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17D Managing bleached coral reefs

# Impact of Coral Bleaching at Mu Koh Similan National Park

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**Abstract.** Coral reefs in the Andaman Sea are now under increasing pressures from marine tourism, especially snorkeling and SCUBA diving activities. The seawater temperature anomaly in 2010 also affected most coral communities. The present study aims to examine limits of acceptable change of coral communities from tourist activities and the coral bleaching impacts at Mu Koh Similan National Park, a popular diving spot in the Andaman Sea. Coral breakage was the most frequent damage category and it was worst in the shallow waters. The survey in December 2009 (before the high season) revealed that the average of live coral cover was 65.0% and it decreased to 63.22% at the end of high season. However the survey in November 2010 (after the coral bleaching event) showed that the average of live coral cover was only 25.19%. The most susceptible coral species to bleaching were *Montipora* spp., *Acropora* spp., *Pocillopora* spp., *Seriatopora hystrix*, and *Porites* spp. Certain diving sites at Mu Koh Similan National Park have been temporarily closed in order to build resilience and to enhance coral recovery. Scientists and national park managers have to work together closely with tourist companies and other stakeholders in order to carefully consider scenarios of coral bleaching impacts and coral reef ecosystem responses. Implementation of the science-based management plan for Mu Koh Similan National Park to cope with climate change and anthropogenic disturbances is very essential.

**Key words:** coral bleaching, limits of acceptable change, tourism, management, Mu Koh Similan.

## Introduction

The degradation of coral reefs around the world leads to the needs for quantifying the damage, identifying the causes and proposing problem solutions. Coral reefs provide goods and services which can supply millions of people along the coastline. (Moberg and Folke 1999; Hannak et al. 2011). The net economic benefits are calculated to be US$ 30 billion per year to world economies including tourism, fisheries and coastal protection (Cesar 2003). Previous studies showed that recreational and commercial human activities, coupled with growing human coastal populations are the main threats to coral reefs (Schuttenberg 2001; Wilkinson 2008; Burke et al. 2011).

The Andaman coast of Thailand is facing the complex of problems such as tourism impacts, destructive fishing practices and coastal development (Yeemin et al. 2006). Coastal tourism is an important sector for Thailand's economy. The nature-based tourism industry contributes significantly to national income and depends mainly on coral reef ecosystems. The condition of coral reefs in the Andaman Sea is relatively good, with high diversity of corals, fish and benthic invertebrates (Yeemin et al. 2010). Live coral cover in the Andaman Sea has decreased in certain reef sites during the last decade, coupled with a significant increase of broken and damaged colonies.

Coral fragment and partial mortality of coral colony were frequent damage categories (Riegl and Velimirov 1991; Jameson et al. 1999). They are good indicators for reef condition and can be used to assess the severity of coral damage due to natural or anthropogenic disturbances. Coral breakage was significantly higher at reef sites with high diving frequency. The damage was worst within the shallow coral reefs (Leujak and Ormond 2008). SCUBA divers and snorkelers were the greatest threat to a large number of coral reefs (Loya 2004; Zakai and Chadwick-Furman 2002; Yeemin et al. 2011). Fishermen also broke corals through trampling and net fishing

Increasing sea surface temperature due to global climate change has already resulted in mass coral reef bleaching events worldwide. Coral mortality and biodiversity decline are predicted to continue with increased frequency and intensity in coming decades (Hoegh-Guldberg et al. 2007; Bohensky et al. 2011). Recently, the seawater temperature anomaly in 2010 affected most coral communities in the Andaman Sea. (Klinthong and Yeemin 2011) Diving impacts on coral reefs include trampling, fin contact, standing on corals and re-suspension of sediment (Chabanet et al. 2005). The degree of physical damage relates to diver numbers (Hawkins and Roberts 1993; Rodgers, Cox 2003). Coral growth form and species composition differ in their susceptibility to diving activities, for example, branching *Acropora* colonies are the most fragile (Riegl et al. 1996)

Therefore diver carrying capacities can play a major role in controlling physical damage on corals. Previous

studies estimated capacities between 4,000 and 15,000 dives per site per year (Davis and Tisdell 1995; Jameson et al. 1999; Cesar 2003). Diving trails can give tourists an understanding of the marine environment and help restrict impacts to defined areas of the reefs (Harriott 2002; Franco et al. 2009).

The present study aims to examine limits of acceptable change of coral communities from tourist activities and the coral bleaching impacts at Mu Koh Similan National Park, a popular diving spot in the Andaman Sea.

## Material and Methods

This study was conducted at southeast of Payu Island, Mu Koh Similan National Park (N 8° 35' 23.16 E 7° 38' 31.33, Fig. 1).

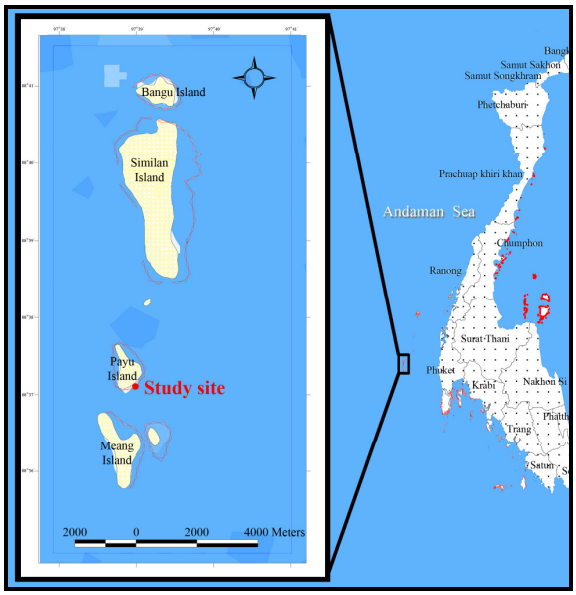


Figure 1: The study sites at Mu Koh Similan, the Andaman Sea.

The reef site is influenced by southwest monsoon from May to October. Coral communities well develop at 2-30 m in depth. Various coral growth forms dominate in this site, such as *Montipora monasteriata*, *Porites rus*, *P. lutea*, *Acropora microphthalma* and *A. elseyi*. The three permanent belt transects, 50X1 $m^2$, were set up at reef slope, 18 m for examining changes in live coral cover, coral fragment and partial mortality of coral colony. The study periods were December 2009 (before the high season), April 2010 (after the high season) and November 2010 (after the coral bleaching event). Carrying capacity was assessed by considering limits of acceptable change of live coral cover, coral fragment and partial mortality of coral colony between the study periods. In this study, percentage of changing below 25% is defined as below carrying capacity (below CC), 25-50% as approach carrying capacity (approach CC) and over 50% as exceed carrying capacity (exceed CC).

## Results

The survey before the high season in December 2009 showed that average of live coral cover was 65% and decreased to 63.22% at the end of high season. However the re-survey following the 2010 mass coral bleaching event showed that the average of live coral cover was only 25.19%. Therefore the percentage of changing in live coral cover was 61.25% and resulted in exceed carrying capacity (Table 1). The change of coral fragment during the high season was only 6.45% and was in below carrying capacity category. All observed coral fragments died after the bleaching event. The partial mortality of coral colony considerably changed and led to approach carrying capacity at the end of high season. The bleaching event caused a large number of whole coral colony mortality (Fig. 2-3). The most susceptible coral taxa to bleaching were *Montipora* spp., *Acropora* spp., *Pocillopora* spp. *Seriatopora hystrix* and *Porites* spp.

| **Parameter** | **December 2009 (before the high season)** | **April 2010 (after the high season)** | **Limits of acceptable change** | | **November 2010 (after the coral bleaching event)** | **Limits of acceptable change** | |
|---|---|---|---|---|---|---|---|
| Live coral cover | 65.00% | 63.22% | Change -2.74 % | **Below CC** | 25.19% | Change -61.25 % | **Exceed CC** |
| Coral fragmentation | 0.29% | 0.31% | Change +6.45 % | **Below CC** | 0%* | * | * |
| Partial mortality of coral colony | 0.18% | 0.12% | Change -33.33 % | **Approach CC** | 0.20% | Change +11.11 % | **Below CC** |

***All coral fragments died from the coral bleaching event.**

Table 1: Carrying capacity assessment for the coral reefs at Mu Koh Similan during December 2009, April 2010 and November 2010 (Levels of carrying capacity were assessed from percentage of changing; Below CC <25%, Approach CC 25-50%, Exceed CC >50%)

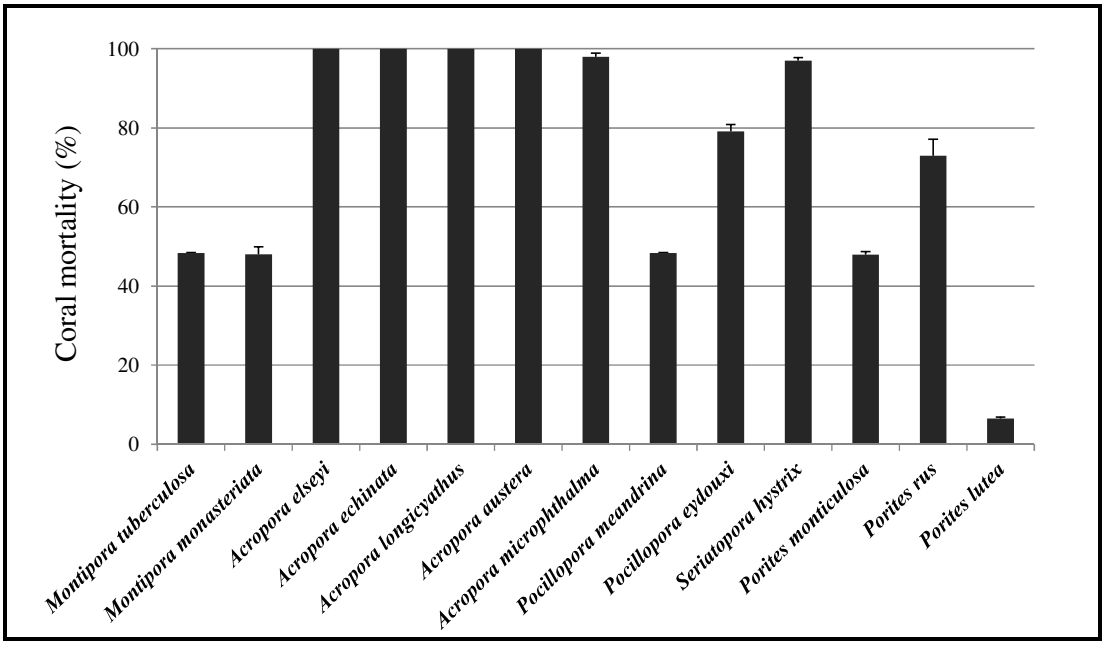


Figure 2: Percentage of coral mortality for each species following the 2010 mass coral bleaching event

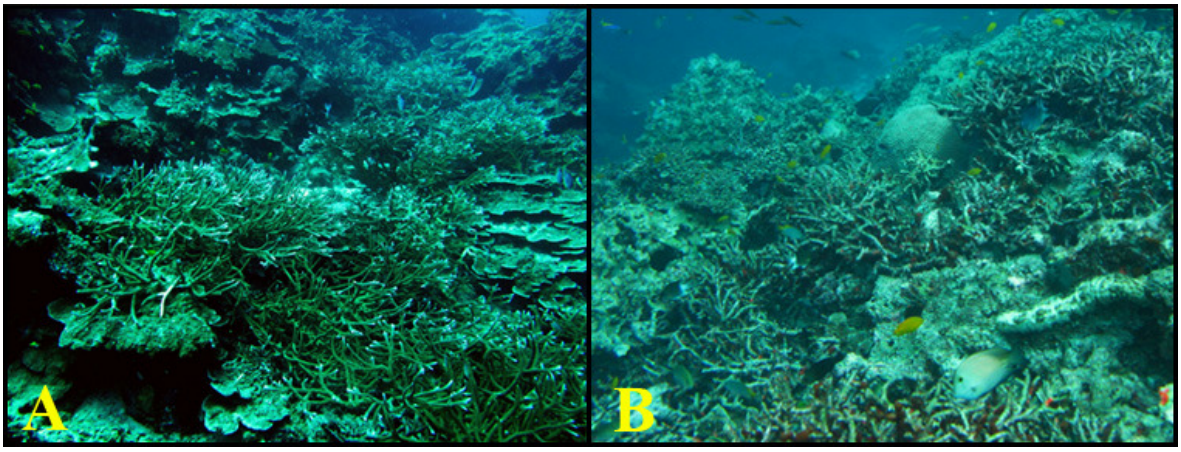


Figure 3: Coral community at the study site: A) Before coral bleaching B) After coral bleaching

**Discussion**

The coral community at our study site was dominated by the susceptible coral species to bleaching therefore the 2010 severe coral bleaching event caused heavily coral damages. The National Parks, Wildlife and Plant Conservation Department (DNP) has realized the impacts of coral bleaching. The key factor to reversing the situation is to immediately mitigate the environment stresses to further coral damages and provide good environment that facilitates the corals to recover. Therefore DNP announced the temporary closure of several diving spots, including East of Eden or Payu Island. The DNP has also developed several measures to ensure the appropriate management of coral reefs and marine resources for tourism purposes. These measures include repair and maintenance of existing buoys and installation of new buoys to prevent anchors on coral reef, promoting better knowledge and understanding of responsible tourism, increasing awareness and promoting a better understanding of the coral bleaching event. The Tourism Authority of Thailand (TAT) can play a major role in promoting increased awareness of environmentally-responsible tourism through the implementation of campaigns, such as the TAT's *Seven Greens* concept and *Travel with a New Heart, for a Sustainable Thailand* (Tourism Authority of Thailand, 2010). In conclusion, scientists and national park managers have to work together closely with tourist companies and other stakeholders in order to carefully consider scenarios of coral bleaching impacts and

coral reef ecosystem responses. Implementation of the science-based management plan for Mu Koh Similan National Park to cope with climate change and anthropogenic disturbances is very essential.

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