FAUNA & FLORA INTERNATIONAL

Tanintharyi Conservation Programme

Worldwide LIGHTHOUSE FOUNDATION sustainable projects involving man and sea

PRELIMINARY EXPEDITION REPORT:

FFI LIVEABOARD DIVE SURVEYS

10-19TH DECEMBER 2014

Edited by Robert Howard

FFI Myanmar Programme Staff

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THE LEONA M. AND HARRY B. HELMSLEY CHARITABLE TRUST

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The programme

The Tanintharyi Conservation Programme is an initiative of Fauna & Flora International's (FFI) Myanmar Programme, implemented in collaboration with the Myanmar Forest Department and a number of local, national and international collaborators and stakeholders. FFI Myanmar operates the programme under a MoU with the Forest Department specifically for marine and terrestrial conservation activities in Tanintharyi Region.

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Cover image

Expedition team. Credit: Dr Barry Russel/FFI (2014).

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1. INTRODUCTION

In December 2015 FFI, with support from the Lighthouse Foundation, undertook its third liveaboard expedition within Myeik Archipelago, Myanmar. The objective of the trip was to elucidate further information on the archipelago's coral reef ecosystems to aid managers in developing sound management strategies. Surveys included continued undertakings of the reef check studies already undertaken within 115 sites throughout the archipelago by FFI's marine survey team. The expedition was also accompanied by several international researchers who undertook more specialised surveys on the reefs ecology and faunal elements. In addition, similar to previous expeditions the trip included Myanmar trainees undertaking there final dives to become certified Advanced Open Water Divers and provided with skills in marine surveys. The following reports details the research activities undertaken during this trip and the sites surveyed. More detailed reports on the outcomes of each study once researchers have analysed their data.

2. PARTICIPANTS

	Name	Position	Institution	Role
1	Antt Maung	Marine Biologist	Fauna & Flora Int'l	Reef Check Surveys
2	Soe Tint Aung	Marine Biologist	Fauna & Flora Int'l	Reef Check Surveys
3	Salai Mon Nyi Nyi Lin	Marine Biologist	Fauna & Flora Int'l	Reef Check Surveys
4	Moe Myint Aung	Forestry Officer	MOECAF	Reef Check Surveys
5	Aung Myo Lwin	University Student	Pathein University	Trainee
6	Si Thu Hein	Demonstrator	Myeik University	Trainee
7	Myat Thu	Demonstrator	Mawlamyine University	Trainee
8	Dr. James True	Lecturer	Prince of Songkla University/IUCN	Coral id trainer, reef resilience, trip adviser
9	Dr Barry Russell	Curator Emeritus of Fishes	Museum & Art Gallery of the Northern Territory	Fish taxonomy
10	Dr David Baker	Assistant Professor	University of Hong Kong	Anthropogenic effects on corals
11	Dr Chris Freeman	Postdoctoral Fellow	Smithsonian Institute	Sponge diversity
12	Dr Joleah Lamb	NatureNet Science Fellow	Cornell University	Coral Disease
13	Lawrence Davis	Scuba Instructor	Denla Scuba	Dive Supervisor/ Instructor
14	Robert Howard	Marine Programme Adviser	Fauna & Flora Int'l	Expedition coordinator

3. DIVE SITES

Description of each site surveyed during the expedition.

site #	Date	Depth	Lat	Long	Name	Comments
124	10/12/2014	15.2	9.65872	98.03837	Hnget Khar Island	*Helipora* dominated substrate, slope down to approx 10m. Diverse fish community, snappers, sweetlips, coral trout etc.
125	11/12/2014	7.2	9.77686	98.02724	Tharn Kyunn Nge	Within bay, patchy coral cover on a flat bottom in front of sandy beach. Number of large *Porites* bommies (2-3m high)
ND	11/12/2014		9.81389	98.00658	Tharn Kyunn	No dive. Large granite boulders, sparse corals
126	11/12/2014	9.1	9.79495	98.05354	Tharn Kyunn	Gentle reef slope from about 3m down to 8m in front of small sand beach. South part of reef dominated by dead staghorn corals and north live massive *Porites*. Banded Sea Krait. Fish abundance low, mostly small coral species.
127	11/12/2014	7.5	10.07908	97.98286	Nyaung Oo Phee Is	Reef off rocky shore. Dead staghorn corals, abundant long-spined urchins, anemones and fungids. Schools (over 20) of parrotfish.
128	12/12/2014	12.8	10.13052	97.96124	Kho Yinn Khwa Is	Steep rocky reef slope of rock shore down to 10m sandy bottom. Granite boulders. Patchy corals, large diplostrea, Corallimorphs, number of soft corals at 10m. Abundant fish life, surgeon fish, trevally, green gobfish, puffers, boxfish, blue spotted stingray.
ND	12/12/2014		10.36563	97.94415	Ba Wei Island	No Dive. Bombed site dominated by urchins
129	12/12/2014	5.9	10.41943	97.95215	Narr Kho Is	Patchy reef in small bay close to shore dominated by Porites and diploastrea, further out large area of dead staghorn corals. COTS numbers high for the archipelago. Big groups of parrotfish.
130	12/12/2014	16.5	10.42068	97.92070	Ja Lann Kyunn	Reef with islands large bay in south. Reef off steep island topo, reef flat approx 20-50m offshore then steep slope down to approx 15m. Diverse coral community. Sweetlips, surgeonfish, schooling snapper at 14m, glassfish.
131	13/12/2014	1.0	10.46143	97.93188	Ja Lann Kyunn Village	Village dive. Sandy flat bottom close to rocky shore. Patches of branching and massive porites in amongst rubble. Damsels, pipefish within coral
132	13/12/2014	16.9	10.84965	97.98581	Rock Pinnacles (Sth Kan Za Gyi)	Rock pinnacles steep rock reef down to approx 16m. Large boulders, patchy encrusting corals. Diverse and abundant fish community: large snapper schools, triggerfish, oriental sweetlip, blue-ringed angelfish.
133	13/12/2014	11.3	10.87875	98.00261	Kan Za Gyi	Small bay with short sand beach in middle. Rock shore dropping steeply from surface to approx 7m. Gentle slope/reef flat covered in small rocks and patchy massive (porites) corals.
134	14/12/2014	15.1	10.86640	97.88773	Kyunn Me Gyee Is	West side of island in large bay. Site heavily damaged by dynamite. Very large porites bommies still remaining providing habitat for a diverse array of fish sp.
135	14/12/2014	20.2	11.22025	98.08241	Pinacle Rock off Thar Is.	Pinnacle sticky approx 1-2m out of water. Steep slope down to approx 20m then gradual slope down past 25m. Wall of rock dominated by colourful soft corals. Diverse fish community with large individuals of the unknown snapper, large snapper schools
136	14/12/2014	9.2	11.34322	98.00227	Hlaing Island	Diverse coral community, dominated by staghorn acropora. High prevalence of disease.

						Reef flat approx 30m off the rocky shore, reef slope down to approx 9m. New signs of dynamite fishing
137	15/12/2014	4.0	11.45457	97.99309	Saw Mon Hia Is	Reef in small bay on North side of island. Reef flat at approx 2-4m stretching out 25m from the shore. Gentle slope down to approx 10m with sand and rubble. Reef heavily damaged from dynamite, however high recruitment and several chorts around the point.
138	15/12/2014	16.1	11.85104	97.67074	East Sular (E side, S of bay)	Reef in southern part of Eastern Bay. Sloping reef flat to approx 5m then gradual slope down to approx 10m then sand. Heavily damaged reef of staghorns and massive porites (dynamite) plus potentially effected by 2010 warming event. Several schools of small snappers
139	15/12/2014	12.6	11.86737	97.67839	East Sular (E side, N of bay)	Similar to 138 and heavily damaged. Over 8 COTS seen. Several schools of snapper, parrotfish, rabbitfish, 16 moorish idol in one group.
140	15/12/2014	11.5	11.86868	97.68000	East Sular (E side, N headland)	Night dive of 139. Eight moray eels. Head of devil ray found freshly cut in water (several fishing boats were moored up for the night in the bay)
141	16/12/2014	19.5	12.02793	97.63313	Double Island	Pinnacle off main island. Steep rock/boulder slope down to over 30m. Large encrusting galaxia corals, some acropora, and several walls covered with anemones. Schools of snapper and fusiliers. Hawksbill turtle.
142	16/12/2014	19.5	12.06090	97.63972	Tower Rock	Large boulders and steep cliff face down to approx 15m. Then gradual drop past 16m. Boulders covered with bivalves and Corallimorphs. Low fish abundance
143	16/12/2014	9.6	12.11297	97.72256	Bailey Is (E side)	High coral cover dominated by massive porites. Near beach area dominated by staghorn corals. Several groups of snappers and rabbitfish. Diverse fish community, several morays.
144	16/12/2014	15.1	12.04389	97.77354	Kyei Laik Island	Bay on south side of island. Gently sloping reef down to approx 14m dominated by massive porites covered with christmas tree worms, sparse clumps of staghorn corals. Low fish diversity and abundance. Abundant urchins
145	17/12/2014	4.6	11.75241	98.02338	Pyin Sa Bu Is. (W, N bay)	Diverse coral community with number of recruits of porites, galaxea, pocillopora. Site dominated by massive porites and fungids. Patchy areas of dead staghorn corals. Low fish abundance.
146	17/12/2014	10.5	11.64009	98.06750	Pyin Sa Bu Is. (W, S bay)	Large boulders to approx 10m then sand. Patchy with a number of juvenile corals.
147	17/12/2014	7.0	11.37887	98.09220	Leik Khon Is	Small rock island off Taw Wet Is. Large boulders down to approx 14-16m to a sandy/muddy bottom. Very patchy massive and encrusting Porites, some encrusting faviids. Large school of over several 100 *Lutjanus lutjanus*
148	18/12/2014	5.4	11.32231	98.00985	Khin Pyi Son Is (village)	Village dive 2. Reef in front of village on east side of bay. High coral cover dominated by massive porites interspersed with acroporas, pocillopora, faviids. Reef flat out to about 50m from the shore at high tide with a steep slope to approx 5 meters. Bottom of slope covered with fungids. Large groups of small parrotfish and high number of anenome fish.
149	18/12/2014	7.4	11.32347	98.00354	Khin Pyi Son Is (north bay)	Reef within small bay of channel gentle sloping reef to approx 7m dominated by staghorn acropora.

150	18/12/2014	6.8	10.83732	98.08479	Wa Ale Kyunn	Reef flat extending approx 40m from shore heavily damaged patched with massive porites. Number of COTS down on the reef slope amongst dead staghorns. Low fish diversity and abundance.
151	19/12/2014	9.0	10.46737	98.21266	Poni Island	Rocky shore stretching to about 2m depth, several schools of rabbitfish feeding on algae. Reef at about 3m gentle slope out to 6-7m consisting mainly of Porites bommies with patches of faviids and acropora. Several small snapper schools and brown striped groupers within bommies.

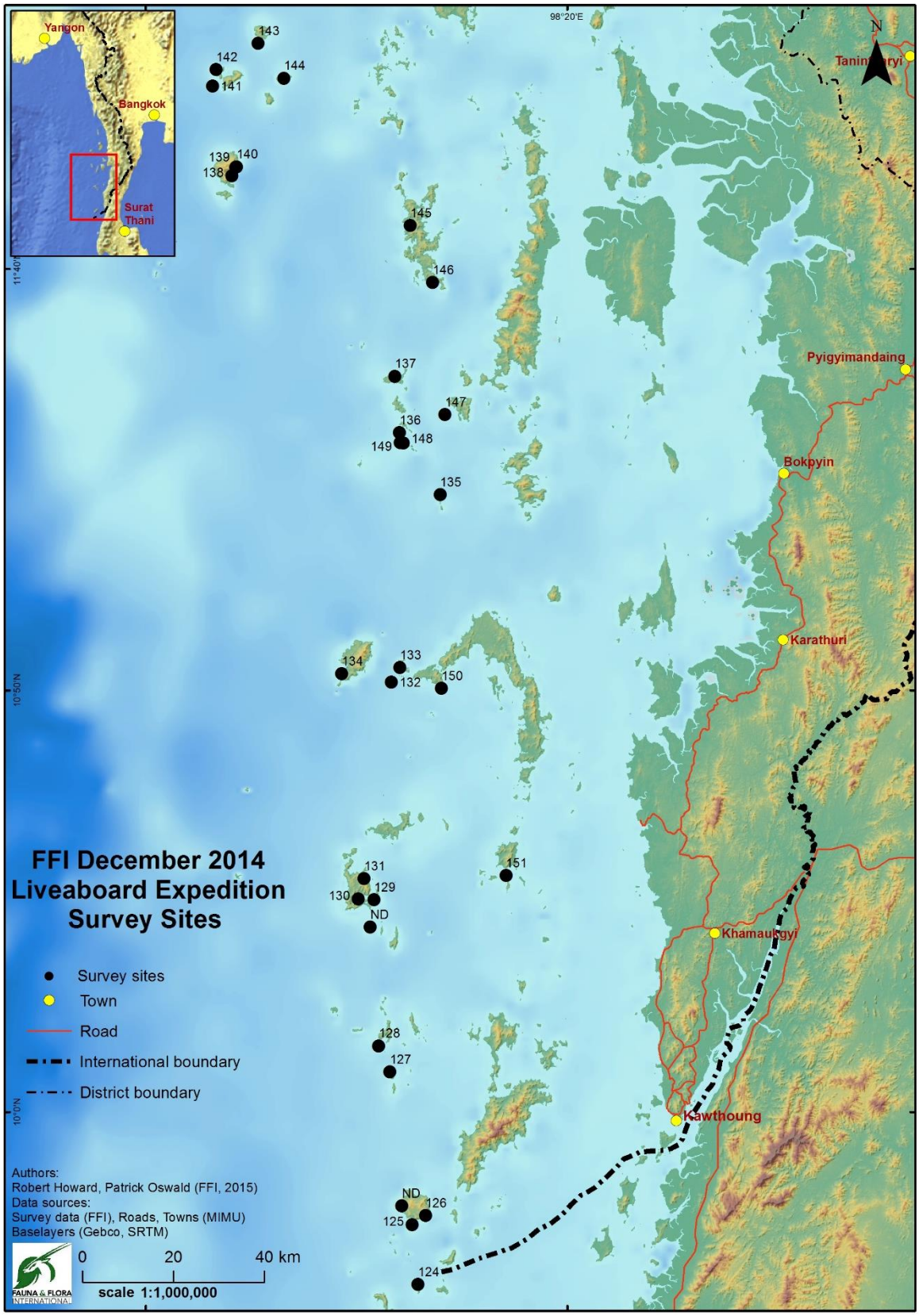


Figure 1. December 2015 survey site locations, Myeik Archipelago, Myanmar

4. RESEARCH ACTIVITIES

4.1. Fish Taxonomy

Dr Barry Russell surveyed the fish diversity at each site during the liveaboard expedition to provide a comprehensive list of coral reef fish species within the archipelago. During the expedition Dr Russell also provided a talk to the Myanmar divers and trainees on fish taxonomy and what resources available for fish identification.

Preliminary report on fishes of the Myeik Archipelago: Dr Barry C Russell

- Underwater surveys of fishes at 27 sites in the Myeik Archipelago off the Andaman Sea coast of Myanmar. The ichthyological surveys involved a total of about 27 man-hours of scuba diving to a maximum depth of 32 m.
- The main goal was to provide a comprehensive inventory of shallow coral reef fishes inhabiting the Myeik Archipelago, and to compare this with the fish fauna of the East Andaman Sea region. It therefore excluded deep water fishes, offshore pelagic species such as flying fishes, tunas, and billfishes, and most estuarine forms.
- Surveys were carried out using high definition underwater video (Sony Action Cam) to record fish species at each site. The technique usually involved rapid descent to 20-30 m, then a slow, meandering ascent back to the shallows. The majority of time was spent in the 2-15 m depth zone, which consistently harbours the largest number of species. Each dive included a representative sample of all major bottom types and habitat situations, for example rocky shallows, reef flat, steep drop-offs, caves, rubble and sand patches, coral areas and “bommies”. Videos were later analysed using slow motion playback and freeze-frame to identify individual species, and to compile species lists for each site. Underwater still photographs taken by other team members supplemented the video records.
- In addition, literature surveys of previous published and unpublished reports were undertaken to compile a species list for the region.
- Preliminary results of the surveys and literature records indicate at least 800 species occur in the Myeik region. Results of the video surveys are still being analysed and this number may be expected to increase. A number of species have not been previously recorded for the region and are new records for the Andaman Sea.
- The most abundant families in terms of number of species were gobies (Gobiidae), damselfishes (Pomacentridae), wrasses (Labridae), groupers (Serranidae), cardinalfishes (Apogonidae), butterflyfishes (Chaetodontidae), surgeonfishes (Acanthuridae), snappers (Lutjanidae), parrotfishes (Scaridae), and moray eels (Muraenidae).

- Notably absent during the surveys were sharks and rays. No shark species were observed at any of the sites visited, and only a few small rays were seen. Larger individuals of predatory species such as groupers (*Epinephelus*, *Plectropomus*), snappers (*Lutjanus*) and emperors (*Lethrinus*) were also present in only small numbers.
- The absence of these larger species is evidence of heavy fishing. Large numbers of fishing boats (trawlers, gill-netters, purse-seine, long-line and squid jig) were observed near all sites and there was evidence of fouled nets on many of the reefs surveyed. In addition there was evidence of explosive fishing, both recent (fresh fish kills on surface, especially fusiliers (Caesionidae) which occurred in schools close to reefs at most sites) and older (coral damage) at many sites, and sounds of explosive fishing nearby was heard underwater during one dive.
- Judging from the large numbers of fishing boats that were present throughout the survey, fishing pressure is enormous.
- In contrast to most areas of the Indo-West Pacific where underwater spearfishing is common and larger fish tend to avoid divers, at sites in the Myeik Archipelago fishes could be approached closely underwater during video surveys, suggesting that spearfishing is not occurring and that the main impacts on reef fish populations are net fishing and explosives.
- Nonetheless, despite the conspicuous absence of many larger fish species, reefs in the Myeik Archipelago continue to support a relatively diverse fish fauna, with only a slight reduction in number of species on the more impacted reefs compared to other reef areas.

4.2. Coral Disease

Dr Joleah Lamb undertook surveys of the extent and the diversity of coral disease within the Archipelago. Dr Lamb is currently analysing results including identifying any comparisons of diversity and prevalence of coral disease between Myanmar and other reefs within SE Asia and below are some of her preliminary results. Dr Lamb also provided a talk on coral disease to the Myanmar divers and trainees during the liveaboard expedition.

<u>Regional coral health and disease in the Myeik Archipelago of Myanmar</u>: Dr Joleah Lamb

1. Project Background

Global deterioration of coral reef ecosystems is of critical conservation concern, not only for numerous reef-associated species, but also for one-eighth of the world's populations who reside within 100 km of a coral reef and benefit from the essential ecosystem services they provide (Moberg & Folke 1999;

Bellwood et al. 2004; Burke et al. 2011). Over the last 30 years, coral cover has decreased, on average, by 50% on Indo-Pacific reefs and 80% on Caribbean reefs (Gardener et al. 2003; Bruno & Selig 2007). While a number of factors have contributed to these declines, including water pollution, habitat destruction, overfishing, invasive species, and global climate change (Pandolfi et al. 2003; Bellwood et al. 2004; Hoegh-Guldberg et al. 2007; De'ath & Fabricius 2010), outbreaks of disease have recently emerged as a significant driver of global coral reef degradation and a major threat to reef sustainability (Harvell et al. 2007). The destructive potential of coral disease is most clearly exemplified in the Caribbean, where successive disease outbreaks from 1986 to 1993 decreased populations of two significant reef-building acroporid corals by 95% and contributed substantially to observed ecological phase shifts from coral to algal dominated reefs (Aronson & Precht 2001; Sutherland et al. 2004; Weil et al. 2006). The overarching goal of this study is to begin to establish baseline levels of coral health and disease levels in the Myeik Archipelago of Myanmar and associate these levels with anthropogenic influences. This short preliminary report presents data collection methods, early findings of coral health at the site level, and analyses that will be examined in the future.

2. Methods

Data collection and site selection we conducted surveys at 19 sites in the Myeik Archipelago of Myanmar during December 2014. Of the 19 sites selected, we surveyed 3 sites located adjacent to small fishing villages, 8 sites with recent signs of craters characteristic of dynamite fishing and corresponding low levels of site complexity, and 8 sites serving as controls sites (no recent signs of dynamite fishing). Coral health surveys At each reef site, three 20 m x 1 m belt transects were laid randomly along reef contours at 2 - 4 m in depth and approximately 5 m apart, consistent with standardised protocols developed by the Global Environment Facility (GEF) and World Bank Coral Disease Working Group (Beeden et al., 2008), which allow the data from this study to be directly compared to other coral disease datasets collected globally (Figure 1). Specifically, within each 20 m2 belt transect, every scleractinian coral over 5 cm in diameter was identified to genus and further classified as either diseased (i.e., affected by one or more of the following disease classes recorded in the Indo-Pacific region (Figure 2): white syndromes, skeletal eroding band, black band disease (including other cyanobacterial infections), brown band disease, atramentous necrosis, yellow band disease, and/or growth anomalies); showing other signs of compromised health (i.e., affected by one or more of the following: tissue necrosis due to sediment, bleaching, non-normal pigmentation of tissue, overgrowth by sponges, red or green algae, and cuts and scars from predation by crown-of-thorns starfish and corallivorous marine snails); physically damaged (recently exposed skeleton from breakage or severe abrasions); or healthy (i.e., no visible signs of disease lesions, other compromised health indicators or physical damage) (Willis et al., 2004; Lamb and Willis, 2011; Lamb et al. 2014).

Corals smaller than 5 cm in diameter were counted as recruits and identified according to coral family. Standard line-intercept surveys were used to determine coral cover and community composition by estimating the linear extent of each coral to the nearest centimetre along the central line of each 20 m transect. In situ water quality measures In addition to coral health and disease surveys, in situ levels of water quality (n = 3 replicates) were measured at each site using an EXO2 Mulitparameter sonde (Xylem, USA, www.exowater.com). Water quality variables included chlorophyll-a, blue-green algae, dissolved oxygen, pH, conductivity, total dissolved solids, turbidity, salinity, depth, and temperature.

3. Summary of Preliminary Key Results

Data in this study were derived from examining 11,216 individual adult hard (scleractinian) coral colonies and 409 juvenile coral colonies across 19 sites (57 transects).

3.1 Coral disease and compromised health

3.1.1 Coral disease

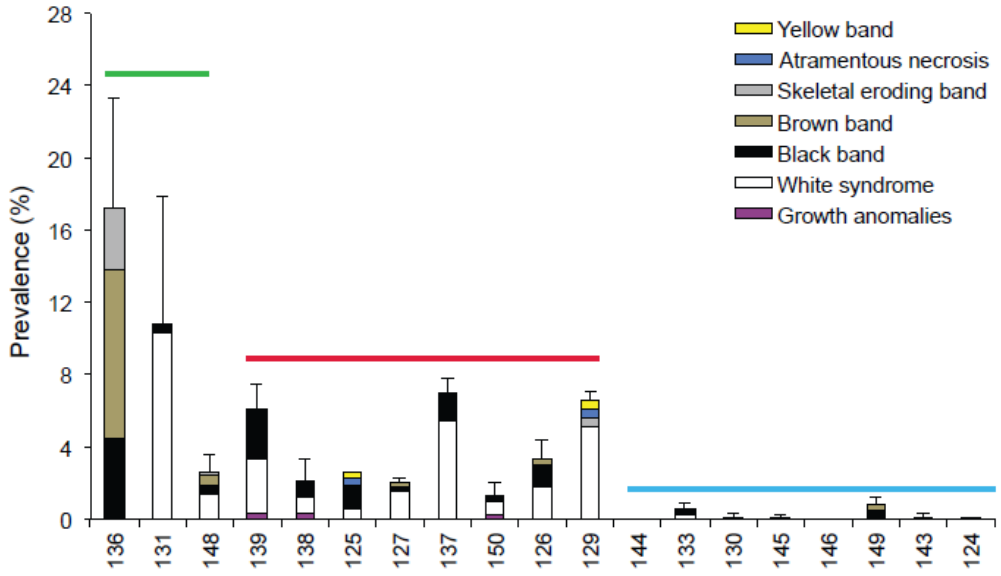


Figure 2 Mean prevalence (± SE) of seven coral diseases at 19 sites surveyed in the Myeik Archipelago, Myanmar during December 2014. n = 3 replicate transects per site. Green line = mean coral disease prevalence from surveys at sites located near small villages, Red line = mean coral disease prevalence from surveys at sites with craters characteristic of dynamite fishing and low site complexity. Blue line = mean coral disease prevalence from surveys at sites without signs of dynamite fishing (control sites). N = 11,216 corals surveyed.

3.1.2 Other indicators of compromised coral health

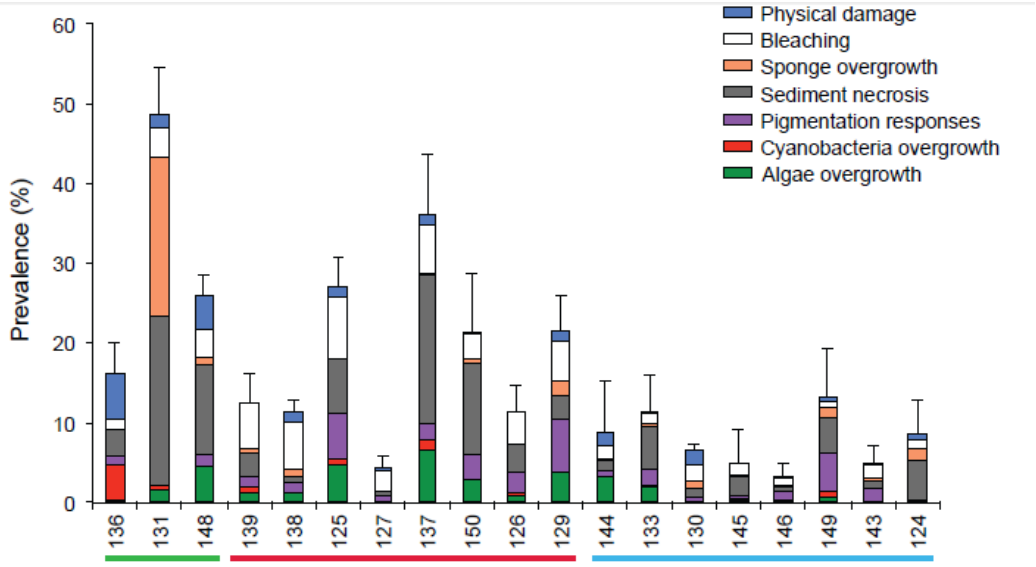


Figure 3 Mean prevalence (± SE) of other signs of compromised coral health at 23 sites surveyed in the Myeik Archipelago, Myanmar during December 2014. n = 3 replicate transects per site. Green line = mean coral compromised health prevalence from surveys at sites located near small villages, Red line = mean coral compromised health prevalence from surveys at sites with craters characteristic of dynamite fishing and low site complexity. Blue line = mean coral compromised prevalence from surveys at sites without signs of dynamite fishing (control sites). N = 11,216 corals surveyed.

4. Additional analyses and data collected for future analyses

In addition to the preliminary analyses of coral health and disease prevalence levels, the goal is to analyse site-level coral density and composition, recruitment of juvenile corals, and water quality using statistical models in order to better understand spatial and environmental drivers of these patterns.

4.3. Anthropogenic Impacts on Coral

Dr David Baker undertook surveys to examine anthropogenic change in hard and soft corals of the reefs within the Archipelago, Myanmar. During the expedition Dr Baker also provided a talk to the Myanmar divers and trainees on to assessing the level of human impacts on coral reefs.

Anthropogenic impacts to coral communities in the Myeik Archipelago: Dr David Baker

1. Summary

Surveys were undertaken to assess the level of human impacts on coral reefs in the region, specifically from the perspective of nutrient pollution and resulting eutrophication. In brief, the assessment is that the nutrient impacts (resulting from sewage, agriculture, and atmospheric pollution) are currently quite low, as evidenced by a complete absence of macroalgae at most sites visited. Macroalgal

overgrowth is often fuelled by nutrient pollution, which is cited as the driver for “phase shifts” from a coral- to algal-dominated reef. The absence of macroalgae may be due to the presence of herbivorous fishes, which were prevalent in comparison to other reefs the author has visited worldwide.

2. Achievements (Field)

Hundreds of samples of reef biota were collected for stable isotope analysis and molecular identification of coral-hosted Symbiodinium. Both metrics will inform the predominant sources of nitrogen on the reefs and environmental conditions that shape coral symbiosis (i.e. light and sedimentation stress). Water samples were filtered for stable isotope and percentage element determination, and filtered water was frozen and stored for eventual determination of inorganic nitrogen and phosphate concentrations. The former will lend some insight as to the major sources of nitrogen in the ecosystem, while the latter is a measure of how much there is. An experimental CTD unit was used to profile the water column temperature and salinity at many sites. These data are uploaded to a GIS software.

Owing to the heterogeneous distribution of hard corals and apparent lack of macroalgae, the sampling protocol was adjusted to an “ecosystem” level assessment. Notably, at most sites reef invertebrates (soft corals, sea stars, hermit crabs, herbivorous snails) and reef fish were encountered. Soft corals were common, especially on deeper dives. Nearly all coral reefs had an abundance of Alcyonacean (“leather corals”) soft corals at the deeper edge of hard coral distribution. At deep sites (>15 m) we frequently encountered large populations of gorgonians, found in mixed species communities. At such sites, specimens were sampled extensively for further study (see below). Notably, at least two large gorgonians estimated to be ~50 years old were sampled. A cross-section of the base of the coral reveals an annual banding pattern. We can mill material from the annual bands to reconstruct past records of nitrogen sources to these reefs. Surprisingly, fish were most consistently encountered group with Pomacentrids (damsels), Scariids (parrotfish), Acanthurids (surgeonfish), and Synodonts (lizardfish) or Scorpaenids (lionfish) found at nearly every location. Attempts were made to collect at least one individual of each “functional group” per site. The stable isotope analysis of their muscle tissues will help to inform the source of nitrogen to the base of the food web, and whether that source is of human origin. Specifically, the damsels will “record” the source of nitrogen present in the suspended particulate matter and plankton, the parrotfish and surgeonfish record the source of nitrogen present in benthic algae, and the predators integrate nitrogen from the entire food web. For the latter, a higher level of isotope enrichment may be observed on reefs that have a higher biodiversity, owing to an increased number of trophic linkages.

Samples of hard corals were sampled opportunistically when encountered to extract their associated Symbiodinium and identify them using molecular tools (extraction, amplification and sequencing of the ITS2 subregion of the nuclear ribosomal DNA). The genetic identity of these dinoflagellates will be compared with other records from SE Asia. This is a novel contribution to science as Myanmar remains an un-sampled locality. The genetic identity of these symbionts can also be indicative of the environmental conditions common to the reef (light levels, sedimentation, thermal regime, etc.).

Two sites adjacent to villages were investigated for anthropogenic impacts. The stable isotope analysis is still pending. Site 131 had only scattered corals of the genus Acropora, Porites, and Galaxea. Corals were not well-developed and signs of past mortality were observed with an abundance of turf algae. This was a huge contrast to site 148 which was a very shallow but impressively diverse reef very close to another village. Large schools of herbivorous fish were observed. There was no substantial algae growth, nor evidence of bomb fishing. Refuse from the village was noted. In the author's opinion, this site and nearby site 149 are excellent candidates for MPA designation as they are both close to the village, quite impressive in their coral cover, diversity, and abundance of fish. More importantly, the sites are easily monitored by the villagers nearby.

3. Achievements (Laboratory)

For now, subsequent analyses at HKU are just underway starting with the soft coral samples (Alcyonaceans and Gorgonians) that were found in high abundance at some sites. Currently, there are at least 18 putative species, with 4 species positively identified based on morphological character analysis. The process is tedious. Comparisons of colony shape (from fragment and photographs in situ) and isolation and microscopic analysis of sclerites (calcareous skeletal elements) used to identify the species. The literature is sparse for this understudied group. Of the 18 putative species, at least 5 species were sampled in sufficient number ($n > 30$) to conduct SIBER analysis of their trophic niche in the food web. Briefly, SIBER stands for Stable Isotope Bayesian Ellipse in R, which is a statistical analysis that uses isotope data to determine the trophic position of an organism. The abundance of these corals in Myanmar afforded the rare opportunity to collect a suitable sample size for this analysis. Some species are believed to co-occur in Hong Kong, so we can use this as a comparative study of corals from a pristine environment (Myanmar) with a heavily urbanized environment (Hong Kong). Such a contrast will be useful in monitoring for the effects of development using soft corals as indicator species and will be a novel contribution to science.

4. Future tasks:
    1. Complete identification of soft coral samples
    2. Section, map, mill, and analyse material from gorgonian cross-sections

3. Complete isotope analysis on all samples
4. Complete FIA analysis of water samples for nutrient concentrations
5. Extract Symbiodinium from hard coral samples, extract DNA, and genotype.

4.4. Sponge Diversity

Dr Chris Freeman surveyed the diversity of conspicuous sponge species within the Archipelago and Identify how these sponge communities change across sites. During the expedition Dr Baker also provided a talk to the Myanmar divers and trainees on sponge diversity.

Marine Sponge Communities in Myeik Archipelago: Dr Chris Freeman

1. Overview:

These surveys were aimed at providing an initial assessment of the overall sponge species diversity in this region and providing information on how these communities change both across sites in Myanmar and throughout SE Asia and the Pacific. These surveys involved swimming transects at each site and collections of a species when present. These samples were preserved in ethanol for future identification.

In addition to these surveys for species diversity, replicate (5-10) individuals of common sponge species were collected at each site. These collections are for future analysis of the elemental composition (via the stable isotope ratios of C and N) and the abundance of cyanobacterial symbionts (via chlorophyll a analyses) of sponge tissue.

Because marine sponges feed predominantly by filtering bacteria and other small particles from the water column, their elemental composition reflects local sources of C and N that can be impacted by numerous factors (for instance, source C and N values can vary with proximity to land and/or human development). By studying the elemental composition of sponge tissue, we can determine the dominant source of C and N utilized by a sponge species at a given site and, by assessing the elemental composition of the same sponge species from across diverse sites, it is possible to investigate how local sources of C and N vary over large and small geographic distance.

Chlorophyll A analysis provides a rapid assessment of the abundance of cyanobacterial symbionts within sponge tissue. By providing their host sponges with supplemental nutrition via photosynthesis, these symbionts greatly expand the metabolic capability of their host. By increasing the potential sources of C and N that a host can utilize at a given site, these symbionts can have a profound influence

on the elemental composition of a sponge species. An assessment of the abundance of these symbionts in different host species is thus important when interpreting isotope data.

Sponges for both of these analyses were collected and frozen.

2. Data Analysis

Sponges will be identified to species by histological analysis to study their skeletal elements and body design. Samples for stable isotope analysis will be prepared and analyzed at Hong Kong University. The resulting data will be analyzed using advanced statistical packages to investigate how different species process C and N and how this varies across sites. Samples for chlorophyll a analysis will be processed and analyzed at the Smithsonian Marine Station in Fort Pierce, Florida. These values will be compared to data from stable isotope analysis.

3. Preliminary results

Preliminary analyses suggest that we collected about 40 species of sponges on this cruise. These samples represent individual species from both common and rare groups of sponges and likely include species that are new records for SE Asia and also potentially species that are new to science.

Site	Approx. Site Depth (m)	Site Name	Tentative ID	Sponge Description
124	15.2	Hnget Khar Island	Stylissa sp	Stylissa sp? Common
124	15.2	Hnget Khar Island	TBD	hard and slighly compressible, outer appearance simialr to I. felix in Caribbean, but has no smell and was easily cut. Field note: called "Ircinia-like"
124	15.2	Hnget Khar Island	TBD	yellow sp, semi cryptic between coral branches and rubble, similar to Moorea samples, oxidized in air and EtOH
124	15.2	Hnget Khar Island	TBD	yellow finger sp, oxidized in air and EtOH, EtOH became green-cyanos?
125	7.2	Tharn Kyunn Nge	TBD	Collected at Site #1, Field notes "Ectyoplasia-like sp", pink outer layer with cyanobacteria present
125	7.2	Tharn Kyunn Nge	Encrusting Neopetrosia-like sp.	Collected at Site #1, common at most sites, enrsuting Neopetrosia-like species. Photosymbionts in outer layer, brittle.
125	7.2	Tharn Kyunn Nge	TBD	Collected at Site #1, hard and slighly compressible, outer appearance simialr to I. felix in Caribbean, but has no smell and was easily cut. Field note: called "Ircinia-like"
125	7.2	Tharn Kyunn Nge	Niphates/Callyspongia-like sp	pink/red species

125	7.2	Tharn Kyunn Nge	TBD	Fan-shaped Neopetrosia-like species with oscula on top of fan blade like a Caribbean Dragmacidon
125	7.2	Tharn Kyunn Nge	TBD	Brown, yellow species. Soft, compressible, looks like a cyanobacterial mat, darker outer layer
125	7.2	Tharn Kyunn Nge	TBD	hard, purple, encrusting sp., pink, purple outer layer and tan inside
126	9.1	Tharn Kyunn	TBD	red encrusting, hard
128	12.8	Kho Yinn Khwa Is	TBD	orange sp., fan shape
128	12.8	Kho Yinn Khwa Is	Xestospongia?	Xestospongia sp?-like X. muta from the Caribbean
128	12.8	Kho Yinn Khwa Is	TBD	orange, bushy fan sp
128	12.8	Kho Yinn Khwa Is	TBD	red cushion sp
129	5.9	Narr Kho Is	Xestospongia sp.	Xestospongia sp.-looks like an X. muta from the Cairbbean
129	5.9	Narr Kho Is	Stylissa sp	Stylissa sp? Common
129	5.9	Narr Kho Is	TBD	large yellow inside, fleshy sp
129	5.9	Narr Kho Is	Cinachyrella sp?	Cinachyrella sp
130	16.5	Ja Lann Kyunn	TBD	Orange encrusting
130	16.5	Ja Lann Kyunn	TBD	red encrusting sp
130	16.5	Ja Lann Kyunn	TBD	orange finger sp
131	1.0	Ja Lann Kyunn Village	TBD	Common green species, like Amphimedon
131	1.0	Ja Lann Kyunn Village	TBD-may be Niphates sp?	purple sp
132	16.9	Rock Pinnacles (Sth Kan Za Gyi)	TBD	Black mound sponge
133	11.3	Kan Za Gyi	TBD	red mound sp
133	11.3	Kan Za Gyi	TBD	orange fan sponge, common
133	11.3	Kan Za Gyi	TBD	encrusting hard green sponge-similar to sp found common in Hong Kong
134	15.1	Kyunn Me Gyee Is	TBD	Red mound with white rings around oscula, soft, compressible
136	9.2	Hlaing Island	TBD	encursting black
136	9.2	Hlaing Island	TBD	Encrusting sp
138	16.1	East Sular (E side, S of bay)	TBD	Orange semi-cryptic with large oscula, compressible

138	16.1	East Sular (E side, S of bay)	TBD	Small, ball sponges with single oscula, turned EtOH green-have abudnant photosymbionts. At the site, these sponges were sticky-spicules extended from them allowed them to stick to substrate and wetsuits
138	16.1	East Sular (E side, S of bay)	TBD	Same as above. These two small vials were combined into one 50 ml Falcon tube
141	19.5	Double Island	Neopetrosia-like sp.	Fan-shaped Neopetrosia-like species with oscula on top of fan blade like a Caribbean Dragmacidon
141	19.5	Double Island	Amphimedon-like green sp.	Very common green rope sponge, feels like Amphimedon sp.
142	19.5	Tower Rock	TBD	orange unknown
143	9.6	Bailey Is (E side)	TBD	Blue sp. encrusting an Acropora branch
143	9.6	Bailey Is (E side)	TBD	field notes: "new species"
143	9.6	Bailey Is (E side)	TBD	Orange, finger sponge, soft, fragile, compressible
144	15.1	Kyei Laik Island	TBD	Orange/Red fan sponge, common at most sites, rough edges
145	4.6	Pyin Sa Bu Is. (W, N bay)	TBD	cute, blue, soft sp with oscula on raised ridges.
146	10.5	Pyin Sa Bu Is. (W, S bay)	Ircinia sp.	Ircinia sp-smelled like Caribbean Ircinia and was almost impossible to cut. Black on top, tan underneath. Encrusting on rock with large, visible oscula.
146	10.5	Pyin Sa Bu Is. (W, S bay)	Lithistid A	#1 sample of this individual, found under overhang, amorphous, massive Lithistid
146	10.5	Pyin Sa Bu Is. (W, S bay)	Lithistid A	#2 sample of this individual, found under overhang, amorphous, massive Lithistid
146	10.5	Pyin Sa Bu Is. (W, S bay)	Lithistid B	found under overhang, fan shaped lithistid
146	10.5	Pyin Sa Bu Is. (W, S bay)	TBD	yellow encrusting sp from near overhang, oxidized
146	10.5	Pyin Sa Bu Is. (W, S bay)	Ircinia sp.	Ircinia sp-smelled like Caribbean Ircinia and was almost impossible to cut. Black on top, tan underneath. Encrusting on rock with large, visible oscula.
147	7.0	Leik Khon Is	TBD	Fibrous green fingers, encrusting, tough, occasional elevated tubes that may be oscula-or may be worm tubes that the sponge has grown around. Filled with chlorophyll, may have algae embedded within it.
149	7.4	Khin Pyi Son Is (north bay)	Callyspongia?	feels and looks like a Callyspongia. Surface with large ridges resembles armigera. Collected by Rob

150	6.8	Wa Ale Kyunn	Xestospongia sp.	Xestopspongia sp.?-brittle like Xesto or Neopetrosia, but had finger sticking up and was not barrel shaped
unknown	unknown	unknown	Cinachyrella sp	huge Cinachyrella
unknown	unknown	unknown	TBD	unknown

4. Expected results and next steps

With the help of sponge taxonomists, we will be able to identify these species and produce a publication or report that describes the sponge species of Myanmar and provides color photos of each species. In addition, with these species identified, we will be able to provide a list of the species present at each site and a description of how this diversity changes across this region. Data from stable isotope and chlorophyll a analyses will be used in a publication outlining resource use and the trophic structure of common sponge species off the coast of Myanmar.

5. Management implications

By providing an initial assessment of the common sponge species present at diverse sites off the coast of Myanmar, these data increase our understanding of the overall biodiversity in this region. Isotope and chlorophyll a data may allow us to understand how local sources of C and N vary within this region, and whether some of these sites are impacted by nutrients derived from human development. Importantly, these data also provide a baseline to which future collections can be compared. Because sponges are present at almost all sites, these organisms are a natural integrator of local nutrient sources across sites. Repetitive collections of these species, especially following development within this region, may thus allow researchers to monitor changes in nutrient inputs to these ecosystems.

4.5. Resilience and coral recruitment

Dr James True continued his research on coral reef replenishment gradients within the Andaman Sea. This included a continuation of the March 2014 liveaboard expedition which included research into reef resilience[1]. Dr True also undertook a follow-up liveaboard expedition with IUCN in January 2015 and all data will then be complied for a final report. Below is an overview of his work:

Resilience Assessment of Myeik Archipelago: Dr James True

[1] Obura, D.O., Benbow, S. and Zau Lunn (2014) Coral Diversity and Reef Resilience in the Northern Myeik Archipelago, Myanmar. Report No. 3 of the Tanintharyi Conservation Programme, a joint initiative of Fauna and Flora International (FFI) and the Myanmar Forest Department. FFI, Yangon

A system's capacity for resilience, which involves its ability to absorb disturbances without its ecological foundation being undermined, is an important element of any sustainable management response to environmental or anthropogenic stressors. The term “resilience” used here refers to the ability of natural or socio-ecological systems to cope with and adapt to change. Healthy ecosystems have significant ability to absorb impacts; degradation of ecological resources can severely erode the level and quality of goods and services they provide, although the socio-economic factors shaping the ways that people in Myeik Archipelago use coral reefs and coastal ecosystems are poorly understood. It is the perceived ability to recover from impacts, rather than to resist them that determines “resilience”. Risk factors – including degradation of the potential spawning population through destructive fishing, predators, targeted fishing of ecosystem maintenance species (such as parrot fish)and environmental impacts (such as pollution) – provide information about the vulnerability of a reef system. The abundance and diversity of “sensitive indicator” species, and the environmental conditions affecting a reef provide corresponding information about either the potential robustness of the site, or the length of time since it was last severely impacted (unfortunately, in ecology, as in quantum physics, it is not usually possible to detect the reasons for a change of state until it is observed to change). Reef resilience assessment is a semi-quantitative process, relying in large part on the experience of the assessor and the ecological context of the observed system. Previous work in the Thai Andaman Sea indicates that – of all the many factors that contribute to resilience in coral reefs – it is replenishment that is the key factor that controls recovery potential for Thai reefs; the goal of this research is – in part – to establish whether the same can be said for Myeik reefs.

To explain: the shallow water coral communities at Koh Surin, in the northern Andaman Sea of Thailand, were badly affected by the 2010 mass bleaching event. Extensive mortality of hard corals (up to 95%), particularly amongst the staghorn corals, left some of the most famously prolific reefs in Thailand a wasteland of dead coral colonised by ascidians and zoanthids. So extensive was the mortality that some species of *Acropora* appeared to be locally extinct, or so depauperised that locally-sourced replenishment of stocks seemed unlikely. In a largely self-seeding system, recovery might take many decades, and the resultant community would be comparatively depauperate. However, extensive recent recruitment of juvenile *Acropora* to previously impoverished reefs suggests immigration of larvae from unaffected reefs nearby in Myanmar. This, in turn suggests that the Myanmar reefs must somehow have been less badly affected by the 2010 bleaching event than Thai reefs. It also means that the prolonged dynamite fishing known to occur on the reefs near the maritime border – while devastating to those reefs targeted – may not be destroying the overall resilience of the system.

This is a tremendously important finding, since it reveals a raft of ecological processes that determine reef resilience, larval source redundancy and population connectivity on a large spatial scale. It is also clear that, to ensure the long term resilience of the most popular diving sites in Thailand, and the reservoir of biodiversity and ecosystem services the Myeik reefs represent, it is important to both asses the scale, diversity and condition of the probable source reefs of Surin's replenishment in the Myeik Archipelago. For the people of the Myeik Archipelago who rely even more directly on those ecosystem services, understanding the drivers of resilience and patterns of replenishment will allow spatial planning for resource protection and management that will provide them (and their children) with livelihoods and food security in the future.

4.6. Reef Check Surveys

The FFI Myanmar Dive team, with support from Dept. of Forestry staff, undertook 21 surveys using reef Check methodology to assess coral reef health focusing on the abundance of a set of readily identifiable indicator species that are used to gauge the health of a coral reef ecosystem. These included 1. Substrate composition (point sample, substrate data along 5 replicate transect line); 2. Fish abundance, size and diversity (pre-selected indicators only) – abundance estimates along the belt transects; 3. Invertebrate abundance, size and diversity (pre-selected indicators only) - the total number of certain invertebrate species within the survey area; and 5. Anthropogenic impacts (e.g. dynamite fishing).The standardised methodology is useful for comparing reefs and regions and therefore provide Myanmar marine decision makers with information on the relative status of their reefs. For the purpose of these surveys Reef Check was also used to provide a baseline of quantitative data on the archipelago's coral reefs and for the identification of key biodiverse areas. Including the sites from this liveaboard over 200 reef check surveys have now been conducted within the archipelago.

Data from this expedition is being compiled with the aim of identifying any key biodiverse areas within the archipelago. Preliminary results show an average coral cover of 27.9% across the 21 sites surveyed with a range of 7.5% (at site 142) and 67.5% (at site 136) (figure 4). This places the reefs studied in the 'average' (26-50%) class for coral cover under the reef check method which is similar to the previous average estimated for the archipelago following analysis of 115 surveys. Several sites however were in the Good (51-75%) class for coral cover, notably sites 143 with 63.7% and site 136 with 67.5%. The islands around site 136 have already been identified as a key biodiverse area and a priority for protections and the recent surveys have confirmed its importance.

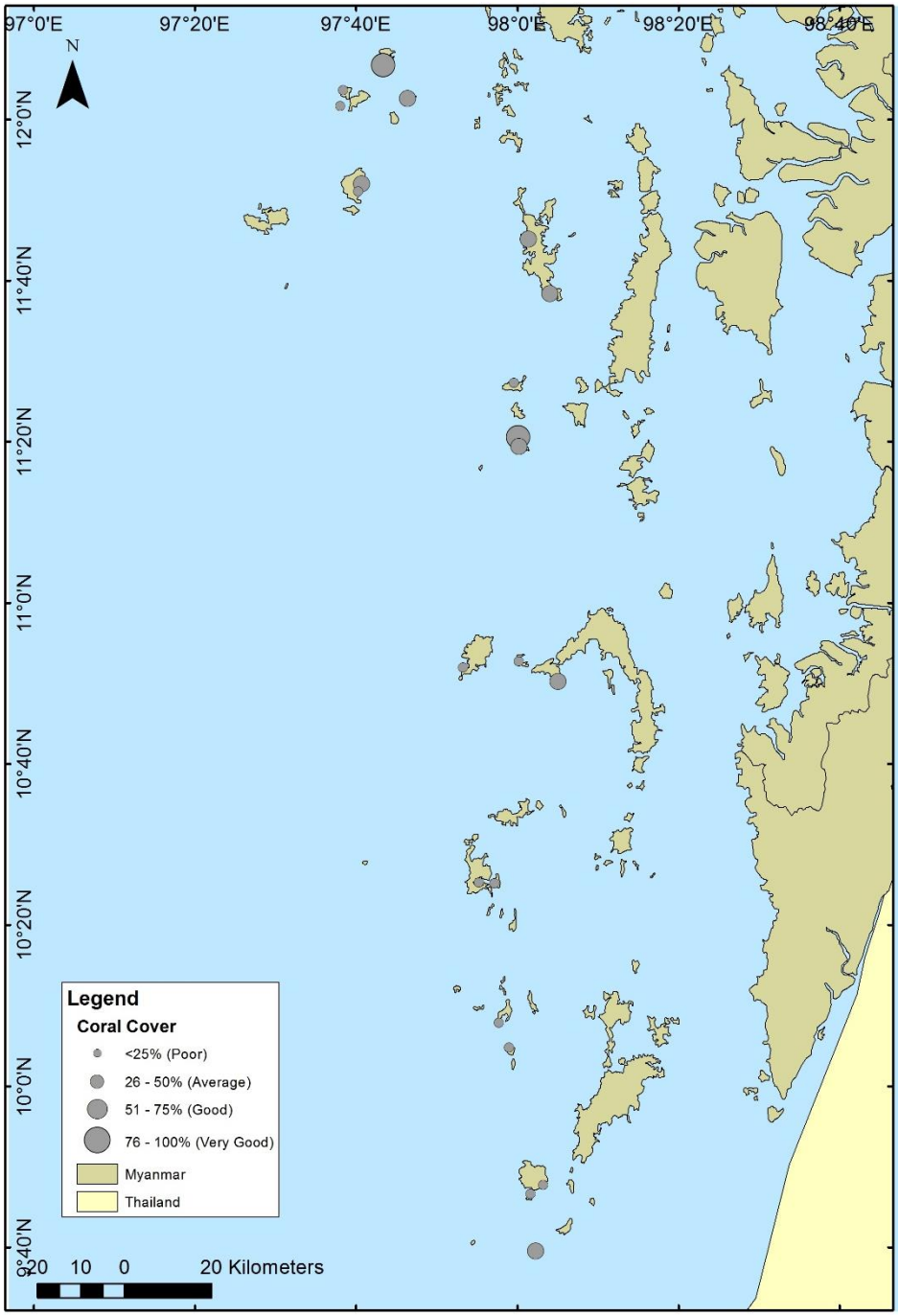


Figure 4. Hard coral cover for 21 sites surveyed using reef check methodology in Myeik Archipelago.

5. TRAINING

In October 2014 three Myanmar nationals began their training to become advanced open water divers. The liveaboard saw the completion of this training as they undertook their deep dive as the final task towards certification. Instruction was undertaken by Lawrence Davis from Denla Scuba in Thailand. Following this training the new divers then began training in coral reef wildlife identification

including coral family id (supported by Dr James True), other invert id and fish id as per the reef check indicator species list. The divers also learnt how to lay transects for surveys and undertook invertebrate surveys as a practice to surveying, recording observations underwater and most importantly improving their buoyancy skills to undertake surveys without damaging the reef.

6. CONCLUSION

The results from the expedition revealed a number of new sites with high conservation value, even if just in terms of coral cover or due to their high resilience potential given the large number of new coral recruits observed. Reef check surveys showed 5 out of the 21 sites to have coral cover over 40%. Furthermore the more specialised surveys from international researchers is providing not only extensions of the species lists for Myanmar but also information that will go towards supporting and being able to monitor management interventions. Most notably the studies on coral disease, sponge nutrient levels and anthropogenic change in hard and soft corals will provide a baseline for the reef in terms of nutrient/pollution levels. In addition the reef resilience studies are revealing how important the archipelago is not just on a local but regional level in acting as in integral source of larvae for reefs in Thailand.

The expedition did however find a number of damaged sites as a result of dynamite fishing which have reduced the reef to rubble and/or sea urchin barrens. Trawlers, large fish trap and longline boats were a common site during the trip and the dearth of large pelagics continues to be an issue. Most notably following 28 dives, with most dives including 14 divers in the water, not one shark was seen. Furthermore fishing for devil rays was observed first hand with fresh discarded heads observed off one island in the Torres group. Although the fish taxonomists noted the diversity of fish species throughout the surveys the low biomass is of concern. The number of small boats fishing on the outer islands in the Torres group was also revealing showing that this area is not restricted to large fishing vessels.

Using the information from this expedition and from previous liveaboard trips and reef check surveys FFI is undertaking a two-step approach to managing marine resource use within the archipelago. Firstly, at the local level FFI is currently engaging local fishing communities in several sites within the archipelago to develop co-management of their marine resources alongside the department of fisheries. Using the LMMA approach (Locally Managed Marine Areas) FFI is working with fishing communities in Langann and Thawaythadangyi Island groups to establish resources management committees, zoning and management plans to provide local fishers with a certain level of ownership

over their resources and encourage sustainable use. Secondly FFI is looking at the broader picture of marine resource use within the archipelago including usage by larger commercial fishing interests. This is being supported by technical input from the Smithsonian Institute firstly to develop a more systematic data collection platform for fishers and the department of fisheries to understand the number of boats, fishing grounds, target species, catch volumes etc. Such information is aimed to help support marine spatial planning of the archipelago including establishment of marine protected areas. Given the volume of work required to support management of the archipelago liveaboard expeditions such as this are therefore an invaluable means of data collection and have provided important information on the area critical to aiding management interventions noted above.

7. PHOTOS

Dr Barry Russell undertaking fish surveys

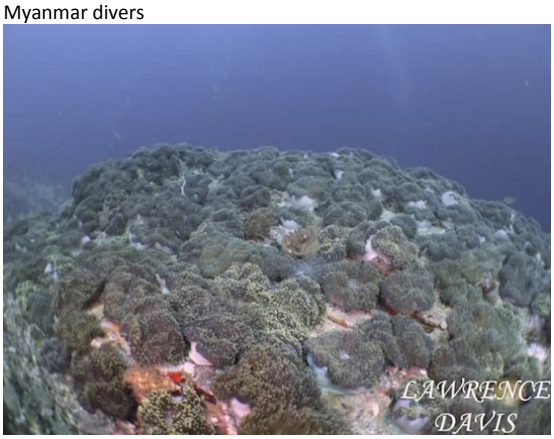
Hawksbill turtle. A rare sight within the archipelago

Barrel sponge

Trainee divers returning from completing their deep dive

Myanmar divers

Devil Ray head, freshly cut and discarded from fishing boat



Anemones

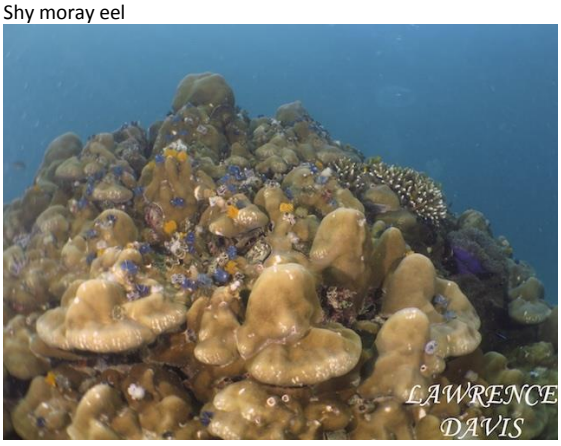
Dr Dave Baker undertaking coral surveys

Gorgonian coral

Returning from dive

Shy moray eel

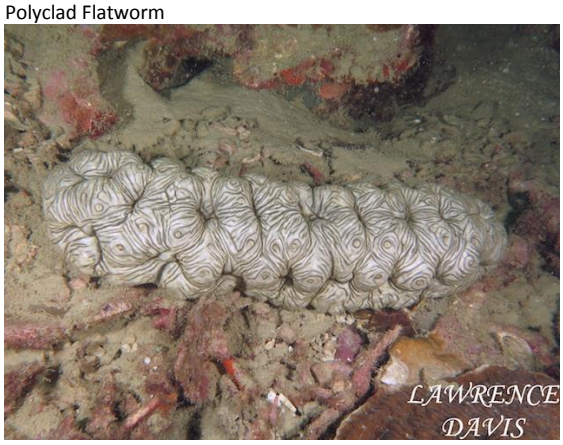
Myanmar divers undertaking reef check surveys



Christmas tree worms bored into Porites coral

Polyclad Flatworm

Pipefish



Stichopus sp. sea cucumber

Jellyfish

Zebra lionfish

Giant moray

Coral trout


Dr Chris Freeman preparing sponge smaples


Fishing trawler, common sight during the expedition


Dr Joleah Lamb giving Myanmar team a talk on coral disease


Dr James True off to scope for suitable sites

Diverse and complex coral reef

Mushroom corals (fungiids)