Leveraging Enterprise Partnerships for Coral Reef Conservation Outcomes

Kathryn Farrell Bimson

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Ecology (International Program)
Prince of Songkla University
2018

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ABSTRACT

As the health of coral reefs continues to decline worldwide, scientists must begin to broaden their engagement with stakeholders in marine conservation and restoration. Tropical beach destinations, such as Phuket, Thailand, depend on public perception of healthy coral reef ecosystems to continue to attract international tourists, whose visits constitute a significant proportion of the country's GDP. A large proportion of high disposable income visitors patronize corporate hotels, lured by the promise of exclusivity and highly aesthetic surrounds, and thus these businesses have a vested interest in protecting the marine resources surrounding their properties. By fostering mutually beneficial partnerships between NGOs, government agencies, and private enterprises, the agencies charged with protecting marine resources increase their potential scope for conservation activities. Highlighting conservation partnerships with local groups will also serve to increase the resorts' Corporate Social Responsibility (CSR) profile, a factor that is increasingly considered by travelers in trip planning. Reef rehabilitation is historically perceived as an expensive and highly technical endeavor, however this approach aims to scale-up low-cost models that have previously been proven effective on the community eco-tourism scale. Here, we analyze the strengths and weaknesses of traditional systems and

highlight the effectiveness of *de facto* enterprise co-management in reducing fishing pressure, pollution and physical damage to corals. The goal is development of a standard model for corporate hotel house reef conservation engagement that, once proven in implementation, can be easily exported to similar localities whose tourism is heavily dependent on marine ecosystem goods and services.

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LIST OF ABBREVIATIONS AND SYMBOLS

BGFD	Broken Discarded Fishing Gear
DoF	Department of Fisheries
DNP	Department of National Parks
DMCR	Department of Marine and Coastal Resources
EMPA	Entrepreneurial Marine Protected Area
IUCN	International Union for Conservation of Nature
MPA	Marine Protected Area
NGO	Non-Governmental Organization
PCA	Principal Component Analysis
PMBC	Phuket Marine Biological Center
THB	Thai Baht
USD	United States Dollars

CHAPTER 1

Current status of Coral Reefs and Conservation Efforts

1.1 Coral Reefs

Coral reef ecosystems around the world are under increasing assault from an array of anthropogenic stressors on both local and global scales (Wilkinson 2008). Although global climate change and its associated long-term environmental effects threaten the integrity of reef ecosystems on a large scale, local actions such as overfishing, coastal development and pollution currently pose an immediate threat to more than 60% of the world's reefs, and 85% of reefs within the Coral Triangle (Burke, Reytar, Spalding and Perry 2012). In spite of increasing public awareness of reef degradation, coral reef health continues to decline; in the Indo-Pacific, yearly loss of coral cover was approximately 1% over the last twenty years, and 2% between 1997 and 2003 (Bruno and Selig 2007). According to Wilkinson (2008), 19% of the services provided by the world's coral reefs were effectively lost a decade ago; either rendered non-functional due to degradation or polluted so heavily that most organisms were unable to survive. To address this loss, governments around the world are acting to passively protect large-scale reef ecosystems by augmenting the existing network of marine protected areas (MPAs). In many areas, however, the reefs are so badly degraded that active restoration is needed, and researchers are continuing to investigate new methods and technologies to restore reefs to a healthy state, using both asexual reproduction and larval rearing techniques. Collaborations between researchers, private organizations, government agencies and citizen scientists serve to actively address the loss of coral cover on small scales, while investigating approaches to decrease associated costs and scale-up the project size. Engaging corporate stakeholders, such as beach resorts in areas with reef-based tourism, can serve as an alternative revenue source for these costly restoration programs. Additionally, allowing recreational divers to actively participate in restoration provides another avenue to raise much-needed funds for these costly projects, while also reducing the manpower required from trained coral scientists, allowing for greater areas of reef tract to be restored. Establishing these programs within corporate

hotels creates a much-needed funding avenue for costly reef restoration, while also providing stakeholders with a positive corporate social responsibility project.

1.2 Marine Protected Areas

One of the key roles of marine protected areas is to reduce or eliminate the impacts of human activities—especially fishing—on the protected area, providing the ecosystem a reprieve from anthropogenic threats. Between 1996-2006, about 40 new marine protected areas (MPAs) were created to protect coral reefs worldwide (Mora 2006). After negotiating and establishing the development of a marine protected area, the remaining obstacle is the effective enforcement of the established laws. A study on the effectiveness of MPAs by Mora (2006) found that despite 18.7% of coral reef ecosystems being located within marine protected areas, only 1.6% of the total reef area is within a well-enforced MPA that prevents poaching within its boarders.

An investigation into the benefits of MPAs found that they were most profound when they met five key criteria: well enforced, no take, large (>100km^2), old (>10 years) and isolated from adjacent fished reefs by sand or deep water (Edgar et al. 2014). The researchers found that 59% of the MPAs investigated only met one or two of these key criteria; as a consequence, it was nearly impossible to distinguish these so called “protected areas” from fished sites using ecological data (Edgar et al. 2014). They did, however, find that effective MPAs have twice as many large fish species per transect, and fourteen times higher shark biomass than fished areas, highlighting the impact of these key criteria on ecosystem function (Edgar et al. 2014). Others have found that MPAs that allow some use, whether seasonally, or using only specific fishing techniques, can be as effective as no-take areas, due to low rates of compliance in strict no-take areas (McClanahan et al. 2006).

In Southeast Asia, where marine biodiversity is the highest in the world, forty-six percent of marine protected areas have little to no management in place (Tun et al 2004), a direct result of improper planning and inadequate long-term funding. Changes in government regimes have also been shown to have a direct affect on marine park funding and consistency of enforcement. Enforcement of MPAs is further

burdened by accessibility from shore, failure to assign enforcement responsibility to a specific agency, and inadequate public support, leading to poaching in the area (Jones 2002). Enquiries into successful MPAs have found that participatory decision-making between stakeholders on the local, national, and international levels provides a sense of ownership over the area and leads to a greater chance of compliance within the MPA (Fox et al. 2012). Recently, there has been a gradual change from a top-down planning approach to a bottom-up method, allowing the implementation of community goals and local collaboration, as well as an adaptive management plan that provides flexibility throughout the planning process (Ban et al. 2011). Involving local stakeholders and providing adequate compensation for lost fishing grounds is essential to reach conservation goals.

1.2.1 Entrepreneurial Marine Protected Areas

One solution to the lack of funding for marine conservation is to engage local stakeholders who benefit financially from healthy reefs. Businesses such as beachfront resorts and dive operators in Southeast Asia have begun collaborating with local governments to protect reef ecosystems, leading to mutually beneficial outcomes for both the private sector and government agencies. Arrangements vary according to location and the stakeholders involved, however in each case, the local government has permitted the private sector a degree of control over the management and enforcement of a protected area adjacent to their property, relieving the local government of the duty of enforcing the area and allowing them to direct their focus elsewhere.

The concept of Entrepreneurial Marine Protected Areas (EMPAs) was first proposed by Colwell (1997), who suggested that dive resorts that have an economic incentive to protect marine life can be the primary protectors of small-scale commercially supported MPAs. These EMPAs can protect small areas of reef that serve as refuges for threatened marine life while also building local capacity in MPA management and increasing public awareness of MPAs. Many resorts with private beaches already demonstrate *de facto* control over adjacent reefs by controlling the only land-based access to the reef area. Developing multi-stakeholder partnerships to

legitimize this management can lead to more effective marine protection. Ultimately the development of EMPAs in tourism hubs can create an expanded network of small, locally run MPAs that use tourism and commercial support to achieve long-term economic and environmental sustainability (Colwell 1997).

The IUCN World Parks Congress in 2003 built upon Colwell's assertion of the importance of developing multi-stakeholder partnerships amongst governments, the private sector, non-profits, and local communities (IUCN 2003). The Durban Action Plan highlights the value of private-owned reserves and their ability to act complementarily to government protected areas in order to achieve conservation objectives. Recent trends show a shift from solely government managed protected areas towards increased participation of stakeholders including the private sector, NGOs, and local communities (Dearden, Bennett, and Johnston 2005). Historically, 54% of terrestrial parks have had private sector involvement, however, marine parks have significantly less private sector participation (Dearden, Bennett, and Johnston 2005). Over the last three decades, small-scale marine projects have been developed in coastal countries, with varying degrees of success.

There has been considerable diversity in approaching the development of conservation areas in partnership with the private sector. A reluctance by government agencies to be seen as too agreeable to private interests or to appear to favor particular private entities has hindered dialogue, especially where the probity of public financing may be disputed (Stott and Goldberg 2015). One of the pioneering projects in marine ecosystem co-management was established in Zanzibar, Tanzania, where a private marine conservation project named the Chumba Island Coral Park (CHICOP) was developed in 1991 (Riedmiller 2003). CHICOP was given management rights by the government and turned the uninhabited island into an MPA with 7 eco-bungalows, a nature trail and visitor center. The cost of rooms caters to higher end tourists with disposable income who are willing to pay a premium to interact with healthy ecosystems. Local fishermen were trained as park rangers and enforced regulations prohibiting fishing and anchoring on the reef (Riedmiller 2003). The reef has since become one of the healthiest in the region due to successful enforcement by the

unarmed rangers. The park has also collaborated with local universities and NGOs to conduct research and develop educational programs both on the island and with nearby communities. CHICOP stresses the importance of educating local fishermen about the importance of the protected area and the spillover effect to nearby fisheries, leading most to respect the boundaries of the park (Riedmiller 2003).

In Vietnam, Whale Island Resort, an ecotourism resort in Hong Ong, noticed damage to the resort's house reef from destructive fishing techniques such as blast fishing and cyanide fishing (Svensson, Rodwell, and Attrill 2008). The resort approached the local provincial government for permission to restrict public access to the bay and negotiated a 10-year lease on the reef to protect it, creating a hotel managed marine reserve (HMMR). The reserve totals two bays, on either side of a peninsula, and encompasses 16 hectares of ocean. Surveys have reported that fish density, size and diversity within the reserve are significantly higher than those measured outside the boundaries of the protected area (Svensson, Rodwell, and Attrill 2008). The hotel has worked to actively restore damaged coral by creating artificial reefs and initiating a coral transplantation project. A "willingness-to-pay" survey found that guests staying at the resort would be willing to contribute an additional median cost of US $9.60 per night (10% of nightly room rate) to stay at a location with a hotel-managed marine reserve. Though the resort initially did not charge an additional fee to supplement the cost of their conservation efforts, it could provide a substantial source of income in the future (Svensson, Rodwell, and Attrill 2008).

Conservation fees levied on hotel guests have proven to be a successful means of funding at Lankayan Island Dive Resort located in Sugud Island Marine Conservation Area (SIMCA), Malaysia (Teh, Teh, and Chung 2008). Reef Guardian, a private non-profit organization, charges resort guests a nightly conservation fee of US $6.15/night, and the funds are used for training staff, enforcing the no-take zone, reef cleanups, Crown of Thorns starfish removal, and maintaining patrol boats (Reef Guardian 2018). Reef Guardians are certified as Honorary Wildlife Wardens by the Sabah Wildlife Department, highlighting the effectiveness of collaborative management among stakeholders and the importance of government support. Since

the establishment of Reef Guardian in 2004, the total number of nests for both green sea turtles and hawksbill sea turtles has increased steadily (Teh, Teh, and Chung 2008).

In neighboring Indonesia, Wakatobi Dive Resort developed its own hotel managed marine reserve, which includes a 200 hectare no-take sanctuary and a 500 hectare buffer zone where fishing with traditional fishing gear is permitted (Svensson, Rodwell, and Attrill 2008). The resort pays an annual leasing fee to nearby affected communities and sponsors school materials, conservation lectures, and wastewater management technology for the surrounding area (Svensson, Rodwell, and Attrill 2008).

A study on private sector engagement at two reefs near Bali, Indonesia found that the sustainable use of coral reefs can be coordinated with pre-existing local governments and community structures (Bottema and Bush 2012). Both sites invested in Biorock technology, a coral restoration method that uses low voltage currents to grow limestone on underwater structures. On Gili Trawangan, local dive operators came together to create the Gili Eco Trust, an alliance to remove industry competition, and developed a dive tax to compensate local fishermen who had lost their traditional fishing grounds due to a newly developed marine park. In Bali, two entrepreneurs began educating local fishermen about reef degradation and developed a turtle hatchery and coral nursery, creating a no take zone and charging entry fees to the reefs with BioRock structures (Bottema and Bush 2012). In 2006 they established the Reef Gardeners, a group of former fishermen trained to repair damaged corals and protect the reefs (Bottema and Bush 2012). The EMPAs in Indonesia show that "traditionally business-oriented concepts such as entrepreneurship can contribute to a broader understanding of marine conservation, and that profit oriented agents can successfully put forward alternative organizational structures and technologies which can support the sustainable use of coral reefs" (Bottema and Bush 2012).

In the Philippines, Alegre Beach Resort in Cebu established a 16-hectare marine sanctuary, and conducts coral reef restoration and conservation activities such

as the removal of corallivorous *Drupella* snails and crown-of-thorns starfish (*Acanthaster planci*) (Svensson, Rodwell, and Attrill 2008). The resort also deploys artificial reefs, plants seagrass beds nearby to stabilize the substrate, and dredges the reef flat to increase available space for coral recruits (Svensson, Rodwell, and Attrill 2008). This holistic approach to reef conservation and restoration is crucial for rehabilitation reefs that have previously been threatened by coral bleaching and overfishing.

These case studies highlight the wide range of approaches to the establishment and funding of private sector managed marine conservation areas. While resorts in many countries in Southeast Asia have done this, no businesses in Thailand have been formally acknowledged as having a similar hotel managed marine reserve or entrepreneurial marine protected area, therefore funding for marine protected areas remains low, and enforcement capacity is limited. A recent analysis of entry fees for marine parks in Thailand, Malaysia and Indonesia found that potential increases in user fees would have a limited effect on the total number of international divers frequenting these destinations (Pascoe et al. 2014). The funds generated from these fees could lead to increased enforcement and more effective management, leading to an increase in reef health and subsequently increasing diver satisfaction.

Oceanfront resorts similar to the ones mentioned above, which have *de facto* control over adjacent house reefs, are another answer to the issue of understaffed marine park agencies. The resort staff has direct access to the reef and is often in the beach vicinity, allowing them to observe any forbidden activities taking place. A study analyzing the effect of resorts in the Maldives found that the house reefs had a higher cover of reef building hard corals and significantly less algae, than those near local community islands (Moritz et al. 2017). This suggests that the presence of the resort acts as a deterrent to local fishermen and can serve as a refuge for reef organisms include corals, echinoderms, and commercially important fish species (Moritz et al. 2017).

1.3 Phuket Tourism

Historically, Phuket is Thailand's central hub for marine tourism, making it an ideal location to investigate the potential of engaging the corporate sector in reef restoration. Phuket tourism constitutes approximately 30% of Thailand's national tourism income, with dive tourism on the island's surrounding reefs contributing approximately $150 million per year in direct benefits to the local economy (Dearden et al. 2004). During the development of Phuket in the 1980s and 1990s there was a substantial increase from fewer than 10 commercial dive shops in 1980 to 85 in 2002 (Dearden et. al 2004). The Thai government and associated non-profit organizations (NPOs) recognized the value of the marine areas and began developing marine parks to protect them: over 50% of Thailand's reefs are now located within areas that have been designated as marine national parks (Chettamart and Emphandu 2002). Despite marine park designations, the continuing exploitation of Thailand's once abundant marine resources has led to a decline in the health of coral reefs. According to the World Bank, over 80% of Andaman Sea corals and 50% of Gulf of Thailand corals were reported as being in medium or poor status (World Bank 2007). National statistics for the status of coral reefs post-bleaching in 2010 have not yet been published.

Decreases in coral reef health can have significant impacts on Thai tourism. Recent research on the overall value of coral reefs to tourism has found that 1.08 billion USD was generated from "on reef tourism" such as snorkeling or diving throughout the country (Spalding et al. 2017). In addition to the direct uses, reefs also provide indirect tourism benefits including the generation of white sandy beaches (Perry et al. 2015), clear waters, seafood production, and protection from storms (Spalding et al. 2017). These "reef adjacent" benefits provide 2.4 billion USD per year in total tourism value in Thailand, the fourth highest value of any country in the world, emphasizing the importance of conserving these ecosystems (Spalding et al. 2017). Phuket tourism is highly dependent on healthy marine ecosystems, therefore, corporate enterprises have a vested interest in contributing to the conservation and restoration of these areas.

1.3.1 International Guest Engagement

Due to the continuing decline in the health of Thailand reefs, restoration projects – both privately funded and using donations from paying volunteers – have increased in popularity in the region serviced by Phuket's tourism industry. Research on Koh Tao, in the Gulf of Thailand, has found that there is a high willingness-to-pay for the protection of natural ecosystems amongst visitors to the island, especially if they are able to actively participate in protection (Scott and Phillips 2010). This restoration was carried out by a small dive shop on an 21 km^2 island that has become the center of dive training in Thailand, with 59 dive shops (PADI and SSI, 2018). Surveys of the reefs surrounding Koh Tao have also found a correlation between high use dive sites and increased prevalence of coral disease and physical damage (Lamb et al. 2014), highlighting that reefs at dive destinations can be negatively affected by divers, thus prompting the need for restoration projects.

The purpose of this study was to investigate the feasibility of engaging international corporate beachfront hotels on Phuket in reef based ecotourism. While the research in dive-centric Koh Tao has shown that there is ample support for reef restoration activities, we wanted to explore whether there was similar support amongst a high-end clientele that had more diversified interests while on vacation. In addition, engaging the management of corporate hotels that have international reach and larger corporate budgets can serve as a new method of procuring much-needed resources for active reef restoration.

The impact of conservation activities at corporate hotels with over 400 rooms is amplified, and environmental awareness campaigns and fundraising can have a higher impact at these properties than smaller boutique hotels. Past studies on the development of hotel managed conservation areas have highlighted that guests support projects where the hotel has aligned its objectives with the local community, government, and an environmental agency (Svensson, Rodwell, and Attrill 2008). The visibility of these projects is also essential; hotels should highlight conservation areas on website homepages and any advertising targeting international tourists (Svensson, Rodwell, and Attrill 2008). In addition, environmental certifications and awards are

essential in increasing marketing value and providing hotels a return on their social responsibility initiatives (Riedmiller 2003).

Environmental mitigation and restoration projects are commonly espoused for their ecological positives, but such projects can also provide significant socioeconomic and cultural benefits to local communities; projects that explicitly incorporate efforts to build community awareness, involvement, and a shared responsibility for a site may ultimately create the long-term capacity for sustainable stewardship programs (Kittinger et al. 2016). Public-private conservation partnerships are increasingly being seen as a mechanism to augment the jurisdiction of management agencies with limited resources or mandate to achieve mutually beneficial conservation outcomes. Moreover, engagement of corporate partners can have unexpected and powerful conservation outcomes; for instance, the engagement of high profile hotel chains in initiatives aimed at reduction of single-use plastics has cascaded into Phuket municipality declaring itself "foam-free" in 2018 (Mueanhawong 2018). Corporate Social Responsibility (CSR) is increasingly recognized as conferring market advantage in the competitive island resort industry. Increasing pressure from stakeholders has forced tourism companies to adopt sustainable practices and those that do may see market advantage (Fatma, Rahman, and Khan 2016). Guests are increasingly employing CSR profiles as an adjunct to decision making for their holiday accommodation, and data suggest that consumers exhibit more positive response toward establishments which display higher levels of social responsibility, even when the extent of such practices is unclear (Parsa et al. 2015).

1.4 Project Objectives

The main objective of this project is to develop a multi-stakeholder model to enable corporate resorts to better manage their house reefs in collaboration with NGO and governmental partners. Specifically we aim to:

- Develop a framework for educating international visitors about coral reef ecosystems and how to protect them

- Engage corporate funding to implement and support marine conservation initiatives by local government agencies
- Create an exportable template for establishing similar projects in other locations that are heavily dependent on reef tourism

CHAPTER 2
Research Methodology

2.1 Site Selection

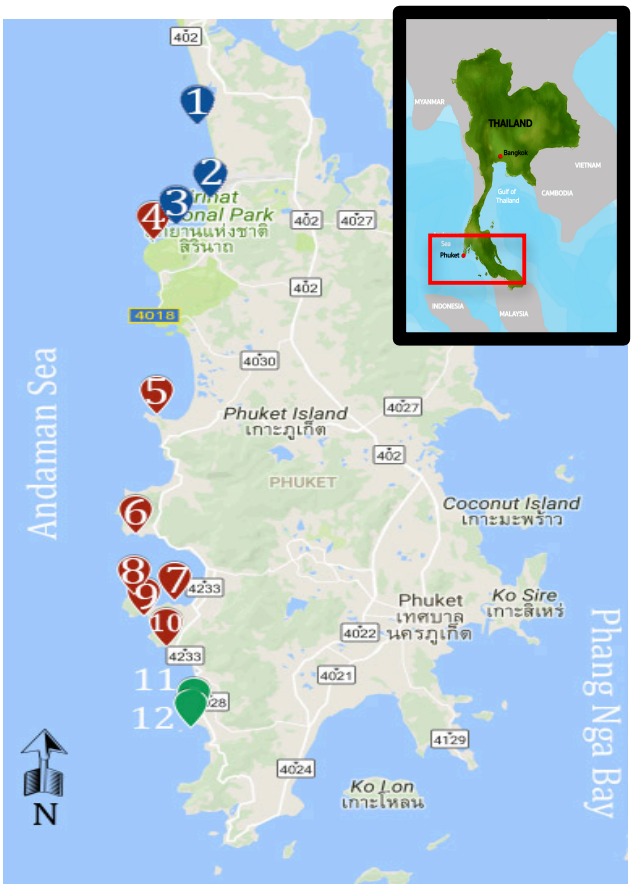
The study was conducted on the shallow fringing reefs of Phuket, Thailand. The island is 576 km^2 and connected to the mainland by a bridge in the north. Phuket is a well-established tourism destination, with an international airport directly connecting it to many major cities in Asia and Europe. The majority of development is along the white sandy beaches of the west coast, where all of the survey sites are located. Phuket is Thailand's main hub for beach and reef tourism, and the number of diver enterprises on the island grew from only 4 shops in 1979 to 85 enterprises in 2002 (Bennett 2002). There are currently a total of 81 dive shops in Phuket registered with PADI and SSI (PADI and SSI 2018).

The seasons on Phuket are dictated by the southwest monsoon occurring from May to November, bringing large waves, rain and onshore winds to the area. From December to April, the northwest monsoon keeps the area dry and the ocean calm, these months are thus considered high season for tourism, where many hotels are fully occupied for the duration of the season. The majority of dive tours visit nearby islands such as Koh Ratcha Yai, Koh Ratcha Noi, and Koh Phi Phi, leaving from the main pier in Chalong Bay. Only a small proportion of divers and snorkelers spend time exploring Phuket's reefs.

Phuket is surrounded by the Andaman Sea, and hosts a relatively diverse community of scleractinian corals. The surrounding waters have a high concentration of nutrients due to the mangrove ecosystems to the north and offshore oceanic upwelling (Janekarn and Hylleberg 1989). The majority of coral reefs occur on the western coast of the island, while mangrove forests and turbid waters dominate the east coast, with few patchy reefs within Phang Nga Bay. Each of the 12 reefs surveyed was within 200 meters from the western coast of the island, allowing for the majority of the reefs to be surveyed via shore dive (**Figure 1**). Some sites that were

adjacent to undeveloped areas were less accessible and required the hire of a local wooden longtail boat.

Sites along the west coast of Phuket fall broadly into three main management clusters in terms of public access. In the first group, private land owners (or those with exclusive use of a site) are able to limit public access to the reef areas by a variety of means. For the most part, these are adjacent to "high-end" resorts that maintain security staff at the property entrance who allow few who are not hotel guests or staff to enter. This groups includes sites at: Amanpuri Bang Tao, Naka Resort, Coral Beach, Paradise Beach, Merlin Beach and Le Meridien. The exception to this rule is the site named by dive tour operators as Coral Gardens; this site lies within Sirinart National Park, but is accessible only by boat. The second group includes sites that lie within Department of National Parks jurisdiction (Sirinart National Park) but are accessible by shore. All of these sites (Mai Khao/Renaissance, Sirinart North and Koh Ping) were once dominated by large stands of branching *Acropora* corals that were wiped out entirely by the 2010 mass bleaching event. The DNP exerts some degree of control by charging entrants an access fee, but the shores remain popular picnic spots on weekends and holidays. Activities such as fishing and harvesting of marine biota are strictly not allowed in National Parks in Thailand, but an amount of gleaning and fishing occurs nonetheless – often outside the hours of regular patrol by DNP staff or conducted by illiterate migrant workers unfamiliar with the regulations. The third class of sites is those without restrictions on public access (or for the most part, activities). The two southern sites are readily accessible and are immensely popular picnic and watersport locations for tourists and local Thai people alike. Likewise, the southern sites (Karon South and Kata) are open to fishing by recreational and small scale commercial anglers.



1 Mai Khao/Renaissance
2 Sirinat North
3 Koh Ping/Nai Yang
4 Coral Gardens
5 Amanpuri Bang Tao
6 Patong North/Naka Resort
7 Coral Beach
8 Paradise Beach
9 Merlin Beach
10 Le Meridien
11 Karon South
12 Kata

Level Of Access
Red: Restricted Access
Blue: Semi-Restricted
Green: No restrictions

Figure 1: Study Sites on Phuket, Thailand

2.2 Impacts on Phuket's Reefs

Historically, the coral reefs surrounding Phuket have been exposed to a series of natural and manmade threats. Elevated sea surface temperatures were recorded in the area in 1991, 1995, 1997, and 1998 (Dunne and Brown 2001). Many coral colonies bleached during May 1991 and 1995, however there was no bleaching recorded during 1997. Sea temperatures were higher in 1998, despite this, only limited bleaching occurred in Phuket, leading to partial mortality in some colonies, with many recovering coloration within 3-5 months (Dunne and Brown 2001).

Though having a greater impact on land than in the sea, the 2004 tsunami left 13% of the reefs in the Thai Andaman Sea in a highly damaged state, with the reefs of southern Patong being the only reefs on the island that were severely impacted, including Coral Beach (**Figure 1, Site 7**) (DMCR 2005).

In 2010, the corals of Thailand again bleached in response to increased sea temperatures, leading to 50-90% coral mortality in the Andaman Sea (Wilkinson 2008). Compared to the 1998 bleaching event, the 2010 event was more severe in the Andaman Sea when compared to the Gulf of Thailand.

2.3 Ecological Survey Data Collection

Surveys were conducted over a two-week period in March 2018. Data was collected using 3 replicate belt transects (20 meters length x 1 meter width). Transects were placed between an average of 5-7 meters depth, with the exceptions of one shallow reef averaging 3.2m and an offshore reef averaging 9.6m over three transects. Transects were laid at random locations parallel to the nearest shore.

A team of researchers recorded various coral health variables. One observed coral health and the presence or absence of common coral diseases. A second researcher recorded live coral cover (cm) to genus level and colony size, noting any sedimentation or signals of stress. Finally the third researcher noted coral juveniles (≤50 mm), broken discarded fish gear (BDFG), plastics, physical damage, recent mortality, and corallivorous Crown of Thorns starfish (*Acanthaster plancii*) and *Drupella* spp. snails.

2.4 Multi-Stakeholder Partnership Development

The property where the majority of the partnership development projects were based is the Phuket Marriott Resort & Spa, Merlin Beach. Marriott recently took over management of the 440-room resort, after having previously been under local management. The property is located on a peninsula south of Patong, on a southwestern facing cove with a coral reef throughout the bay. The hotel controls the majority of access to the beach, with the exception of a small access road where locals can enter the area. Before opening the resort, the management expressed interest in working with the International Union for the Conservation of Nature (IUCN) to develop some on-site reef education programs. Marriott and IUCN have previously

worked together to develop the Mai Khao Marine Turtle Foundation at the JW Marriott Phuket and collaborated to plant mangroves as part of the Mangroves of the Future initiative. This is the first project focused directly on coral reef ecosystems.

Before opening, the hotel management converted a beachfront pavilion to a Reef Education Center, where IUCN could post information highlighting the reef and use the area to conduct educational programs for guests. The on-site dive shop, Sea Bees Diving, is also present at the reef center to offer diving and snorkeling and certification courses. The area is used for snorkel and dive briefings for guests, teaching them about corals and how to snorkel the reef safely. Weekly reef surveys are conducted; removing discarded fishing gear and reattaching any broken coral to the reef. Guests are encouraged to participate in these activities while diving. The IUCN Marine Biologist records damage to the reef and this data has been used to highlight threats to the reef biodiversity.

IUCN has served as an intermediary, connecting the hotel to the government agencies, including the Department of Marine and Coastal Resources (DMCR), Department of Fisheries (DoF), and the Department of National Parks (DNP). Each group has something useful to contribute to reef conservation, while also having drawbacks **(Table 1)**. In this partnership the stakeholders can work in unison to protect coral reefs.

Reef conservation projects are mostly funded through the guest donation program. Upon check-in, guests are informed about the IUCN/Marriott collaboration and are encouraged to visit the Reef Education Center to learn more about the house reef and marine ecosystem. Visitors to the Reef Education Center were recorded and attendance was tracked throughout the year. When checking out, guests were asked to donate $1 USD per night of their stay to support future conservation projects. This allowed them to directly contribute to the program and support the health of the coral reef. The donations were added to the room bill upon checkout, enabling the staff to accurately track program donations.

Table 1: Stakeholder Strengths and Weaknesses

Agency	Strengths	Weaknesses
Corporate hotels with house reefs	•Oceanfront Location •Staff on site •**Funding (CSR, guest donations)**	•No legal standing •Limited understanding of ecosystem
Department of National Parks Wildlife and Plant Conservation (DNP)	•Legal authority •Established presence on Phuket	•Difficulty of establishing new national park •Minimal enforcement capacity •Understaffed ecology unit
Department of Marine and Coastal Resources (DMCR)	•Legal authority •Scientific government agency •Background in reef restoration •Ability to sequester special funding	•Not authorized to develop fishing restrictions (although some power to zone use of areas) •Minimal enforcement capacity •Understaffed ecology unit, limited operational funding
Department of Fisheries (DoF)	•Legal authority •Authority to restrict fishing and subsequent coral damage	•More focused on fish than reef ecosystems •Minimal enforcement capacity •Understaffed ecology unit
IUCN or other International NGOs + Academic partners	•Global scientific knowledge •Active intermediary	•No local jurisdiction to establish laws •No independent funding

CHAPTER 3
RESULTS AND DISCUSSION

3.1 Ecological Survey Data

3.1.1 Community composition

There were no significant patterns of community composition amongst the surveyed sites, with the exception of the northernmost sites, which have not recovered from the 2010 mass bleaching event and have undergone phase change to algal-dominated ecosystems (**Figure 2**). Historical accounts of these sites list them as being dominated by staghorn *Acropora* species, which were the most severely affected by the 2010 event. They remain *Acropora*-dominated, but the large stands of staghorn are absent, and these site are more strongly characterized by encrusting faviid and oculinid coral species.

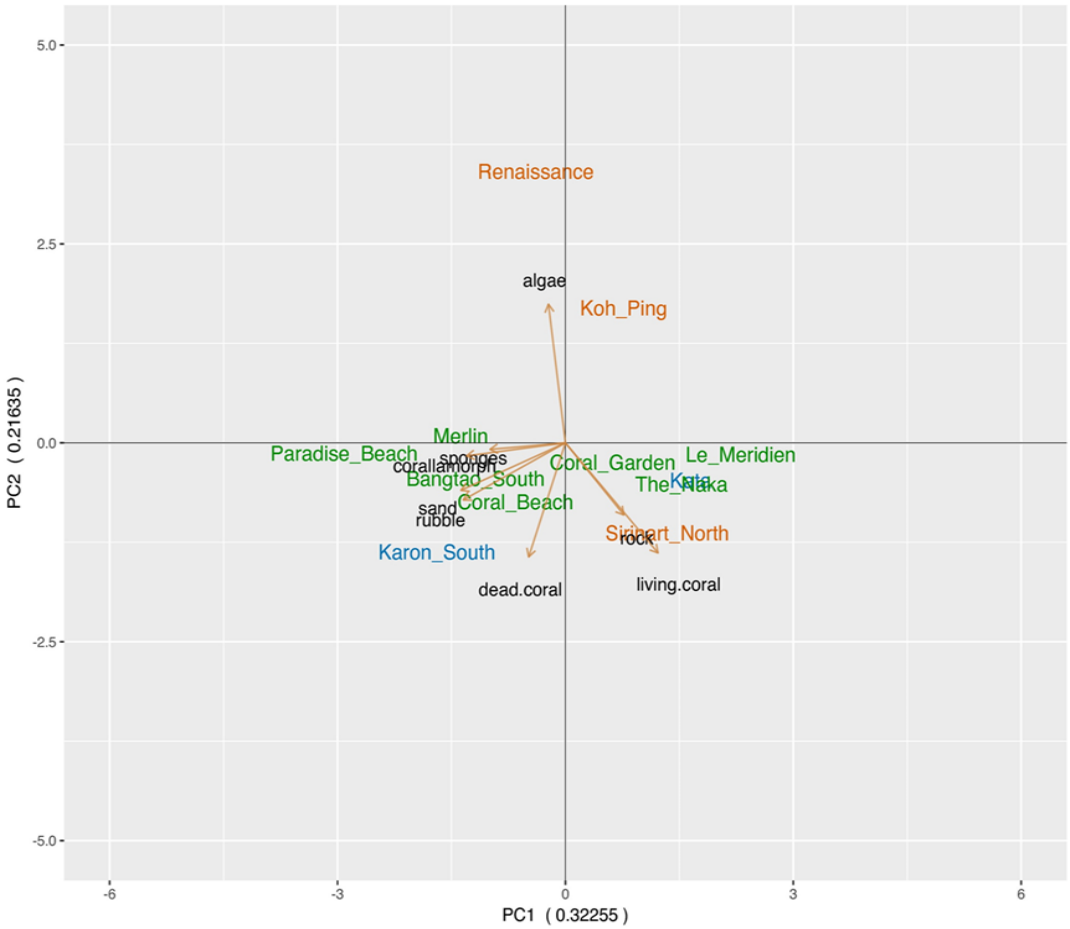


Figure 2: Principal Component Analysis of Community Composition in Western Phuket

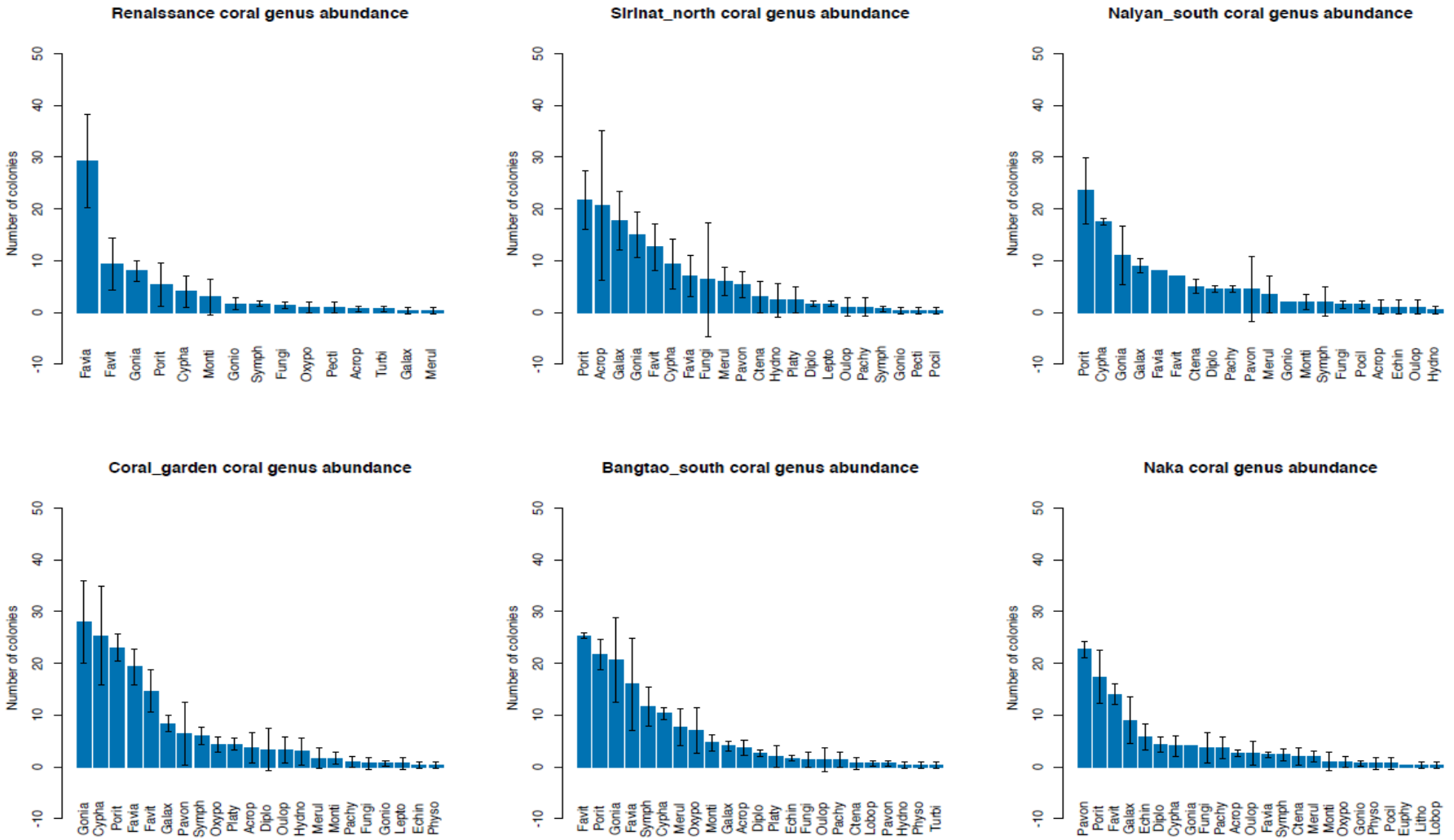


Figure 3: Coral Genus Abundance by Site. Semi-restricted access sites: Renaissance, Sirinat North, Nai Yang South . Restricted access sites: Coral Garden, Bangtao, Naka.

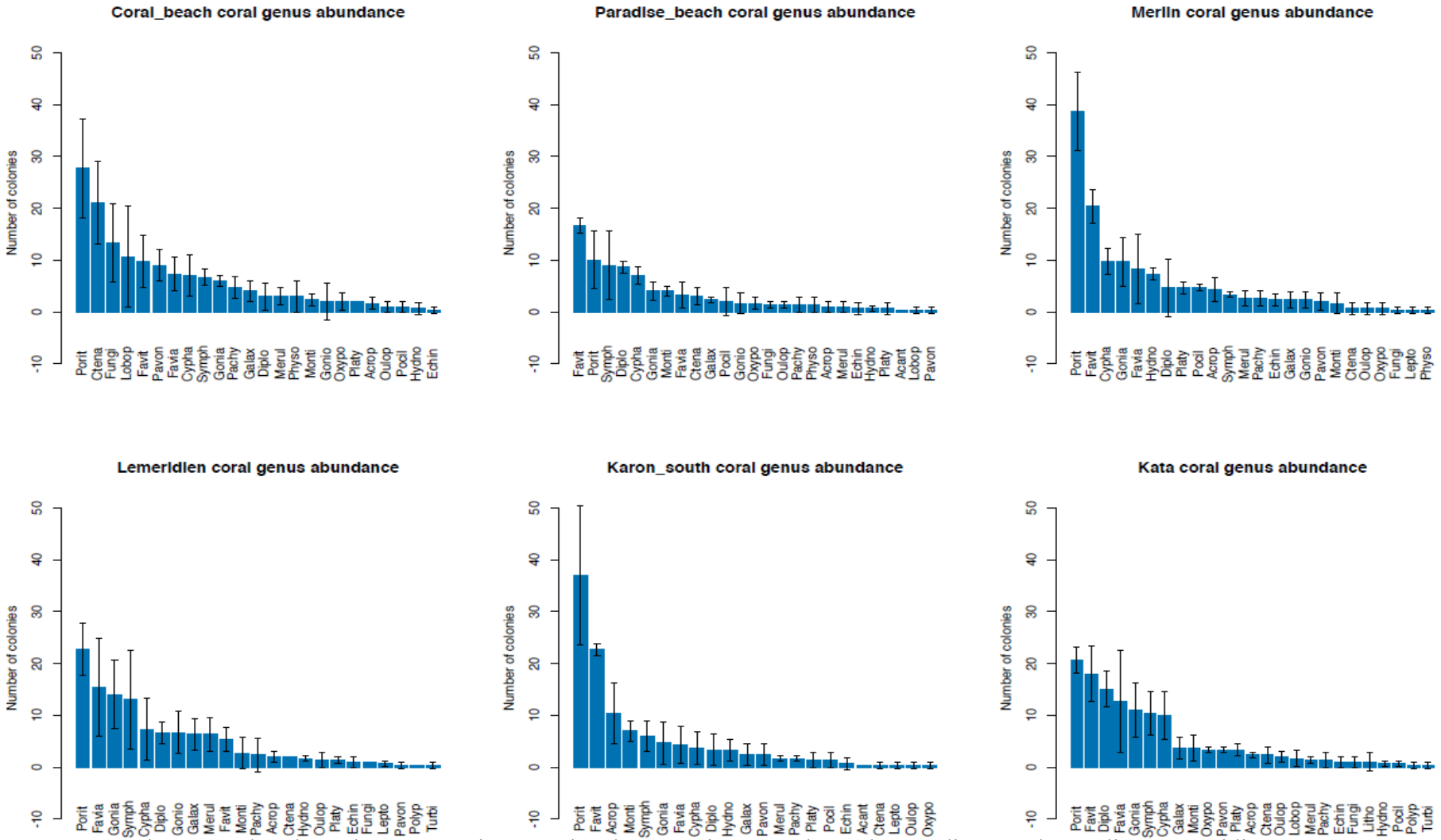


Figure 4: Coral Genus Abundance by Survey Site. Restricted access sites: Coral Beach, Paradise Beach, Merlin, Le Meridien. Open access sites: Karon, Kata.

When separated by coral genus, the results show that there are no strong trends differentiating semi-restricted sites within Sirinat National Park and restricted sites both within and outside of the national park (**Figure 3**). In addition, when comparing restricted sites to open access sites, no strong differences can be seen (**Figure 4**). Most sites are dominated by massive and encrusting genera, regardless of level of access.

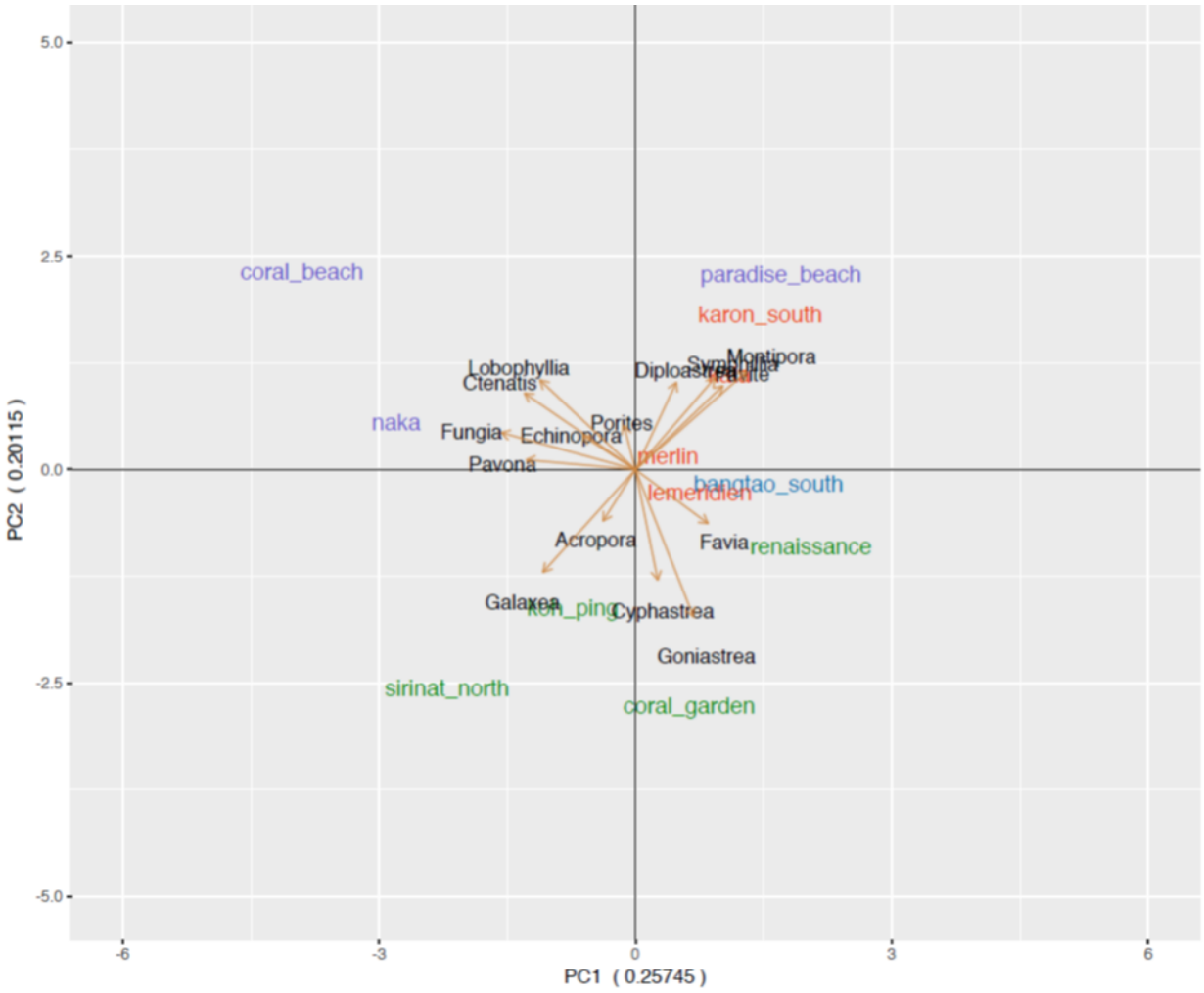


Figure 5: Principal Component Analysis of Coral Genera (45% of variation explained)

When analyzing the sites by region (**Figure 5**) it becomes clearer that the region the site is in has significantly more influence on the composition of coral genera than the level of access. Sites in the north (Sirinat North, Koh Ping, Renaissance, and Coral Gardens) consisted of more encrusting species, while sites in the central coast (Naka, Coral Beach, Paradise Beach) had more free-living, massive,

and foliose encrusting genera. This is likely due to the strong waves present in the exposed north during monsoon season, while the sheltered bays in the central coast have less wave energy.

3.1.2 Health indicators

There were no statistically strong indicators of site-specific health issues for the coral communities. Individual families of corals exhibited different susceptibilities to various stressors, but the prevalence of these health indicators reflects mostly the community composition rather than overlying environmental factors. The exception to this finding was the prevalence of white syndrome in faviid corals, which was associated with the sites closer to urban infrastructure, contrasting with its incidence in *Porites* and *Acropora,* associated with the bleaching-affected northern-sites. Health indicators recorded included black band disease (BB), brown band (BrB), algal overgrowth (ALG), bleaching (BL), physical damage (PHY), white syndrome (WS), growth anomalies (GA), sponge overgrowth (SP), sediment erosion (SED), fishing gear (FG), skeleton eroding band (SEB), pigment response (PR), predation (PD), and anemone overgrowth (ANG).

Acropora in the northern semi-accessible sites were most strongly affected by white syndrome, sponge overgrowth and growth anomolies (**Figure 6**). *Acropora* in Paradise Beach, located within Patong Bay were found to be most affected by anemone overgrowth, likely a sign of poor water quality in the area.

A principal component analysis (PCA) of the health indicators of *Favia* shows that this genus was most strongly affected by white syndrome and predation in the restricted access sites (**Figure 7)**. The remainder of the health indicators were similar in their impact on the genus.

The final genus analyzed for health indicators was *Porites*, which showed the most severe impacts in the northern national park sites of Sirinat North and Renaissance/Mai Khao (**Figure 8**). At Sirinat North, *Porites* was affected by sponge overgrowth, fishing gear, and bleaching. At Renaissance/ Mai Khao the genus was affected by predation, pigment response, and white syndrome. Coral Garden and Le Meridien showed signs of algal overgrowth, while the Merlin site was affected by anemone overgrowth.

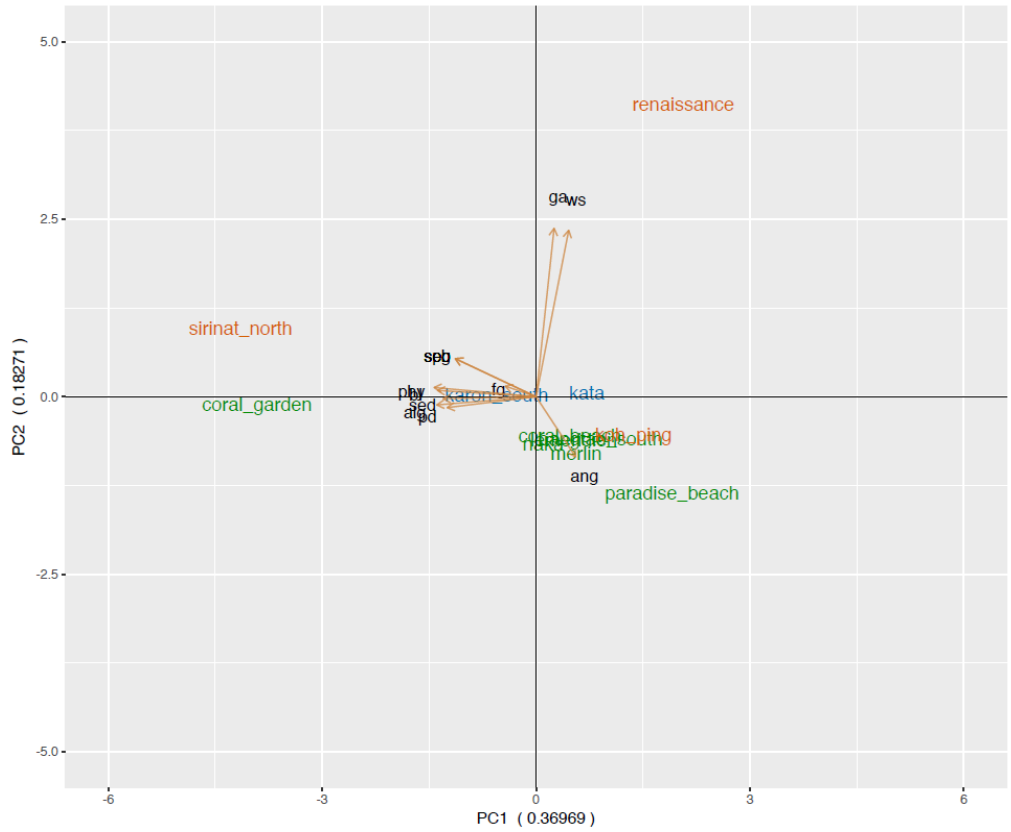


Figure 6: PCA of *Acropora* Health Indicators

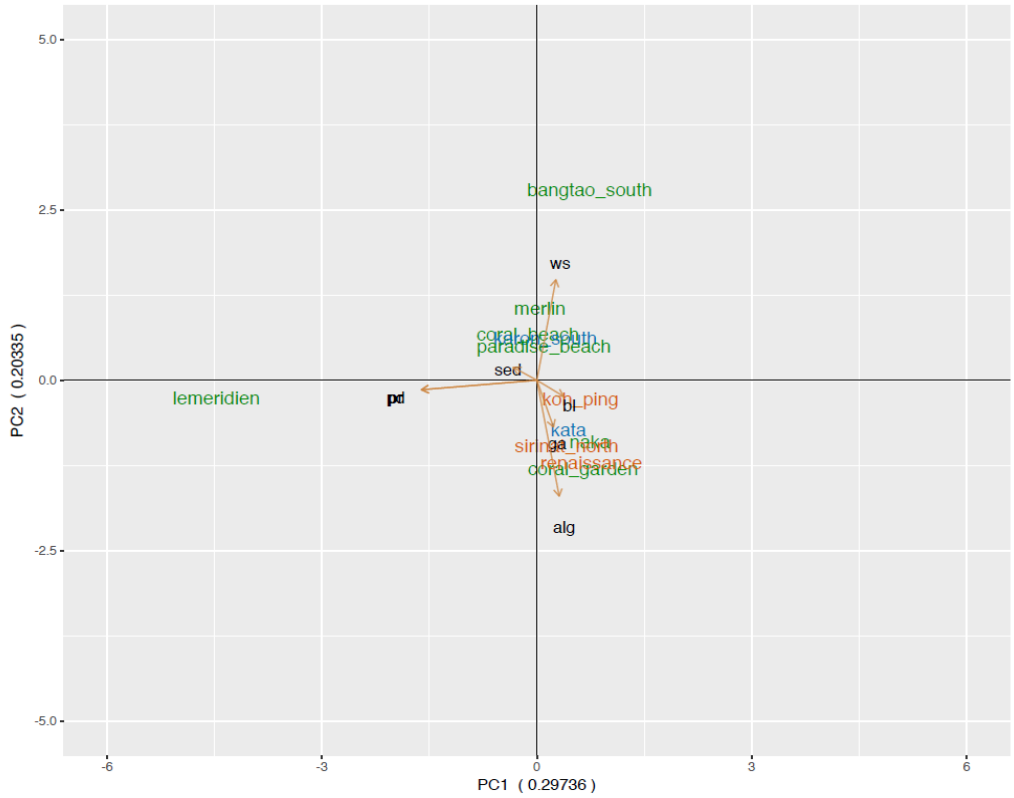


Figure 7: PCA of *Favia* Health Indicators

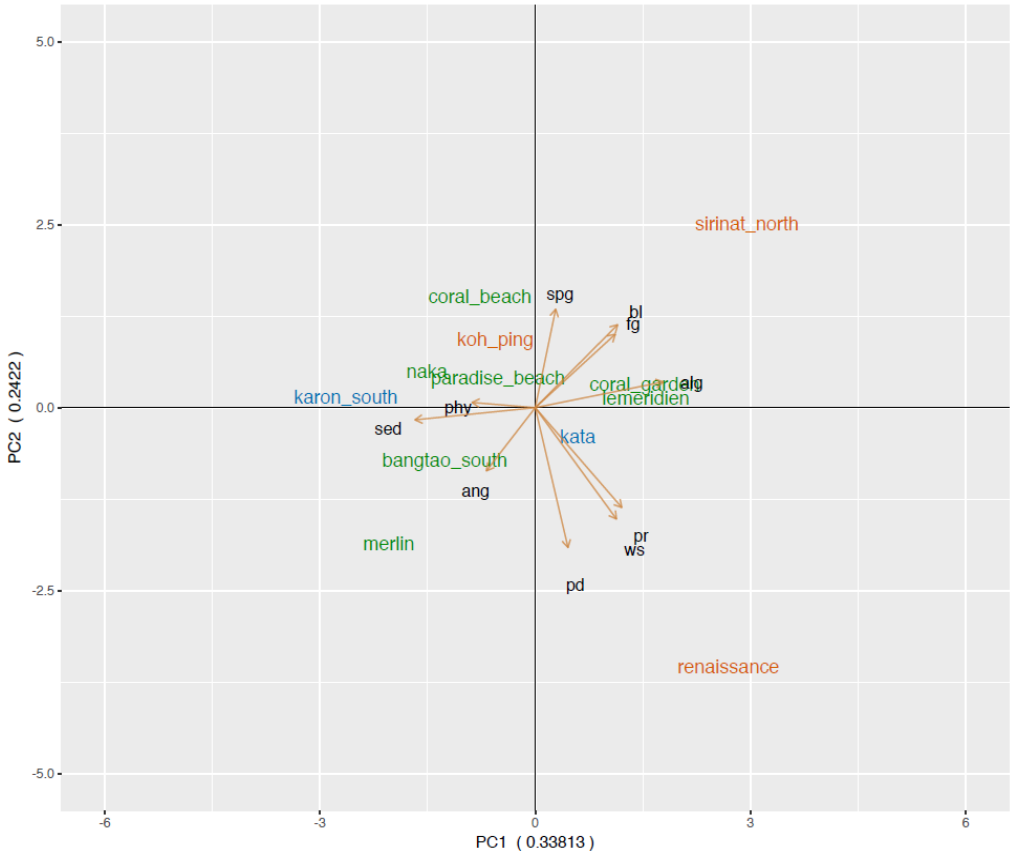


Figure 8: PCA of *Porites* Health Indicators

3.1.3 Discarded Fishing Gear

There was more broken discarded fishing gear found at open access reefs than at reefs that were restricted by private land management. The largest amount of fishing gear on the reef was found at Karon Beach, a public beach where there were 28 total observations of debris on the reef over three 20-meter transects (**Figure 9**). The second highest quantity was at Sirinat North, where there were 22 observations of fishing debris, despite the reef's location within Sirinat National Park. The third highest was at Kata Yai, another open beach with no restrictions on fishing or controlled access (16 observations). The majority of broken/discarded fishing gear (BDFG) encountered during these surveys was comprised of monofilament fishing lines (often with hooks and lures attached) and fragments of monofilament gill nets, generally less than $1m^2$. While the net fragments may have drifted onto the reef from elsewhere, the monofilament lines indicate that fishing activity is occurring at the site. Anecdotal evidence indicates that gleaning and shore-based fishing is often observed

among immigrant labour workers who frequent the southern end of Sirinart National Park and may not be aware of the restriction associated with the marine protected area. The less easily accessible national park sites are less affected by BDFG. It is evident by inspection, however, that BDFG is far more common at those sites where public access and activities are limited either by statutory or civil restrictions to the site.

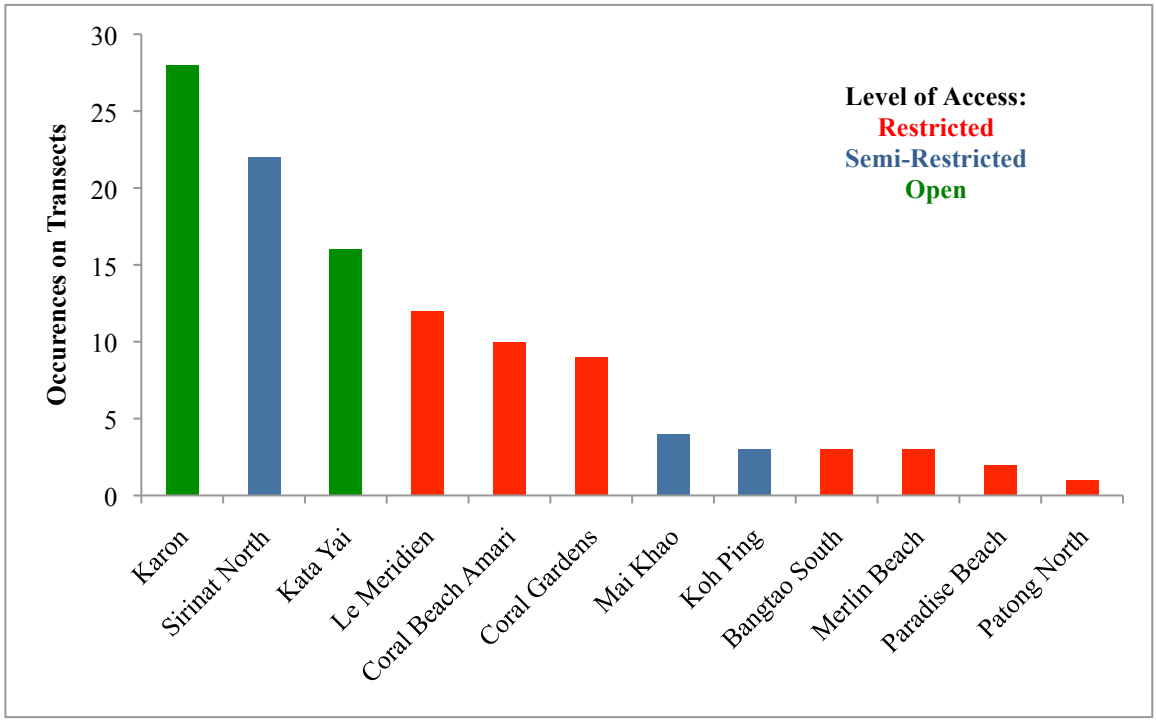


Figure 9: Observations of Broken/Discarded Fishing Gear

3.1.4 Plastics

The amount of marine plastic found on reefs adjacent to Phuket was surprisingly low, given the intensity of use. Although micro-plastics were not measured, macro-plastic marine debris was observed at five of twelve total sites. The majority of plastic found was plastic bags. The highest incidence of plastic on reefs was found at Kata Yai, an open access beach, with nine pieces of plastic on the reef along three 20-meter transects (**Figure 10)**. The second highest amount of plastic (3 observations each) was found at both Sirinat North and at Coral Gardens, both located within Sirinat National Park. The Sirinat North site is easily accessed by the general

public and is a very popular picnic area, however it was categorized as a semi-restricted area due to being within the national park boundaries. Coral Gardens is also within the national park but has no land access, leading it to be classified as a restricted area, although it is popular with boat-based snorkel tourism. Two pieces of marine plastic were found at Bangtao South, another restricted reef that was inaccessible from land, but similarly close to a tourist beach, reinforcing the hypothesis that reefs at open beaches as well as those in the nearby vicinity are at risk of local plastic pollution from adjacent beaches.

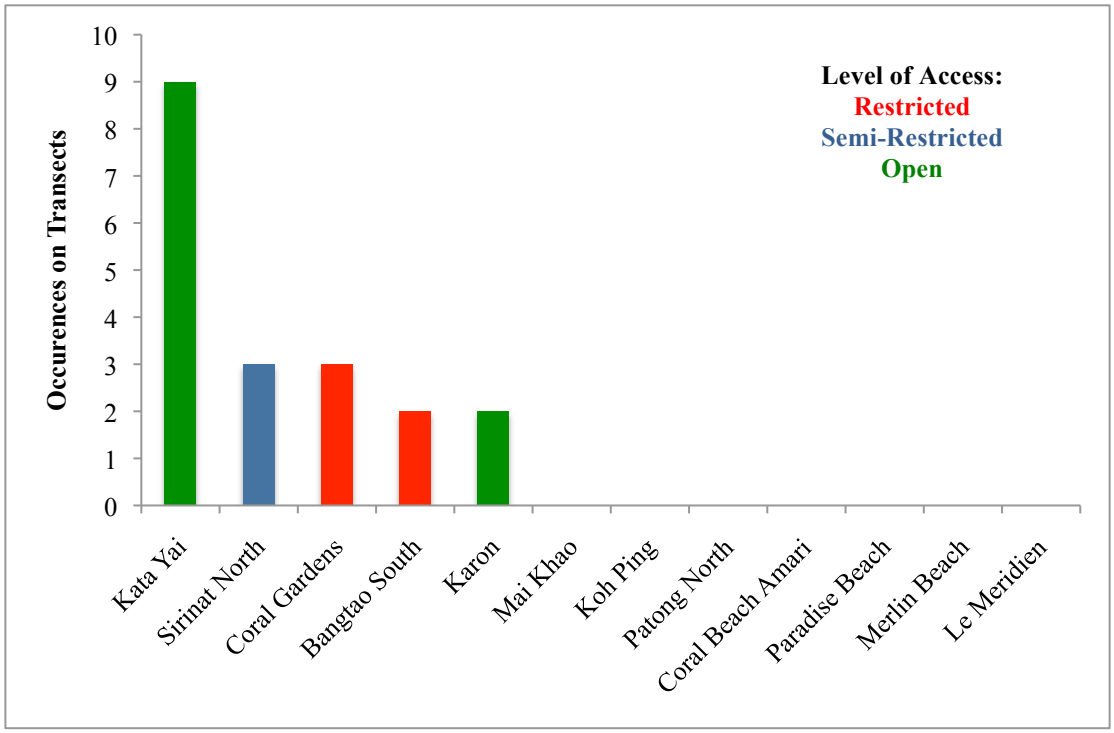


Figure 10: Observations of Plastic on Corals

3.1.5 Juvenile Corals

Coral recruitment was not sensitive to the level of access of adjacent shorelines, but rather reflected the underlying hydrodynamics, existing benthic community and historical impacts at each site. The incidence of juvenile corals from seven families of coral (Faviidae, Poritidae, Acroporidae, Fungiidae, Mussidae, Oculinidae, and Agariciidae) was similar throughout the study sites. Faviids had the highest number of juveniles at all west coast reefs, regardless of level of access,

Acroporids were highest at the Karon reef, an open site, with an average of 23.67 (SE 4.41) juveniles over the three transects. The survey area was characterized by having many large boulders with ample bare space for young recruits, presenting excellent settlement opportunity for the usually sensitive Acroporidae. The fewest Acroporid recruits were found at Mai Khao, an exposed reef within the national park that experienced catastrophic bleaching mortality during 2010, and has since undergone a phase-shift from a coral-dominated reef to an algae-dominated reef.

There was an unusually high abundance of juvenile Agariciidae, (*Pavona* spp.) at the Patong North site (**Figure 12**). This reef is located in a sheltered bay in front of a hotel that restricts access to the beach by the general public, and carefully manages surface runoff using a catchment pond with Vetiver grass. The abundance of juvenile *Pavona spp.* corals on the reef mirrors the high proportion of *Pavona* in the unusually dense adult community. Numbers of juvenile corals often reflect the adult coral composition, as can be seen as Patong North site and the Karon site, which is *Porites* dominated (**Figure 13**).

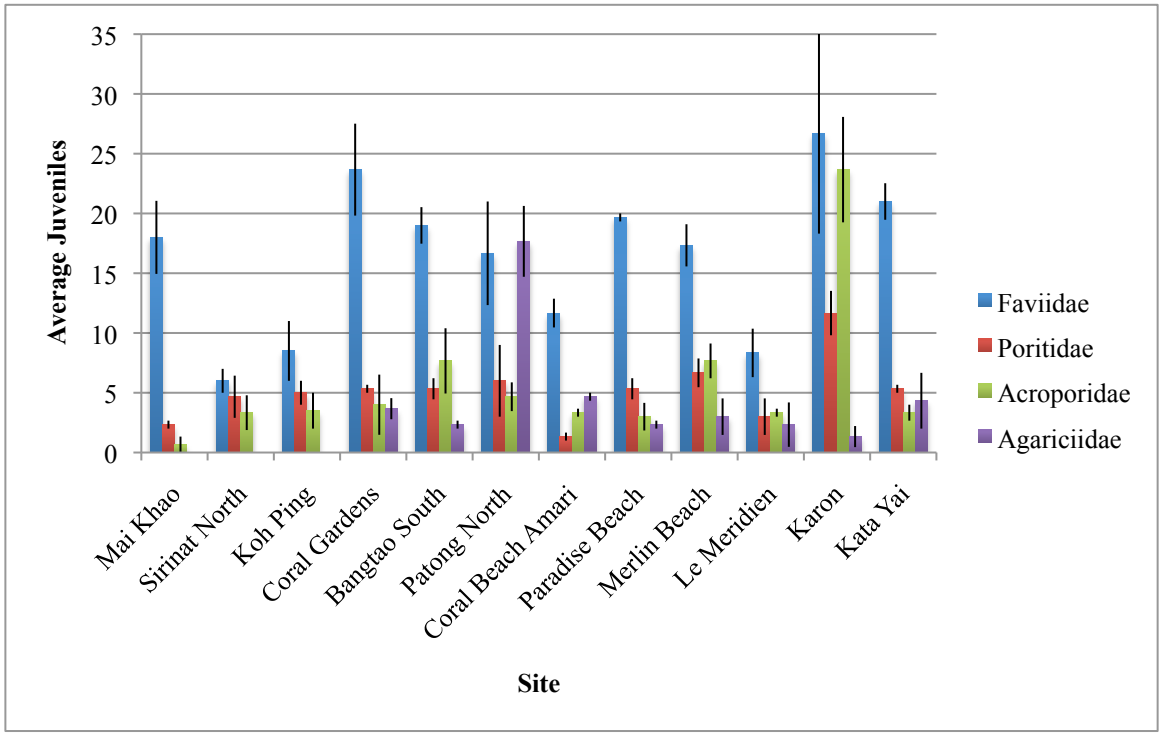


Figure 11: Average Number of Juvenile Corals (±SE) Observed

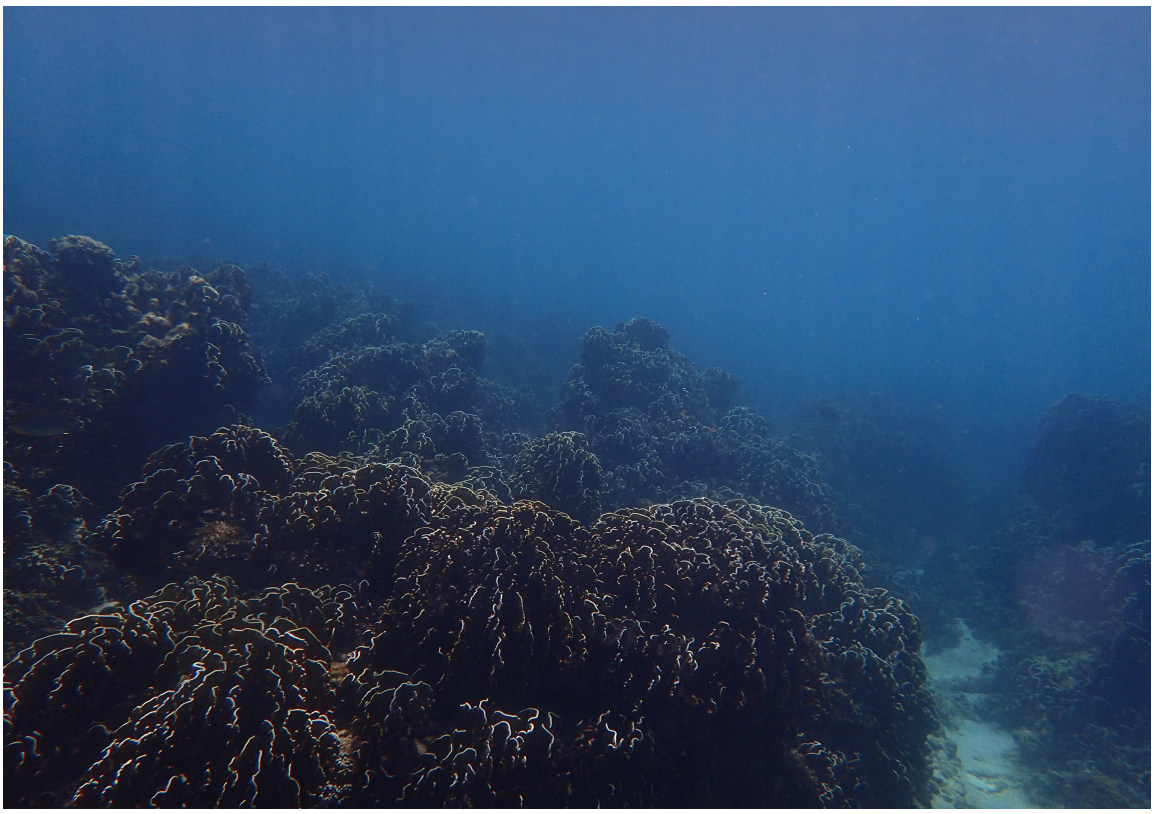


Figure 12: Agariciidae dominated reef at Patong North

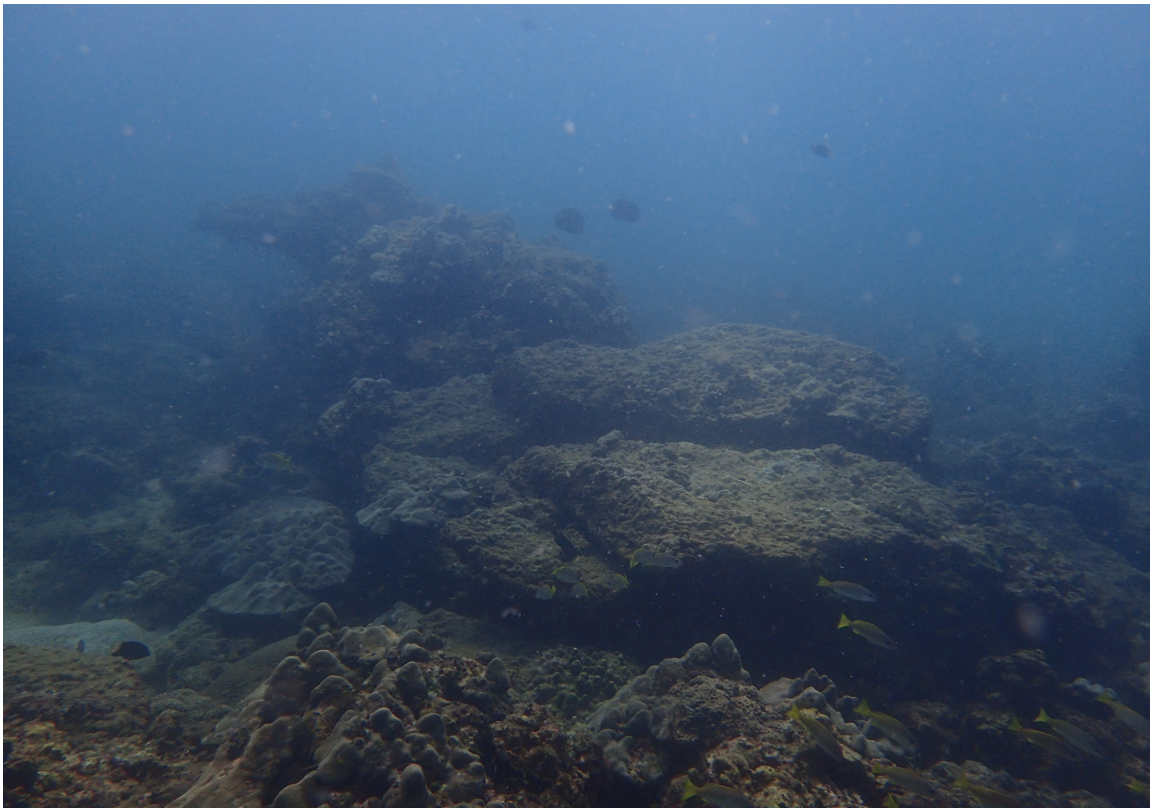


Figure 13: Open access Porites dominated reef at Karon

3.2 Interventions and Multi-Stakeholder Partnerships

In balance, the data presented here suggest that mechanisms for effectively limiting access to reefs and the permitted activities at or adjacent to those reefs have positive effects on reef health and vulnerability to impacts. Active interventions, in which the corporate partner participated to enhance the environment, or to mitigate negative effects of the hotel activities are described below.

3.2.1 Project Funding

During the first year of the reef education program, the hotel raised a total of $17,854 from the nightly room donation program. Upon check-in guests were informed about the IUCN and Marriott house reef conservation partnership, and snorkeling and diving opportunities. Guests were asked to donate $1 per night of their stay to support these conservation projects.

3.2.2 Guest Participation

The Reef Education Center hosted more than 3,309 guests during the twelve-month period from April 2017-March 2018. Many returning guests were shocked to learn that there was a reef adjacent to the property, because the previous management did not inform the guests of its presence. Often guests who snorkeled on the house reef would later go on snorkeling trips to Phi Phi Islands National Park and return from their trip saying that the house reef had more fish and healthier coral.

3.2.3 Reef Cleanups and Coral Restoration

The Reef Education Center hosted three collaborative reef clean-up events, with volunteer divers from various groups collecting over 78 kilograms of marine debris. During cleanups, the most common waste found is broken discarded fishing gear, both from the local fishermen on the shore and ghost nets from offshore boats. Inviting locals, government staff, and professional dive guides has created a sense of community and networking and highlighted the biodiversity of nearshore reefs in Phuket. Throughout the year, the on-site dive instructor also cleans marine debris during dives with guests, allowing them to participate in eco-tourism dives. On these dives, divers will also reattach any broken coral fragments that they find, either by

wedging them in reef crevices, or using marine epoxy to adhere them to stable reef substrate. Participating in these actions allows guests to feel like they are giving back to the country they are visiting.

3.2.4 Mooring Buoys

Reef surveys at Merlin Beach frequently showed new physical damage to the reef. During high season (December-April) recreational boaters would anchor in the bay to spend the night while cruising the western coast of Phuket, or on day charters from Patong. Divers captured an underwater video of an anchor on the reef, showing significant damage to a *Porites lutea* colony and shattered colonies of *Acropora* spp. coral **(Appendix, Figure 18)**. The video and photos of the damage and the boat were presented to the Department of Marine and Coastal Resources and the agency approved the installation of four mooring buoys in the bay to prevent future damage. Divers from the government, IUCN, the dive shop, and the Prince of Songkla University collaborated to install the moorings, making the installation a multi-stakeholder accomplishment (**Appendix, Figure 19)**.

3.2.5 Marine Guides

IUCN and Marriott have worked together to develop "House Reef Marine Guides" for four beachfront resort properties around Phuket (**Figure 14**). These guides were created using professional underwater photos of the resort's house reef, and they allow guests to get a complete understanding of the marine life on the reef, encouraging them to explore it. The books can later be used to identify animals seen while snorkeling. Many guests were shocked to learn that the colorful reef fish could be seen right off the beach of their hotel, making this guide an important tool for creating valuable guest experiences and increasing interaction with the natural ecosystem. The marine guides also have a conservation section, explaining the IUCN/Marriott partnership, risks to coral reefs in Thailand, and how guests can minimize their impact on coral reefs in their daily lives. By providing these guidebooks in each guest room, the resort can better advertise their unique natural resources.

Figure 14: House Reef Marine Guides made using photos taken on the resorts' reefs

3.3 Department of Fisheries Aquatic Species Sanctuary

Nearshore juvenile *Acropora* spp. corals were often entangled in abandoned fishing gear from the local fishermen who fished the reef from the rocky coast in the early mornings and evenings. Spearfishermen were also observed in the area, fishing for cuttlefish (Sepiida) and reef fish including Scaridae and Haemulidae and others. IUCN and the hotel consulted the Department of Marine and Coastal Resources about the possibility of designating the area as a conservation area to reduce fishing pressure on the reef, however, it was deemed to be an arduous, long-term task, since it would be the first designated privately managed marine area in the country.

While discussing the best approach to initiate the conservation area, IUCN attended a meeting with the Department of Fisheries and learned that the reef in front of the hotel is already within an "aquatic species sanctuary," as designated in the

Royal Ordinance on Fisheries B.E. 2558 (2015). While the declaration is a positive step towards conservation, there is a clear lack of adequate enforcement and communication of the protected area. Neither the local community, nor the Department of Marine and Coastal Resources were aware of this sanctuary, highlighting flaws in its implementation. IUCN and Marriott are currently developing signage and training staff to inform fishermen of the law and reduce fishing pressure on the reef.

CHAPTER 4
DISCUSSION

4.1 Discarded Fishing Gear

The surveys on the presence of broken discarded fishing gear revealed that the most easily accessible reef in Sirinat National Park had the second highest amount of fishing gear of all the reefs surveyed. It was expected that reefs on open access beaches would have the highest amounts of fishing gear because of the ease of public access, however, while the site with the highest amount (Karon) was an open reef (28 observations of fishing gear), the nearshore national park reef had more fishing gear (22 observations) than Kata Yai, an open access beach (16 observations). This is likely due to the fact that the Sirinat North reef was easily accessible from land, and unlike the other two reefs surveyed within the park, did not require a long walk or a boat to access. Previous research highlights that the implementation of marine national parks in southern Thailand have been shown to have a minimal impact on local fishers because either (a) the Department of National Parks (DNP) allowed small-scale fishing in the marine park as long as fishers followed the regulations set by the Department of Fisheries (DoF), or (b) DNP managers did not enforce fishing regulations within the park (Bennett and Dearden 2014). The presence of a morning fish market within the national park also highlights the fishing activities within the area, likely contributing to fishing pressure on nearby reefs. This traditional market is allowed within the park because the local fishers agree to not fish within the park boundaries, but likely confuses the many immigrant workers who cannot read the signage (in Thai) and who are accustomed to subsistence gleaning in their country of origin. Since they enter the park through public access areas, and they appear local, park staff largely ignore them.

4.2 Marine Plastics

The amount of plastics on the reef served as a good indicator of proximity to tourist beaches, as all five sites that had plastics on the substrate were either located at or near an open access beach. This is despite the increasingly strict regulations

concerning littering on public beaches, and the provision of garbage receptacles by local authorities. None of the five beaches that were privately managed by hotels or the private sector had any plastic debris along the transects. This may be due to the practice of hiring daily beach cleaners to remove debris throughout the day and maintain pleasant beach aesthetics for paying guests. In addition, privately managed beaches have fewer vendors, who often sell their food products in "to-go" containers, which may end up in the sea accidently or intentionally after their use. Plastics on reefs are a threat to coral health; the likelihood of disease increases from 4% to 89% when corals are in contact with plastics (Lamb et al. 2018). The reduction of plastic pollution in public areas can have a significant affect on the rates of nearshore coral disease. Initiatives to "ban the bag" have stalled in Thailand, with major retailers like 7-11 resisting bag taxes. Phuket municipality launched an initiative to forbid the use of Styrofoam food containers in 2018, in an effort to curb plastic pollution, however, the price disparity between cheap plastic and recyclable alternatives is a barrier to uptake by street vendors, who are the largest source of this type of pollution. With a better understanding of the changing tourist market, hotels in the area are more amenable to plastic alternatives, a practice that they can then highlight as a CSR initiative.

4.3 Status of Coral Reefs in Phuket

The results show that coral reefs throughout Phuket have similar community compositions regardless of level of access. Reefs in the central part of the island, especially those near Patong Bay are exposed to poorer water quality, and thus show a higher incidence of algal overgrowth and anemone overgrowth. The amount of monofilament fishing line and nets was highest in the open sites and within the easily accessible reefs in the national park. This highlights that oceanfront resorts that control access to the house reef are already providing a type of *de facto* marine protection, by reducing fishing pressure. The development of partnerships between government agencies such as the Department of Marine and Coastal Resources and the Department of Fisheries with corporate hotels would give the hotels the

legitimacy enforce no fishing zones on their reefs, leading to a potential increase in fish biomass and a reduction of fishing gear on the reef, thus higher coral cover.

4.4 Multi-Stakeholder Partnership Development

One of the most important findings of this study was that there is a significant lack of communication between government agencies charged with managing the near-shore marine environment in Phuket. While the Department of Fisheries had established an aquatic species sanctuary in the area, this was done without consultation with the Department of Marine and Coastal Resources (which is responsible for nearshore areas outside of national parks), nor with the Department of National Parks, neighboring local community or private sector. This finding is consistent with a previous study on community perceptions of marine protected areas in southern Thailand: "the inability to manage the area was attributed to lack of capacity within the agency and coordination with other agencies by NGO representatives, academics, and individuals from other government agencies" (Bennett and Dearden 2014). It is not that Thai government agencies are unaware of, or uncommitted to their joint responsibility to manage the environment, but rather the historical balkanization of bureaucracy that plagues governments all over the world. Reporting tends to occur within a ministry, but minor matters are seldom passed between ministries, even when their areas of responsibility overlap.

This deficit highlights an operational space for a coordinating agency, such as a financially disinterested NGO to create a network of personal contacts between stakeholders and act as a go-between for local reef management **(Figure 15)**. While government agencies play an essential role in the establishment of no-take fishing areas, their field teams are often chronically understaffed, and the operational funding to inform the local community and enforce the law is sparse. In the absence of visible engagement, the area risks becoming a "paper park." An increasing number of tourism enterprises that cater mainly for dive tourism are realizing that positive engagement with environmentally sustainable practices provides a clear marketing edge. Likewise, large resorts with effective control over access to adjacent reefs are realizing that customers of all wealth and educational backgrounds respond positively

to healthy reef communities, and negatively to degraded environments. Engaging the corporate tourism sector can provide funding avenues to subsidize mitigation of impacts, extend the reach of agency enforcement, and help to increase visibility and stewardship of protected areas adjacent to the property (Dharmaratne, Yee Sang, and Walling 2000). Tourism enterprises benefit by receiving sympathetic treatment by management agencies, and recognition of their proactive stance by the tourist market.

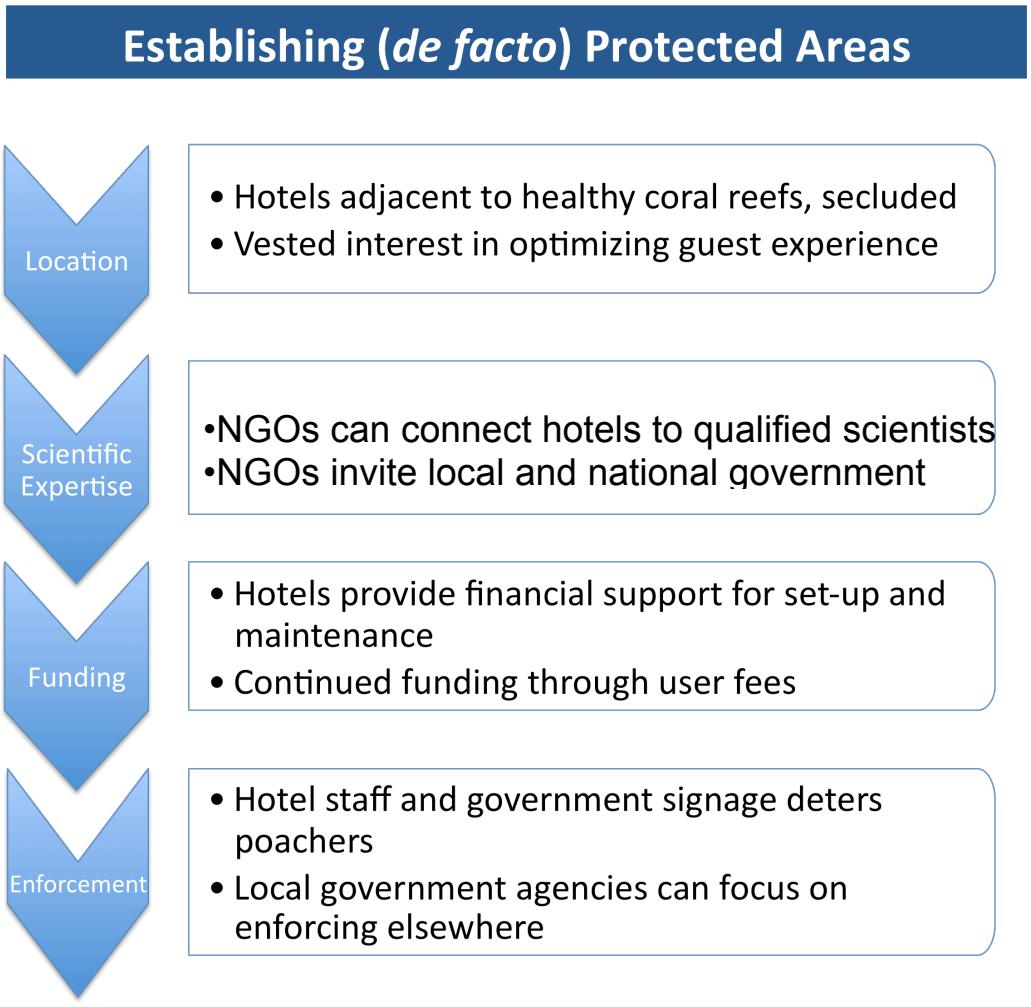


Figure 15: Establishing *de facto* Protected Areas

The development of a multi-stakeholder approach to nearshore reef conservation can enable various groups to contribute expertise and funding to accomplish their shared goals. There is potential to create similar partnerships in other international tourism areas that are highly dependent on healthy nearshore reefs, such

as Indonesia and the Philippines. By coordinating activities and responsibilities within the network, weaknesses within the current system, such as a lack of funding and enforcement, can be reduced or eliminated, and the effectiveness of coral reef conservation and restoration can increase substantially.

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APPENDIX

Figure 16: Reef Education Center at Marriott Merlin Beach

Figure 17: Information Boards Inside the Reef Center

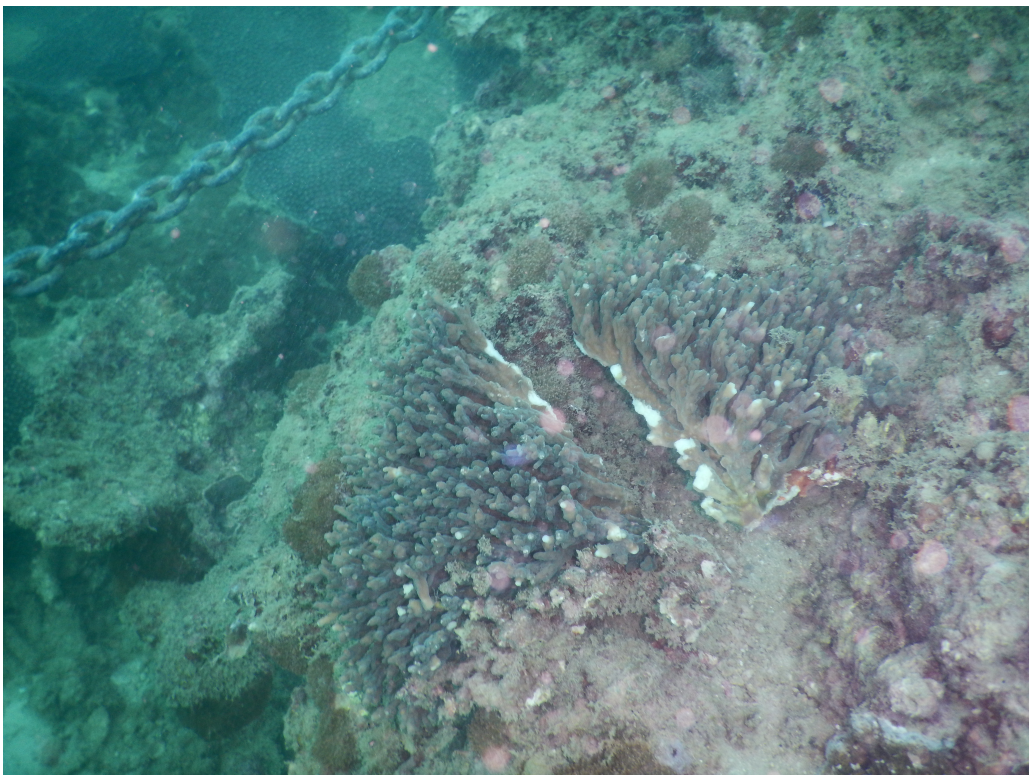

Figure 18: Damage from Anchoring

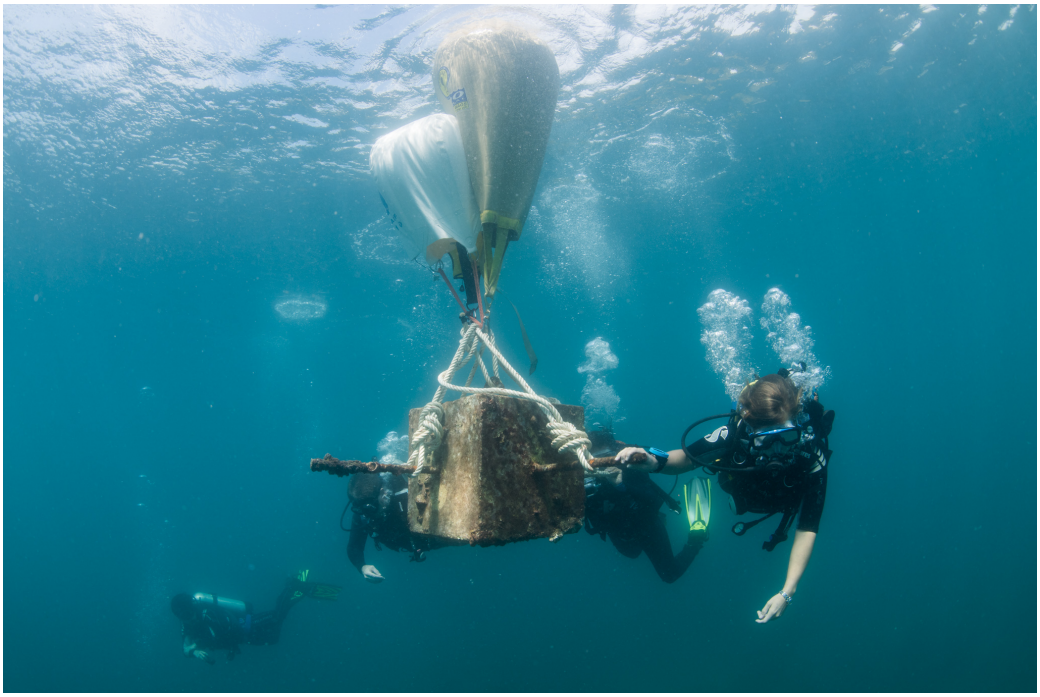

Figure 19: Mooring Installation

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