downward trend. The highest frequency of damage was caused by "other" followed by nets (fishing gear). From the severity level aspect, on average trash from "other" sources (tourism and domestic) made the greatest contribution. Although only observed in low numbers with a low overall impact level, nets were found which had become entangles in the coral reef and discarded as trash, this shows that nets are used in coral reef fisheries.

Table 6. Average impact levels (Trash) per transect per year

Year	Trash Type							
	Fish nets				Other			
Level	0	1	2	3	0	1	2	3
1997	0,0	0,3	0,0	0,0	0,0	0,6	0,1	0,1
1999	0,0	0,4	0,0	0,0	0,0	0,2	0,2	0,0
2000	0,0	0,4	0,0	0,0	0,0	0,1	0,0	0,0
2001	0,0	0,2	0,0	0,1	0,0	0,2	0,0	0,3
2002	0,0	0,1	0,0	0,0	0,0	0,4	0,1	0,1
2003	0,0	0,3	0,0	0,0	0,0	0,4	0,1	0,0
2004	0,0	0,4	0,0	0,0	0,0	0,5	0,2	0,0
2005	0,0	0,2	0,1	0,0	0,0	0,4	0,1	0,0
2006	0,0	0,2	0,1	0,0	0,0	0,7	0,2	0,1
Average	0,0	0,3	0,0	0,0	0,0	0,4	0,1	0,1

An abandoned net covering a tabulate coral (reefcheck.org)

Protected vs. Unprotected Areas

Reef Check data over this decade indicates a trend of relative increase in hard coral cover within Protected Areas as compared to unprotected areas.

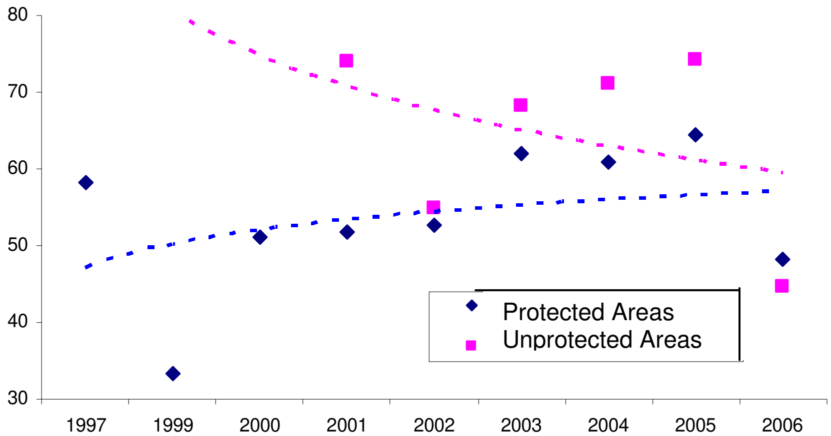


Figure 13. Comparison between the trends in HC cover in protected and un-protected areas

Although in some cases use or extraction from Protected Areas still occurs, the levels of HC observed are a proof that Protected Areas can indeed improve the quality of the ecosystem within them.

Reef Check by MSDC UNHAS at Barang Lompo Island, Makassar in December 2005

4
Lessons Learned and Success Stories

Reef Check in Central Sulawesi

The story of Reef Check in Central Sulawesi began in 1999 with a survey at 4 sites in the Togean Islands by local NGO Yayasan Toloka with support from the Reef Check Foundation. Reef Check was subsequently adopted as one of the survey methods in the training and coral reef survey programme run by local NGO Yayasan Adi Citra Lestari (YACL) from 2001-2004, with support from the UNEP EAS RCU (United Nations Environment Program East Asian Seas Regional Coordinating Unit), the David & Lucille Packard Foundation, NOAA and PADI Project Aware. From 2005 up until now, training and survey with Reef Check methods has been continued by local NGO Yayasan Palu Hijau (YPH) in partnership with the Fisheries and Marine Higher Education Institute (Sekolah Tinggi Perikanan dan Kelautan Palu, STPL) with some support from the national and provincial Sea Partnership (Mitra Bahari) Program.

As far as indicator organisms are concerned, the data from all survey sites strongly indicates overfishing, with all economically indicators recorded in low numbers or absent. Both Reef Check and manta tow surveys identified population explosions of *Acanthaster plancii* in several areas, from North to South/East: Buol District(Sulawesi Sea), Tolitoli & Donggala Districts (Makassar Straits), Palu City (Palu Bay), and Banggai Kepulauan District (Gulf of Tolo). The most obvious causes of coral reef degradation were coral mining; bomb and poison fishing; breaking apart of corals in the search for invertebrates such as clams (Tridacnidae) and abalone; trampling, especially during the use of nets and gleaning for invertebrates at low tide; anchor damage; and sedimentation.

Because of the importance of Reef Check in evaluating the condition of the coral reef ecosystem, the method was used as the basis of Aquatic Ecology (Ekologi Perairan) field activities for undergraduate fisheries students from 3 institutions (STPL, UNISA, UNTAD). The goals of using Reef Check in this context are to provide an introduction to the coral reef ecosystem and develop an understanding of the basic principles and practical requirements for meaningful data collection and analysis.

Socialisation regarding Reef Check and the coral reefs ecosystem in Central Sulawesi reached the international level, through a presentation at the 10^{th} ICRS (International Coral Reef Symposium), held in Okinawa in 2004. Reef Check activities were also included in the UNEP EAS/RCU report in 2004, as well as the Jurnal Mitra Bahari (Sea Partnership Journal) in 2006. Reef Check was a major component of the Dive in to Earth Day 2006 activities with the theme " The Oceans are our Front Yard - Lingkungan Laut, Halaman Depan Rumah Kita". We intend to make this an annual event, with varied activities, of which Reef Check survey or monitoring will continue to be an integral part.

Reef Check in Central Java

The Karimunjawa National Park was the first place in Indonesia where a Reef Check survey was carried out, in the year 1997. In 1999, this survey was followed up by students from the Marine Science Department of Diponegoro University who were members of the Marine Diving Club. Reef Check was used as a tool to raise awareness regarding the importance of coral reef ecosystems not only among the local communities in Kepulauan Karimunjawa, but also at the Provincial level. Efforts did not stop there, and volunteers from provinces outside Java were also invited to take part in Reef Check surveys in Karimunjawa. Based on records from Karimunjawa alone, the number of Reef Check volunteers, originally only a handful, had risen to 300 by the year 2006. Awareness raising was assisted by the mass media, including the Central Java regional television station (Borobudur TV), National TV (INDOSIAR), Semarang regional radio stations (Sonora FM, Radio Corpora FM, Radio Smart FM), and newspapers (KOMPAS, Suara Merdeka and Kedaulatan Rakyat). Indeed in 2006, MURI (Museum of Indonesian Records) recorded the first Underwater Chess Tournament, held in conjunction with Reef Check activities.

Reef Check outputs were not limited to raising awareness of the general public, but were further presented at Provincial and National scientific events. Records show that Reef Check was used to support coral reef conservation through a Regional Seminar in Semarang in 2003, and presentations at the Vth National Coasts and Small Islands Conference held in Batam in 2006, with recent presentation at the National Seminar "Coral Reefs: from Ecology to Industry" held in Semarang in 2007.

During a decade of monitoring in Karimunjawa, Reef Check have been supported not only by the Jepara District Government, but also by the Provincial Government and private sector. In addition support from UNEP EAS RCU (United Nations Environment Program East Asian Seas Regional Coordinating Unit) and USAID (United States AID) are a clear indication that the international community cares about the Reef Check activities in the Karimunjawa National Park.

Reef Check in North Bali and Padang

RC in these two areas has been implemented by the MAMTI (Marine Aquarium Market Transformation Initiative) programme, which is partnership between three non-organisations (NGO): the Marine Aquarium Council (MAC), the Conservation and Community Investment Forum (CCIF), and Reef Check (RC), who have established a team and mutually beneficial cooperation and are working together with the International Finance Corporation (IFC) under an integrated strategy. This Programme has 3 (three) main targets which are: 1) certification of the marine ornamental trade to international standards, 2) improvement of the business and financial skills of fishers, and 3) establishment of resource monitoring and management. With support from the Global Environment Facility (GEF), the strengths of this team will be channelled to re-direct the marine aquarium industry towards more environmentally friendly practices and to ensure wiser management of resources by fishers so that their livelihoods can become sustainable.

The MAMTI Programme has now been running in Indonesia for 2.5 years out of the 5 year programme action plan (from 2005–2009) with implementation in 2 (two) countries which are Indonesia and the Philippines. Since 2005, Yayasan Reef Check Indonesia as a member of the Global Coral Reef Monitoring Network has taken an active part and demonstrated it's concern through the MAMTI Programme, in particular in regards to coral reef conservation. In MAMTI, Reef Check has 2 (two) main roles which are:

1. Providing the initial scientific basis and designing a method for the monitoring of fishing grounds
2. Strengthening of community marine protected area (DPL) management and the improvement or rehabilitation of coral reef condition to ensure resources sustainability

Together with local communities, MAMTI develops local coral reef survey teams in order to evaluate the "health" condition of coral reefs within the DPL area, and compare this with the condition of reef areas outside the DPL. The results of these surveys show that in general the condition of the coral reefs and associated organisms are higher within the area which is protected (inside the DPL) compared with unprotected areas (outside the DPL). This phenomena proves how important it is to establish protected areas. With comprehensive data and information such as this it is hoped that in Reef Check can bring the general public to understand and realise the importance of Marine Protected Areas (MPA).

Table 7. MAMTI Reef Check monitoring results

Indicators	**Inside the DPL (MPA)**	**Outside the DPL (MPA)**
Live coral cover	48,8	38,7
Average density of indicator fish / 500 m^2	48,3	49,1
Average density of indicator invertebrates / 100 m^2	35	6,2
Average density of ornamental fish / 500 m^2	1444,7	1140,2
Average ornamental fish species diversity / 500 m^2	22	42,9
Average density of ornamental invertebrates / 100 m^2	17,3	7,9
Average diversity of ornamental invertebrates / 100 m^2	5,9	1,4

During the capacity building process, the programme approach is not limited to the level of the village communities but also includes relevant government institutions such as the Fisheries and Marine Service, National Park Rangers, Traditional and Administrative Village Heads, the Tourism Service, and the local Planning Agency (BAPPEDA). This approach is followed in order that the activities and plans made at the community level obtain a positive response from and are in line with the policy of local governments.

5
Recommendations

There has been a documented ongoing decline in the condition of coral reefs and the organisms living in this ecosystem. For a decade Reef Check has been run with very limited operational resources. However, thanks to the co-operation of many parties, the JKRI has succeeded in developing the most extensive non-government monitoring programme in Indonesia. With all the limitations faced by Indonesia in the development of coral reef conservation, this cooperation is extremely important. Coordination and the enthusiastic togetherness are the keys to success in developing and managing coral reef conservation.

Based on the results of data analysis and the process of learning within the network throughout this decade, we underline several important points that we need to address together:

- developing public awareness regarding coral reef conservation through active stakeholder involvement.
- developing active coordination and communications between the parties involved in implementing coral reef conservation which is cross-sectoral in nature (including NGOs, government, industry, universities, etc).
- developing the active involvement of non-specialist groups in reef management through providing opportunities to take part in activities such as Reef Check surveys, etc.

Do your part:

There are many opportunities for us to help the management and conservation of coral reefs in our daily activities. Here are a few examples:

1. Be a responsible diver. Follow the code of conduct of your dive association and local, codes of conduct at places where you dive.
2. Be a good diver. Make sure you have good diving skills, especially good buoyancy control. Make sure also that each time you go diving all your equipment is properly attached and will not get caught in or damage the corals.
3. Be a blue diver. Become an environmentally responsible diver by taking part in voluntary conservation activities. And select dive operators and resorts which hold a

reputation for environmental friendliness. Your friends in the network are ready to help you.

4. Be a blue agent. Ours is the blue planet. Whatever we do in our homes and daily lives on the land will have an impact on the sea.
    a. Reduce electricity consumption. Electricity generation in Indonesia is still largely dependent on fossil fuels (oil and coal) which produce greenhouse gasses. These gasses are responsible for the global warming which can cause coral bleaching. This bleaching is usually followed by mass mortality, requiring many long years for recovery to take place.
    b. Reduce, reuse, recycle. Everything we use comes from nature and requires processing plus transportation before it reaches us. Paper for example, trees must be felled, processes and sent to the shops before we can buy and use it. The more paper we use, the more trees that have to be felled (meaning increased sedimentation of rivers, and eventually the sea), and more greenhouse gases produced during processing and transport.
    c. Do not dispose of waste improperly. Waste which we throw away in the town will reach the rivers and be carried to the sea. Many marine animals have been reported dead as a result of entanglement in waste, or through eating plastic (which tends to resemble jellyfish, a common food source for many marine animals)
    d. Inform: spread the word, ask your friends, family and other people around you to join in and do what they can in their every day lives

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Of no less importance is the tireless support of the JKRI members in promoting conservation, knowledge and awareness for our coral reef ecosystems.

References

AIMS. 1997. Crown of Thorns starfish: Outbreaks. Download 15 May 2007 from http://www.aims.gov.au/pages/reflib/cot-starfish/pages/cot-q10.html

Bryant, D., L. Burke, J. McManus and M. Spalding. 1998. Reefs at Risk: A Map-Based Indicator of Threats to the World's Coral Reefs. Washington, D.C.: World Resources Institute.

Burke, L., E. Selig and M. Spalding. 2002. Reefs at Risk in Southeast Asia. World Resources Institute. USA.

Cesar, H., Lundin, CG., Bettencourt, S., and Dixon, J. 1997. Indonesian coral reefs-- An Economic analysis of a precious but threatened resource. Ambio 26 (6): 345-350

FAO Fisheries Department. 2002. The State of World Fisheries and Aquaculture 2002. Rome: FAO, 150 pp.

Hodgson, G., Kiene, W., Mihaly, J., Liebeler, J., Shuman, C., and Maun, L. 2004. Manual Instruksi Reef Check: Petunjuk teknis pemantauan terumbu karang dengan metoda Reef Check. Reef Check, Institute of the Environment, University of California at Los Angeles.

Hodgson, Gregor and J. Liebeler. 2002. The Global Coral Reef Crisis: Trends and Solutions. Reef Check, Institute of the Environment, University of California at Los Angeles.

Hughes, T.P., A.H. Baird, D.R. Bellwood, M. Card, S.R. Connolly, C. Folke, R. Grosberg, O. Hoegh-Guldberg, J.B.C. Jackson, J. Kleypas, J.M. Lough, P. Marshall, M. Nyström, S.R. Palumbi, J.M. Pandolfi, B. Rosen and J. Roughgarden. 2003. Climate Change, Human Impacts, and the Resilience of Coral Reefs. Science 301 : 929-933

Johannes, R.E. and M. Riepen. 1995. Environmental, Economic, and Social Implications of the Live Reef Fish Trade in Asia and the Western Pacific. Unpublished;

Mous, PJ., Pet, JS., Arifin, Z., Djohani, R., Erdmann, MV., Halim, A., Knight, M., Pet-Soede, L., Wiadnya, G. 2005. Policy needs to improve marine capture fisheries management and to define a role for marine protected areas in Indonesia. Fisheries Management and Ecology 12: 259–268

Pet-Soede, Lida., Hirason Horuodono and Sudarsono. 2004. SARS and the live food fish trade in Indonesia: Some anecdotes. SPC Live Reef Fish Information Bulletin #12 – February 2004.

PRPT-BRKP and PPPO-LIPI. 2002. Pengkajian Stok Ikan di Perairan Indonesia 2001. Badan Riset Kelautan dan Perikanan - DKP bersama Pusat Penelitian Oseanografi LIPI, Jakarta

Razak, T.B. 1998. Struktur Komunitas Karang Berdasarkan Method Transect Garis dan Transect Kuadrat di Pulau Menyawakan, Taman National Karimunjawa, Jawa Tengah. Skripsi Sarjana. Institut Pertanian Bogor. Bogor

Veron, JEN. 2000. Corals of the world. Australian Institute of Marine Science, Australia.

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