Status of Coral Reefs in the Surin and Similan Archipelagos, Thailand

NIPHON PHONGSUWAN, CHAIMONGKOL YAMARUNPATTANA, SATHIKA PAOKANTA & PAPANGKORN AREECHON

Phuket Marine Biological Center, P.O. Box 60, Phuket, 83000, Thailand

INTRODUCTION

The Surin and Similan Islands are located about 60 km off the Thai Andaman Sea coast, between latitudes 9o 28' 50.7" N to 8o 28' 22.4" N, and longitudes 97o 37' 53.1" E to 97o 54' 17.9" E. Since the area is close to the continental shelf edge there is no influence from sediment or polluted water from the mainland. As a result the region contains the largest area of fringing coral reefs in Thailand, covering approximately 12 km2 (about 15% of the total area of Thai reefs in the Andaman Sea).

Surin and Similan Islands, designated marine national parks in 1981 and 1982 (Lee and Chou, 1998) are of the same chain of granitic outcrops, with a total area (including marine area) of 135 and 140 km^2 respectively. They are the most popular diving destination in Thailand. The parks face significant internal and external management challenges. According to Worachananant (2007) the parks face internal and external challenges. Internally, staff are not sufficiently skilled to manage maritime environments, and externally illegal fishing, degradation of reefs from mass coral bleaching and human activities, such as overcrowding during peak seasons, are the focus of management.

Phuket Marine Biological Center, under the ASEAN-Australia Cooperative Programme, surveyed the reefs in this area between 1988 and 1989 using the manta tow technique, to explore the status of the reefs (Chansang, et. al. 1989). Manta-tow surveys were repeated in these areas during a second period 1995-1998 (Chansang, et. al. 1999) and a third period in 2002 (Phongsuwan unpublished).

The status of the reefs has changed over time due to natural as well as human disturbances. Illegal fishing in the no-take zone is still occurring especially in the monsoon season when patrols by park staff are insufficient. The increase of intensive diving tourism causes negative impacts to the reefs (Phongsuwan, 2006, Worachananant 2007). Impacts from frequent mass coral bleaching since the early 1990s has also been reported (Phongsuwan and Chansang, 2000). Reef damage from sporadic infestations of crown-of-thorns starfish has been reported since the mid 1980s (Chansang et. al. 1986) to the present.. Lastly, in late 2004 the reefs were damaged by tsunami waves (Phongsuwan et. al. 2006, Satapoomin et. al. 2006, Phongsuwan and Brown 2007). In view of these multiple processes Phuket Marine Biological Center has updated its evaluation of reef status by repeating reef surveys in 2006, the results of which are contained in this report.

METHODOLOGY

The manta tow technique (English et. al. 1986) was used for surveying reef characteristics, by estimating percentage cover of live coral, dead coral, and other sessile fauna (e.g. corallimorpharians, sea anemones,

Obura, D.O., Tamelander, J., & Linden, O. (Eds) (2008). Ten years after bleaching - facing the consequences of climate change in the Indian Ocean.CORDIO Status Report 2008. Coastal Oceans Research and Development in the Indian Ocean/Sida-SAREC. Mombasa. http//:www.cordioea.org

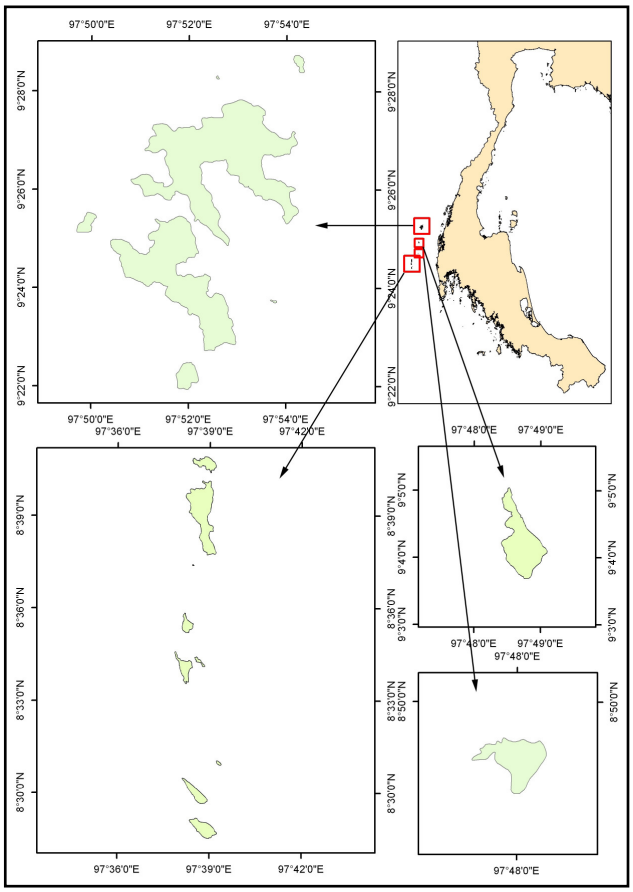

Figure 1. Study sites in Surin and Similan Marine National Parks.

soft corals, sponges), sand and rocky substrate. Coral species encountered were also recorded.

Surveys were carried out at 4 islands in the Surin and 10 islands in the Similan islands (Table 1, Fig. 1). The reefs generally extend down to 15 m, except at some specific sites such as those on the large bays on the east of Surin Island and Similan Island, where fully developed reefs continue down to 30 m depth. Two-minute manta tows were recorded on the interface between the reef edge and upper reef slope where depths ranged from 3-15 m. The number of replicate tows ranged from 4 to 190 depending on size of the island. The location of every tow was recorded by GPS.

A total of 419 two-minute-tows were made on reef

Table 1. Study sites, locations (GPS location approximately at the center of the islands) and total size of the reefs on the islands (from Chansang et al. 1999).

Island	GPS coordinates	Reef area (km^2)
Surin Mar. Nat. Pk.		
	9 ° 28.512'N;	0.079
Stok	97 ° 54.436'E	
	9 ° 28.037'N;	7.174
Surin	97 ° 53.463'E	
	9 ° 25.205'N;	0.111
Pachumba	97 ° 50.062'E	
	9 ° 22.112'N;	0.172
Torinla	97 ° 52.156'E	
Similan Mar. Nat. Pk.		
	9 ° 17.905'N;	0.853
Tachai	98 ° 19.672'E	
	8 ° 43.362'N;	0.130
Bon	98 ° 06.714'E	
	8 ° 40.250'N;	0.294
Ba-ngu	97 ° 38.397'E	
	8 ° 38.633'N;	1.941
Similan	97 ° 38.249'E	
	8 ° 35.416'N;	0.198
Payu	97 ° 37.931'E	
	8 ° 33.789'N;	0.367
Miang	97 ° 37.770'E	
	8 ° 33.998'N;	0.212
Ha	97 ° 38.290'E	
	8 ° 31.022'N;	0.014
Payan	97 ° 38.978'E	
	8 ° 30.276'N;	0.147
Payang	97 ° 38.094'E	
	8 ° 28.800'N;	0.376
Huyong	97 ° 38.443'E	

areas where the sum of live and dead coral was equal to or greater than 25% of the total benthic cover. It was estimated that each two-minute-tow covered a distance of about 120 m and therefore the whole survey covered a distance of 50 km over the reefs. Areas with sparse coral communities on rocky substrate, generally exposed to strong southwest monsoon waves, were not included in this study.

A status ranking of each reef was assigned

Table 2. Health status categories based on ratio of live coral cover (LC) to dead coral cover (DC). Decimal ratios are rounded to the nearest integer.

LC:DC	Health status
≥3 : 1	Very healthy reef
2 : 1	Healthy reef
1 : 1	Fair reef
1 : 2	Poor reef
1 : ≥3	Very poor reef

according to the ratio of live coral cover (LC) to dead coral cover (DC, Table 2). The average live coral cover surrounding the islands collected from surveys in period 1 (during 1988-1989), period 2 (during 1995-1998), period 3 (2002) and period 4 (2006) was compared.

RESULTS

The most abundant species were the main reef builders *Porites lutea, P. (Synaraea) rus* and *Acropora* spp. Table 3 shows distribution of dominant coral species at the study sites. *Acropora kosurini* named

Table 3 Dominant coral species found in the Surin – Similan Islands.

Dominant species	Stok	Surin	Pachumba	Torinla	Tachai	Bon	Ba-ngu	Similan	Payu	Miang	Ha	Payan	Payang	Huyong
Porites lutea	x	x		x	x	x	x	x		x	x			x
P. rus		x			x			x		x				
P. nigrescens		x					x		x	x			x	
P. cylindrica					x									
Acropora formosa		x					x	x				x		
A. nobilis	x	x	x	x		x								
A. clathrata		x				x	x	x						x
A. vaughani		x												
A. austera		x												
A. subulata		x												
A. humilis		x												
A. grandis		x												
A. microphthalma		x												
A. echinata-group		x												
A. florida													x	x
A. palifera							x	x						
Montipora aequituberculata		x				x								
Diploastrea heliopora		x			x	x								
Millepora platyphylla		x				x				x	x			
M. tenella		x			x		x			x	x			
Goniastrea retiformis								x						
Pachyseris speciosa		x												
Pocillopora verrucosa		x												
Turbinarea reniformis		x												
Hydnophora rigida							x	x	x	x	x	x	x	x
Echinopora lamellosa								x	x					
Heliopora coerulea	x	x			x	x	x	x	x					

Table 4. Reef health in 2006 and trends from 1995 to 2006. Total number of tows per island and the percentage of tows categorizing the reef status in each of five categories is shown. An "overall average rating" is provided for each island based on health in 2006. The long term trend in coral cover (Fig. 3) is shown: Inc – increasing, Dec – decreasing and Flu – fluctuating for statistically significant changes from one period to the next (1, 2, 3 and 4).

Island	# tows	% of tows					Overall rating		Trends
		very healthy	healthy	fair	poor	very poor			
Surin Mar. Nat. Pk.									
Stok	9	0	11.1	44.4	22.2	22.2	poor	(1 : 1.5)	
Surin	181	42.5	21	24.9	5	6.6	healthy	(1.8 : 1)	Flu: 1>2, 2<3
Pachumba	15	33.3	26.7	26.7	13.3	0	fair	(1.2 : 1)	
Torinla	13	38.5	30.8	7.7	7.7	15.4	fair	(1.2 : 1)	Inc: 1<2
Total	**218**	**39.9**	**21.6**	**24.8**	**6.4**	**7.3**	**healthy**	**(1.7 : 1)**	
Similan Mar. Nat. Pk.									
Tachai	30	46.7	20	30	3.3	0	healthy	(2 : 1)	Inc: 1<2<3<4
Bon	14	0	14.3	14.3	28.6	42.9	Poor	(1 : 2.2)	
Ba-ngu	18	5.3	21	73.7	0	0	fair	(1.2 : 1)	
Similan	46	6.5	23.9	30.4	21.7	17.4	fair	(1 : 1.3)	Flu: 1<2, 3>4
Payu	20	15	20	45	20	0	fair	(1.1 : 1)	Flu: 1>2, 2<3
Miang	13	0	7.1	78.6	14.3	0	fair	(1 : 1)	Inc: 2<3
Ha	14	0	64.3	35.7	0	0	healthy	(1.5 : 1)	Inc: 2<3
Payan	6	0	0	0	28.6	71.4	very poor	(1 : 3.2)	
Payang	22	27.3	4.5	45.5	18.2	4.5	fair	(1.2 : 1)	Dec: 1>2
Huyong	18	27.8	44.4	27.8	0	0	healthy	(2 : 1)	Dec: 1>2
Total	**201**	**15.8**	**22.7**	**38.9**	**13.3**	**9.4**	**fair**	**(1:1.1)**	
Overall	**419**	**28.3**	**22.1**	**31.6**	**9.7**	**8.3**	**fair**	**(1.4 : 1)**	

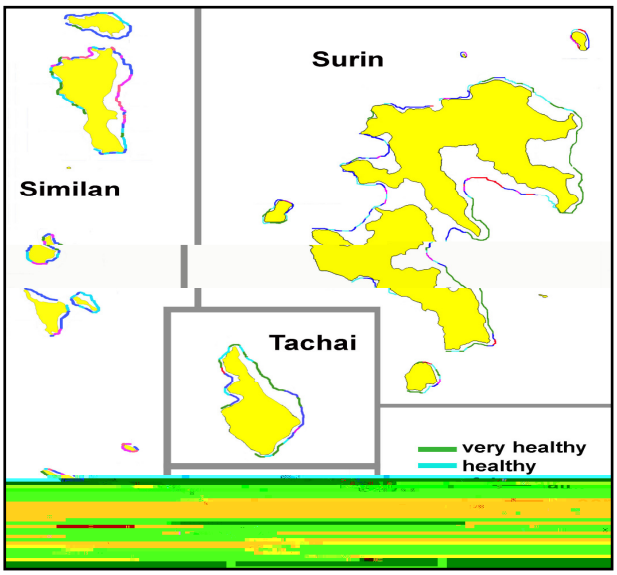

Figure 2. Manta tow results around the Similan islands for 2006.

after Surin Island and endemic to the region down to western Sumatra and the northwest of Australia (Wallace, 1999; Veron, 2000) was recorded as rare.

The condition of most of the reefs in Surin Marine National Park ranged from healthy to very healthy while those at Similan were assessed as being mostly in fair condition (Table 4). Overall, the reefs of the Surin islands are assessed to be in healthy condition, those of Similan fair. Overall results for the two island groups was an average total live cover and dead cover are 41.5% and 29.2% respectively, i.e. ratio of 1.4, i.e. fair condition. Fig. 2 shows Surin and Similan Archipelagos with the distribution of coral reefs and their health status.

DISCUSSION

A comparison of coral cover between the four study periods does not show a fixed pattern of change in live

coral cover over time (Fig. 3). Two main factors have been identified as having extensively disturbed the reefs in this region. Firstly, mass coral bleaching occurred in 1991 and 1995 and a minor bleaching event was recorded in 1998 (Phongsuwan and Chansang, 2000). The negative impact of coral bleaching was remarkable especially in sheltered bays and areas with dominant *Acropora* on shallow reef flats and down to the mid-slope at approximately 15 m depth. This includes e.g. the big bays on the east and north coasts of Surin Island and on the east coast of Similan Island (Phongsuwan and Chansang, 2000). Secondly, an outbreak of crown-of-thorns starfish caused reef destruction at some sites during the mid 1980s (Chansang et.al. 1986). A survey in 1985 observed crown-of-thorns starfish densely distributed or even aggregated on the rocky coasts exposed to wave action, with a higher density on small islands than on larger islands in the vicinity. The tsunami in late 2004 had a patchy effect on certain reefs (Phongsuwan et.al. 2006).

When live coral cover is compared between the first and second periods, 1988-89 to 1995-98, it is noteworthy that reefs deteriorated significantly only at Surin, Payu, Payan, Payang and Huyong. In contrast, live coral cover increased significantly on reefs at Torinla, Tachai, and Similan. When compared between the second and third periods, 1995-98 to 2002, live coral cover increased significantly at Surin, Tachai, Payu, Miang, and Ha. No sites showed any significant declines in coral cover over this time span. It is noteworthy that in spite of significant coral bleaching at Surin Island in 1995 the impact was very site specific and did not lead to an overall decrease in live coral cover. Between the third and fourth period, 2002 to 2006, coral cover increased significantly at Tachai, while at Similan coral cover showed a significant decrease. Live coral cover at this latter location, especially on the northeast part of Similan, declined by approximately 16% due to the impact of the tsunami in late 2004.

Considering the status of the Surin and Similan reefs over the long term the system as a whole appears resilient, however with the exception of Payan, a small island where an outbreak of crown-of-thorns starfish was recorded during a survey in 1995. The latest

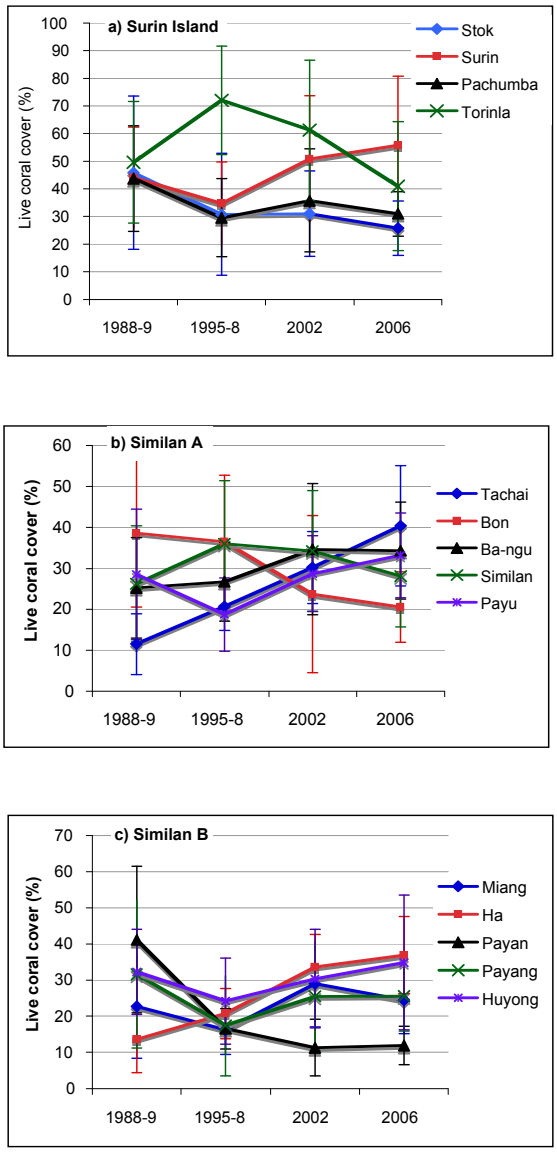

Figure. 3 Average live coral cover at study sites in a) Surin Islands National Park, and b,c) Similan Islands National Park, in the 4 survey periods. Error bars indicate standard deviation. Significant differences in coral cover from one period to the next, based on t-test of two independent samples, are summarized in Table 3.

survey in 2006 revealed that the reef had still not recovered. Payang, which is adjacent to Payan, showed a significant decrease of live coral cover over the same period. There is no clear evidence for the cause of reef destruction at this site. During a visit in 2001 to Payang considerable amounts of dead coral fragments were scattered on the steep sand slope along the northeast coast, and the survey in 2006 did not record any signs of recovery. The loosened coral fragments do not provide a stable substrate for coral settlement and recruitment, a factor which has been shown to be important in delaying recovery of reefs dominated by branching corals (Brown and Suharsono 1990). Another area that has shown poor response to stress is a reef located in the northwest bay at Similan Island. Anchor damage seems to be a major factor responsible for reef deterioration here. At present there is no sign of reef recovery although a mooring system has been introduced in the bay. Loosened coral fragments were abundant at this reef site and there were very few coral recruits on large dead massive corals. Waste-water discharged from live-aboard diving boats could be considered a possible factor that might prevent successful coral recruitment or re-growth.

In contrast, a nearby site at the southern cove of Ba-ngu Island appears very resilient. This reef was damaged by crown-of-thorns starfish in the mid 1980s, but recovery was rapid due to successful recruitment of fast growing species of *Acropora* of many growth forms, including arborescent, caespitose, digitate, submassive and tabulate. Other similar sites are found at the northern coast of Surin Island, and the eastern part of Torinla and Pachumba Islands. The eastern part of Torinla was highly damaged by tsunami waves in 2004. However, the living fragments of *Acropora nobilis* could regenerate rapidly (Phongsuwan and Brown, 2007). The negative impact from diving/snorkeling tourism was remarkable at some specific sites, especially on the east of Torinla and Pachumba where the reefs are shallow and made up of fragile species (Worachananant, 2007). Interestingly, the reefs at Tachai Island, having showed signs of bleaching in 1995, showed an increase in average live coral cover throughout the 4 study periods. Dead stands of *Porites cylindrica* were still common during the survey in 1997 (Chansang et. al. 1999). However this fast growing species together with another dominant species, *P. (Synaraea) rus*, contributed to reef recovery.

ACKNOWLEDGEMENTS

This work was fully supported by CORDIO. The authors would like to thank the staff of the Marine Biology and Ecology Unit of Phuket Marine Biological Center and boat crews who assisted with the fieldwork. The authors also thank Jerker Tamelander for his comments and editing.

REFERENCES

Brown, B.E., and Suharsono (1990). Damage and recovery of coral reefs affected by El Nino related sea water in he Thousand Islands, Indonesia. Coral Reefs 8:163-170.

Chansang, H., Boonyanate, P., Phongsuwan, N., Charuchinda, C. and Wangboonkong, C. (1986). Infestation of *Acanthaster planci* in the Andaman Sea. Paper presented at the Second International Symposium on Marine Biology in Indo-Pacific, Guam. (Abstract published in Bulletin Marine Science 41(2):634.

Chansang H., Satapoomin U. And Poovachiranon S. (ed.) (1999). Maps of coral reefs in Thai Waters: Vol.2 Andaman Sea. Coral Reef Resource Management Project, Department of Fisheries. 198 pp. (in Thai)

English S. Wilkinson C.R. and Baker V. (eds.) (1986). Survey Manual for Tropical Marine Resources. Australian Institute of Marine Science, Townsville, 368 pp.

Lee F. and Chou L. M. (1998). The Aseanarean Expeditions Series – Marine Parks of Thailand. SNP Publishing Pte Ltd, Singapore. 164 pp.

Phongsuwan N. and Chansang H. (2000). Repeated coral bleaching in the Andaman Sea, Thiland, during the last decade. Abstract in the Proceedings of the 9th International Coral Reef Symposium, Bali, Indonesia.

Phongsuwan N., Yeemin T., Worachananant S., Duangsawasdi M. Chotiyaputta C. and Comley J. (2006). Post-tsunami status of coral reefs and other coastal ecosystems on the Andaman Sea coast of Thailand. In Status of coral reefs in tsunami affected countries: 2005. Australian Institute of Marine Science. pp. 63-77.

Phongsuwan N. and Brown B. (2007). The influence of the Indian Ocean tsunami on coral reefs of western Thailand, Andaman Sea, Indian Ocean. (paper to be published in Atoll Research Bulletin)

Satapoomin U., Phongsuwan N. and Brown B. (2006). A preliminary synopsis of the effects of the Indian Ocean tsunami on coral reefs of western Thailand. (paper to be published in Phuket Marine Biological Center Research Bulletin in 2006)

Veron J.E.N. (2000). Corals of the World. Australian Institute of marine Science, PMB 3, Townsville MC, Australia. Vol. I, 463 pp.

Wallace C.C. (1999). Staghorn Corals of the World: A revision of the coral genus Acropora (Scleractinia; Astrocoeniina; Acraoporida) worldwide, with emphasis on morphology, phylogeny and biogeography. CSIRO, Collingwood, VIC, Australia. 421 pp.

Worachananant S. (2007). Management approaches in marine protected areas: A case study of Surin Marine National Park, Thailand. A thesis submitted for the degree of Doctor of Philosophy at the University of Queensland. 252 pp.