2017 CORAL COMMUNITIES IN THE SEYCHELLES

Annual Report for the Seychelles National Parks Authority

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Contents

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of the Earthwatch volunteers and fellows, Mitsubishi Corporation and finally our in-country partners, the Seychelles National Park Authority, which has been actively involved with every aspect of the project and research.

EXECUTIVE SUMMARY

In 2017, with Mitsubishi Corporation's continued support, the Earthwatch Institute (Europe) successfully conducted an eleventh year of coral reef monitoring in the richly biodiverse marine park of Curieuse in the Seychelles and the sixth year of a socio-economic research study on local Seychellois communities on the islands of Praslin, Mahe and La Digue. Between the 21st April and 6th May 2017, five Mitsubishi Corporation (MC) fellows and nine early career researchers selected from within the Indian Ocean joined Professor David J Smith and Dr Julian Clifton on Curieuse Island for a period of 16 days. They assisted the lead scientists and research team in data collection and learnt about the challenges threatening this part of the world, and the global impacts of those challenges. The programme was divided into a coral reef research team hosting five MC employees and three early career researchers, and the socioeconomic research team hosting six early career scientists. This was the second year that included the involvement of Emerging Scientist fellows, and their skills, knowledge and enthusiasm greatly benefitted the team.

Collectively the two research teams volunteered 140 days towards science which will underpin the conservation management plans for select Seychelles marine parks and provide further insights into the impacts of reef degradation on the local Seychellois community whilst enhancing fellow's own scientific understanding of the project and other related environmental challenges.

Data from Professor Smith's team (coral reef research) this year revealed that live coral cover remained static or increased in the extreme site (Baie Laraie) since last year, while in all other sites it declined. The coral microbiome samples collected in 2016 and analysed in 2017 demonstrated that the diversity within the microbiome is associated with the environment it is collected in and species of coral host. In addition, sampling of the coral microbiome of individual colonies that survived the mass bleaching indicates that some coral genotypes may be naturally adapted to withstand environmental pressures, and establishing nurseries of translocated resilient corals should be a future priority to increase resilient species biomass

Data from Dr Julian Clifton's team (socioeconomic research) revealed that about 29% of households on Praslin participate in artisanal fishing; and that the importance of artisanal fishing on Praslin is significant in terms of its total economic value. In addition, while the hotel and restaurant sector represents a significant demand for locally caught fish, there is little evidence that this impacts the availability of fish for local residents.

Fellows and scientists feedback has provided overwhelmingly positive comments with useful insights as to how we might continue to evolve programme delivery in future years.

The following report provides a summary of this year's research findings for the Seychelles National Parks Authority.

RESEARCH UPDATE

Contribution: Lead Scientist, Prof David Smith, Essex University.

IMPORTANCE OF CORAL REEFS AND THE SEYCHELLES

Reefs are home to thousands of species of fish and hundreds of types of coral. Although they take up a fraction of the Earth's surface, they provide mankind with a wealth of goods and services including fisheries, coastal protection, pharmaceuticals and tourism. Yet our reefs are under threat, facing numerous challenges that stem from human activities, ranging from over-exploitation of fish stocks to anthropogenic climate change, which is changing weather patterns, raising ocean temperatures and increasing ocean acidity. The sum of these impacts means that nearly all reefs around the world are considered threatened, and by the middle of this century it is predicted that around three quarters will be facing critical threats.

This means that understanding how present day and future reef systems will respond to environmental change is key to managing coral reef ecosystems of the future. This is what makes Mitsubishi Corporation's long-term commitment to global coral reef conservation so important.

Research in the Seychelles examines reef responses to large environmental disturbance events and utilises an experimental approach to assess the tolerance of reef building corals to climate change predictions. We know that corals do not all exhibit the same response to environmental change; we have identified resilient species and have begun to reveal the mechanisms behind this. In addition we have identified ecological refuge environments that may buffer reef systems from future environmental change, because these tolerant corals can re-seed areas of reef following degradation. All this has significant implications for conservation by highlighting the possibilities of instigating changes to management practices that will lead to more resilient reef systems; reefs that have greatest potential to recover from, or be tolerant to, environmental impacts.

Alongside exploration of the adaptability of coral to a changing planet, it is important we do not forget the impacts that changing reefs will have on local communities, because of the strong dependencies many people have on coral reefs as a source of food and livelihoods. We know that environmental impacts on our oceans will also play out on land, so it is vital that this research also explores the ability of reef-dependent human communities to adapt, so that we can inform strategies for enhancing their resilience.

It is these two complementary objectives – biological and social – that drive the Earthwatch project 'Coral Communities in the Republic of Seychelles'.

RESEARCH SITE AND OBJECTIVES

The Island of Curieuse, located in the north-east of the Republic of the Seychelles (see Figure 1), is an inner granitic island. Importantly, Curieuse has both veneering and carbonaceous based reef systems of varying topographic complexity.

Figure 1: Map of Curieuse Island

As a research site, it warrants investigation for several reasons. Scientific evidence suggests that corals in the Seychelles were "severely impoverished" by the El Niño event of 1998 and also the Asian Tsunami of 2004 that caused significant damage to coastal structures and which severely impacted the sub-littoral coral community (Harris 2014). Coral management in Curieuse requires detailed knowledge of the community structure, drivers of change, long term monitoring and possible management suggestions. The presence of a sedimented mangrove habitat also provides a perfect opportunity to examine marginal reef systems because of the resulting sediment plume that stems from the mangrove system and greatly alters the light environment.

RESEARCH AIMS

The overriding goal of this research programme is to provide managers and policy makers with the key information they need, in as far as is possible, to mitigate the combined threats to coral reefs of the region, specifically environmental degradation and climate change. To achieve this goal a number of aims have been investigated, but in 2017 the key objectives of the coral reef research team were:

1. To quantify coral resilience across species and environments;
2. To characterise resilient holobionts[1];
3. To harvest resilient corals via selective breeding

The objectives of the socio-economic research team were:

1. To quantify the full range of fishing-related pressures associated with local communities;
2. To examine the nature of casual fishing within local communities;
3. To examine the impact of the hotel and restaurant sector on nearshore fisheries.

RESEARCH UPDATE

The 2017 field research season represented the most recent of the current project. The research outcomes can be divided between the two teams fielded during the season: The Marine Research Team (Team 1) and The Social Science team (Team 2). Within this section we report on the preliminary outcomes of these two teams and describe the status of research that is still under way.

TEAM 1: MARINE RESEARCH TEAM.

The 2016 ENSO event had a devastating impact on reefs around the world, driving coral bleaching and mortality. The Curieuse Marine National Park (hereafter referred to as “CMNP”) was heavily impacted and across all sites bleaching - most probably leading to mortality - was evident. Maximum bleaching reached 90% within shallow coral beds off Praslin northern coast but averaged 57% across the 66 transects surveyed. Lowest bleaching and mortality was recorded at the Baie Larae site, the most turbid site located adjacent to the mangrove system. Bleaching was reduced

[1] Holobionts are complex assemblages of organisms that form ecological units. They include a ‘host’ the coral reef head and the surrounding microbial genomes that live outside of the host. (http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002226)

to 19% of corals present and tolerance was observed across all taxa including branching *Acropora* which is generally the most sensitive of the reef building coral genera. Research identified key areas within which corals were more tolerant to the anomaly. This finding is of key conservation interest and one we hope to capitalise on in future efforts aimed at protecting corals from environmental change and identifying priority areas for conservation.

Data Collected:

a) Coral Benthic Videos (66 x 30m Point Line Intercept Coral transects)

b) Videos of Fish Communities (66 x 30m Belt Fish video transects)

c) *Diadema* species abundance and size frequency distribution (12 x 10m belt transects)

d) Sponge abundance and size frequency (12 x 10m belt transects)

e) Benthic rugosity (12 x 10m line intercept transects)

Objective 1 results: Quantifying coral resilience across species and environments

During 2017, researchers and volunteers undertook a large number of surveys around the CMNP to determine the status of reef environments following the 2015-16 mass bleaching event (Figure 2). Data collected was compared to previous year's research findings to determine changes in benthic cover and the implications of the thermal anomaly as compared to longer term trends (Figure 3). Across the majority of sites both off the northern coast of Praslin and south coast of Curieuse (encompassing the major coral habitats within the CMNP) coral cover declined. This is set against a longer term trend of stability or small year-on-year increases in coral cover across the majority of sites.

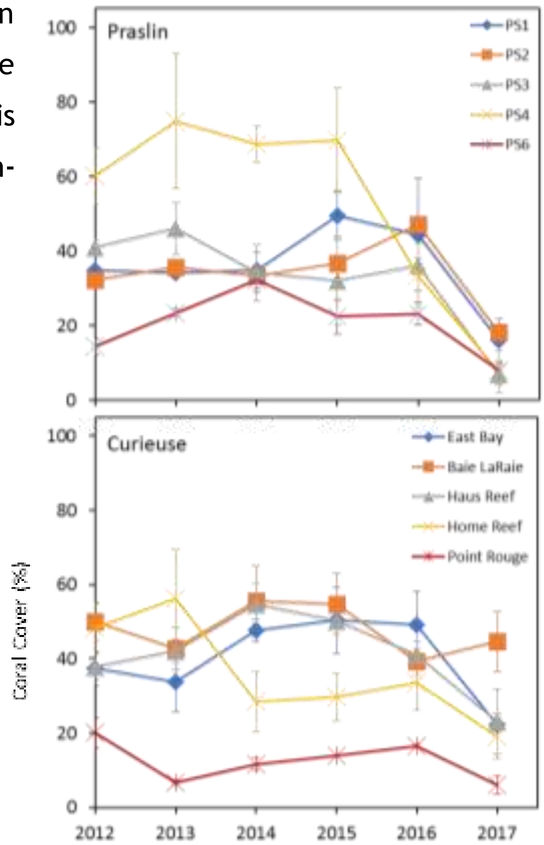
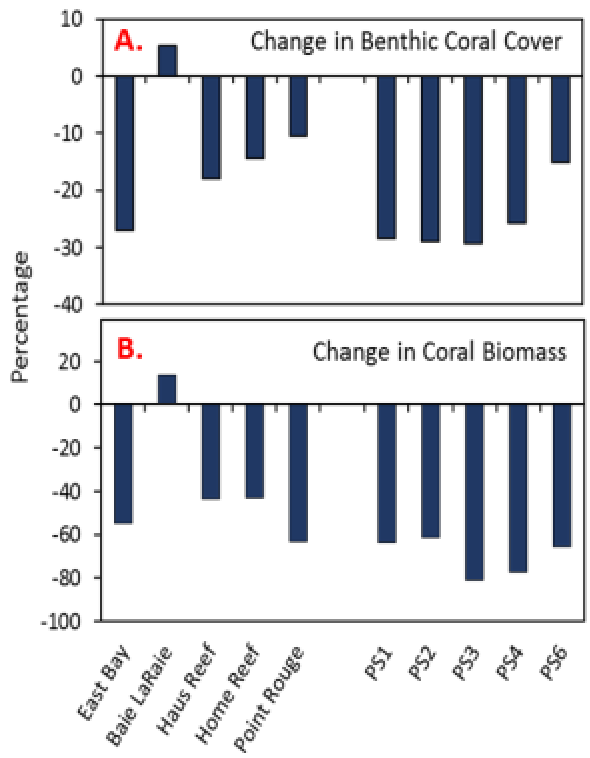


Figure 2*. Location of continuously monitored reef sites within the Curieuse Marine National Park 2012-2017. Inset map shows close up of Baie Laraie with possible refuge site (yellow area) with an area of ca 10,000m^2 Source Google Image*

Figure 3*. Change in coral benthic cover between 2012 and 2017 at sites within the CMNP. Top figure represents sites off the coast of Praslin. Bottom figure represents sites off the south coast of Curieuse Island. Figure 1 shows location of these sites. Mean ± SE are presented (n = 3)*

Off the South Coast of Curieuse Island the percentage cover of coral varied between 6 to 44% live coral cover. Baie Laraie (see inset in Figure 2) had the highest coral cover. Coral cover at this site has not varied significantly over the past 6 years (long term mean of 47±2%). Similarly coral cover at Point Rouge has also not changed significantly since 2012 but historically has always been low (12 ± 2%), primarily due to the geomorphological characteristics of the site (exposed granitic boulders). The abundance of coral on all other reefs surrounding Curieuse Island has changed significantly, primarily due to large decreases in coral cover between 2016 and 2017 (Figure 4A).

Similar trends in coral cover change were also observed at sites located within the CMNP immediately off the coast of northern Praslin (See Figure 2 and sites with prefix PS) but changes over the past 6 years are more marked. Compared to data collected in 2012, coral at all sites has declined with the exception of the single site where coral has always been low due to its unique habitat and benthic structure (PS 6 – long term mean of 20 ± 3%). However, even here coral cover declined significantly between 2016 and 2017, although the decline in coral cover at all other sites was much more pronounced, possibly as a result of much higher starting values and a greater diversity of corals (i.e. containing a mix between vulnerable and tolerant species). The majority of this decline was due to a high rate of coral loss between 2016 and 2017 (average annual loss of coral biomass present = 70 ± 4% - see Figure 4B). However coral decline at PS4 (previously a well-developed mono-stand of *Acropora*) was already apparent in 2016. Mortality of coral at all other sites was observed across the majority of taxa, although the most vulnerable genus was *Acropora* and the least vulnerable *Porites, Favia, Favites, Goniastrea* (*Coelastrea*) and *Diploastrea*.



Figures 4A and 4B*. Change in coral cover and percentage of coral loss between 2016 - 2017 at sites within the CMNP.* ***A****. represents percentage change in actual benthic cover of coral.* ***B****. represents the percentage change in coral biomass from 2016. Mean ± SE, n=3.*

With the exception of one site, the scale of coral decrease between 2016 and 2017 was dramatic across all sites examined (see Figure 4). The benthic cover of coral only increased in Baie Laraie, and this site was adjacent to mangrove environments (See Figure 2) and regularly experiences extreme turbidity (Camp *et al*. 2016). Between 2016 and 2017, 5% more of the benthic substrate was covered in coral at this site. Loss of coral from other sites was relatively constant; the park average loss of coral as a percentage of benthic habitat covered was 25 ± 2% (from 2016-2017). As a percentage of coral biomass present, used here as a measure of annual coral mortality, values are much higher. Across the whole of the park the average percentage of coral present that was killed between 2016 and 2017 was 70 ± 3%. However coral cover at Baie Laraie increased by 13% between 2016 and 2017 (as a proportion of coral present in 2016). The abundance of coral in 2016 versus 2017 is shown in Figure 5. Here across all sites apart from Baie Laraie, coral cover in 2017 and 2016 shows a linear relationship.

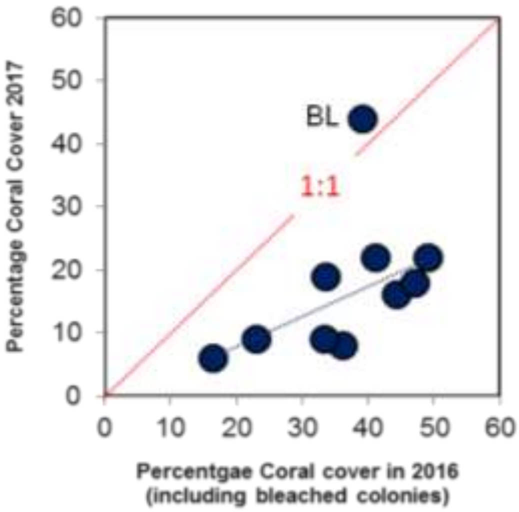


Figure 5. *Coral cover recorded in 2016 including colonies that showed signs of bleaching but were not dead, and the percentage of live corals recorded in 2017. The outlier (BL) refers to Baie Laraie (see Figure 2)*

However, Baie Laraie deviates from this trend as a result of no coral loss. Using regression analysis we can predict the Baie Laraie coral cover if the colonies at the site were impacted to the same extent as other sites (note that coral community composition was similar across all sites). The predicted ($r^2 = 0.77$, $p < 0.01$) coral cover would be *ca* 16 ± 3 % whereas coral cover recorded in 2017 was 44%. This further demonstrates the reduced vulnerability of corals within this region (demarked within inset map of Figure 2).

Objective 2: Characterisation of resilient holobionts

This research objective was addressed in a number of ways. During 2016 the research team (scientists and volunteers) took samples from several species of coral across representative environments. Half of the corals sampled showed evidence of paling (bleaching) whilst the remainder appeared to be physiological unaffected. These samples were analysed during 2017 and the data are presented below. Further data analysis and interpretation is required however preliminary investigations suggest that the diversity of the coral microbiome varied with species and environment (see Figure 6).

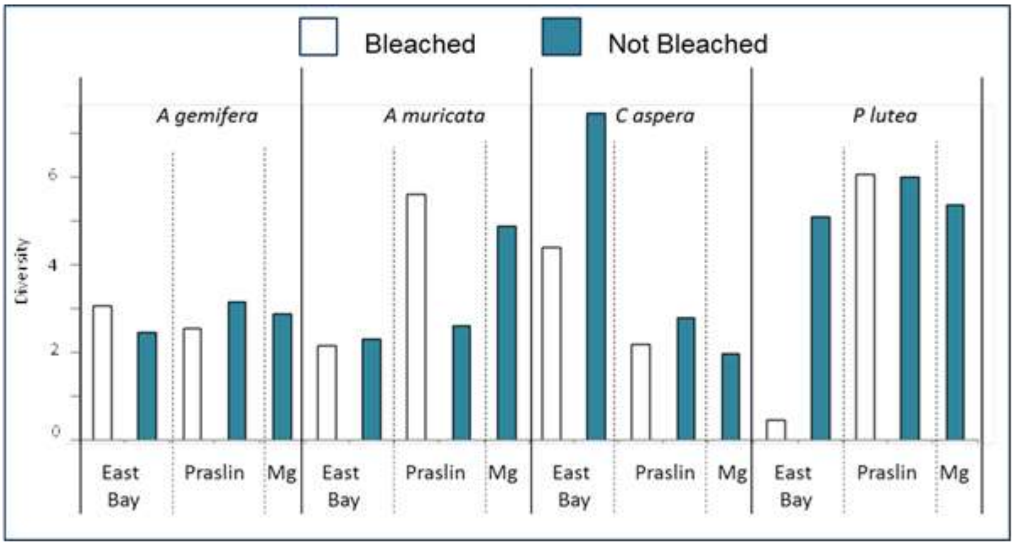


Figure 6*. Diversity (Shannon Index) of the microbiome associated with dominant coral species across reef sites. Microbiome of bleached and non-bleached corals are shown. East Bay represents clear water site, Praslin turbid but shallow, and Mangrove (Mg) an extreme (temperature) environment. No corals were bleached at the mangrove sites.*

There was a positive interaction between species of coral host (see Figures 7 and 8) and environment in influencing diversity of the coral microbiome. Generally *Acropora gemifera* had a reduced microbiome biodiversity (but high variability), whereas *C aspera* and *Porites lutea* had the highest, although there was significant variation across environments.

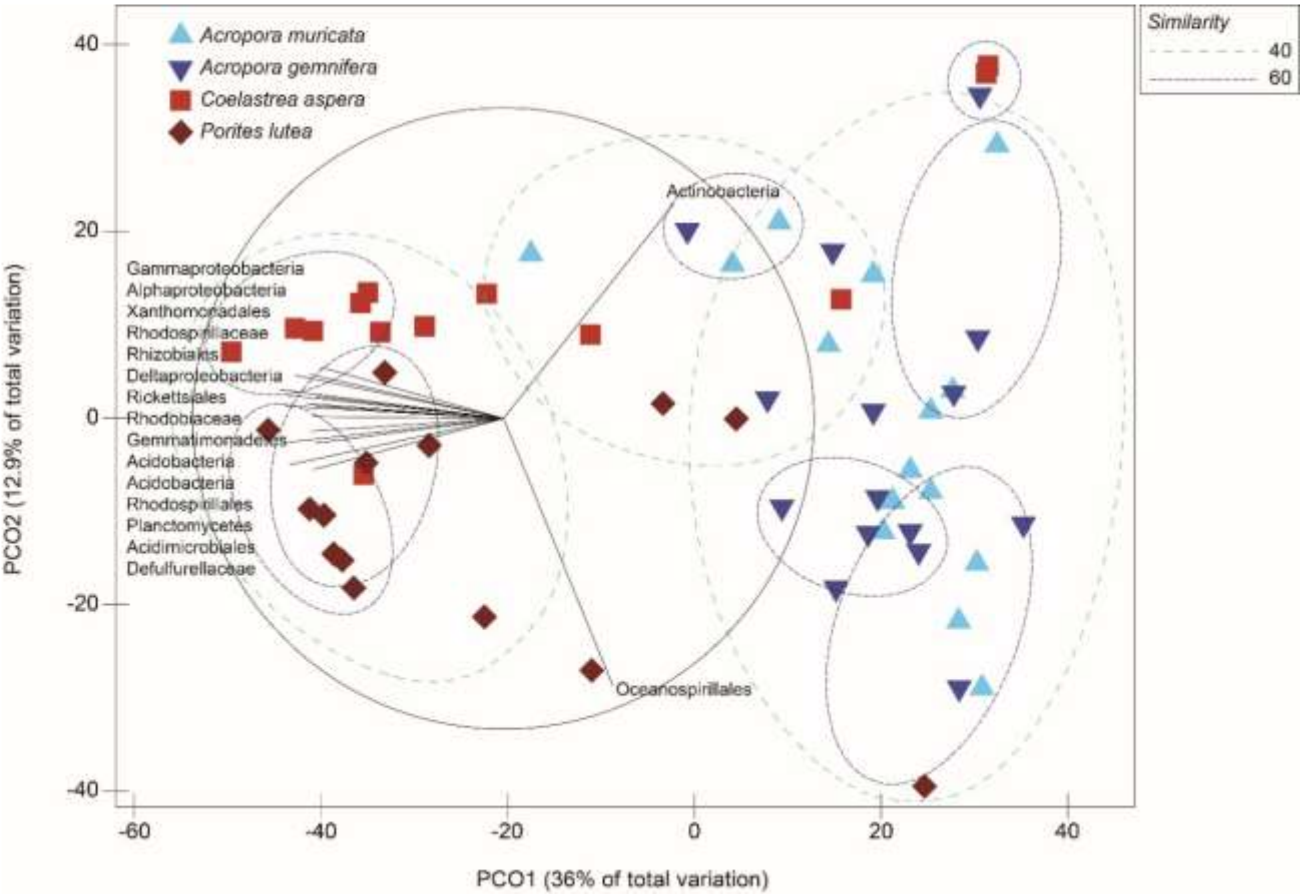


***Figure 7**. Principle Coordinates Analysis PCoA for B16S data obtained from coral samples (as per Figure 5). The two axis explain 48.9% of the variation and show the main differences between coral genera. Variability in assemblage is mostly driven by bacterial taxa.*

The diversity of bleached and non-bleached corals varied in some coral hosts (see Figure 6) but not others, as did the composition (see Figure 8). Generally the microbiome of *A gemifera* did not vary. The diversity of the microbiome of *C asper*a and *P lutea* was always higher in non-bleached colonies regardless of environment. However the diversity of the microbiome in *A muricata* was greatest in bleached colonies at Praslin. However when considering the microbiome of *Acropora* species at the Praslin site we must take into account that our previous field surveys demonstrated that prior to the thermal anomaly the large stand of *A muricata* that dominates the site was already showing signs of disease and mortality – a common feature of monoclonal stands – and therefore the microbiome data from this site is probably a reflection of the coral core microbiome plus pathogens plus opportunistic bacteria.

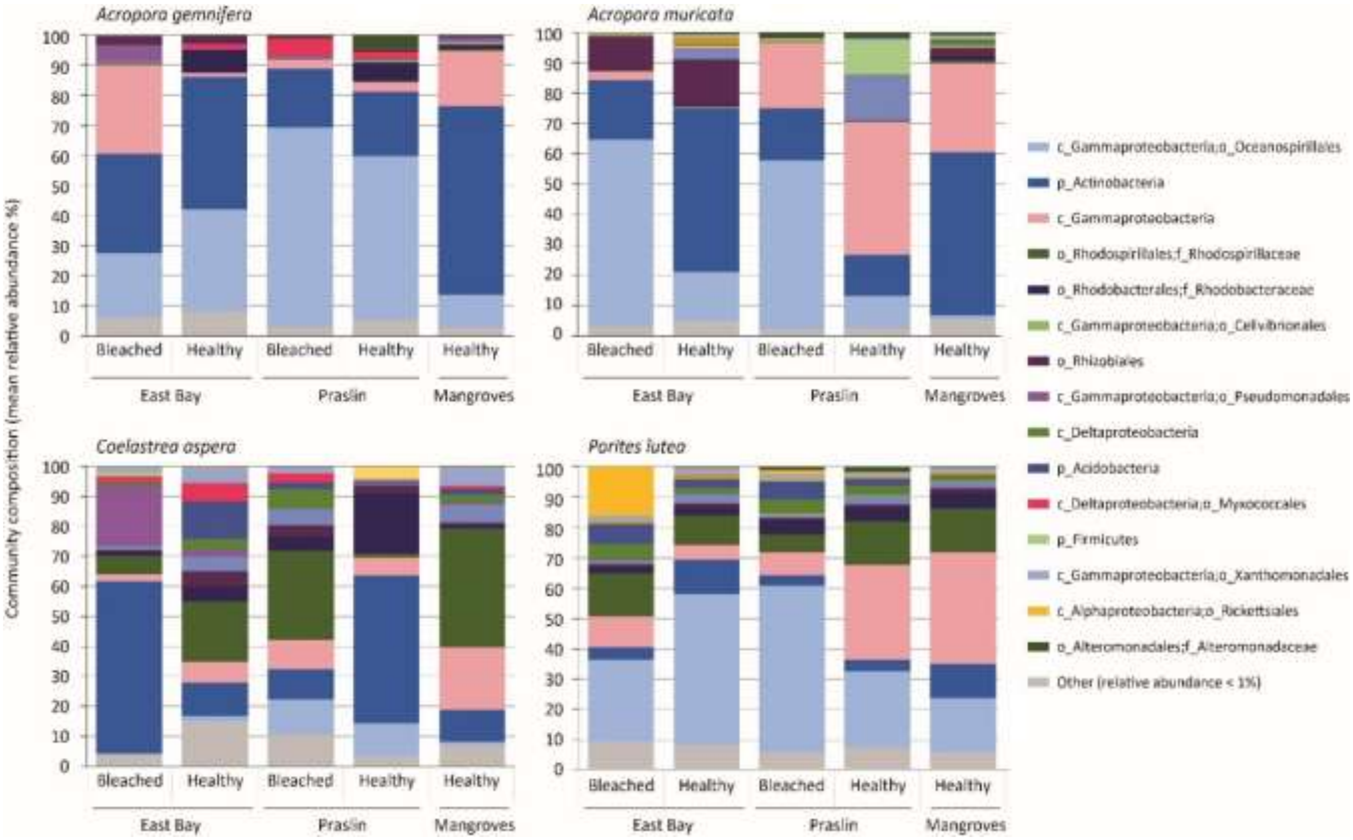


***Figure 8**. Comparison of the relative microbial composition of bleached and 'healthy' coral samples from each species and site (as Figure 5). Alpha diversity indices for B16S data are presented.*

During 2017 further samples were collected (See Figure 9) from corals at the bleaching refuge environment Baie Laraie – see Figures 2, 3 and 4) and also from control clear water sites. To determine if the coral microbiome was environmentally driven, coral fragments were translocated from the refuge environment to the control site (small natural fragmented samples – no corals were physically impacted). Samples were taken at the time of sample collection and samples are to be taken following 1 year. Samples were also taken from conspecific corals that were treated with broad spectrum antibiotics (antibiotics were not administered in the environment, samples were treated *ex situ*, washed with axenic seawater and then reintroduced into the environment). The microbiome of these corals will reflect bacterial colonisation from the environment. These samples will be analysed over the coming year.

Figure 9. *Sampling over coral microbiome at mangrove site and clear water site (Home Reef) during 2017 (Fig 9A). The microbiome of half of the coral specimens were eradicated through use of antibiotic treatment. Following treatment (Fig 9B) corals were placed back in to their native environment (Fig C,D) or relocated into the second environment (RED circle represents extreme site and YELLOW circle represents clear water control site Fig 9E).*

Objective 3: Harvesting resilient corals: selective breeding

The rapid evolution of the coral holobiont may provide one of the most important mechanisms by which a coral may increase its resilience to environmental change. The enforced reorganization of a coral holobiont through manipulation of environmental conditions is one approach to management that requires detailed attention if we are to actively drive positive coral resilience. One of the other approaches (that may be related to resilient / tolerant microbiome or may be related to specific characteristics of the coral animal itself), is the selection of naturally occurring tolerant coral colonies for propagation to increase the frequency of tolerant colonies within the environment. The 2017 surveys demonstrated mass bleaching but it was rarely at 100%. The question therefore arises why some, if only a few, corals survived the 2016 event even in the most impacted of environments (see Figure 10 A and B). It is possible that some microclimate effect reduced the impact of the environmental anomaly for particularly colonies, but it is also possible that some coral genotypes are naturally adapted to withstand environmental pressures. In 2017 we planned to identify colonies that did survive and trial propagation techniques aimed at increasing the abundance of these corals in the environment (e.g. see Figure 10C). We have now trialled the nursery techniques (primarily within Indonesia, but similar techniques have been used in CMNP in clear water sites by the SNPA though an EBA funded UN project). We have also sampled the coral microbiome of those individual colonies that did survive (as described earlier) and are currently investigating the impacts on the microbiome of those corals transplanted from one environment to another (as described earlier). The next stage in the proposed research will be to establish permanent nursery structures to increase biomass of resilient species. However this approach depends on long term opportunities and knowledge of the effects of translocation of corals on thermal tolerance (a key aim of 2018).

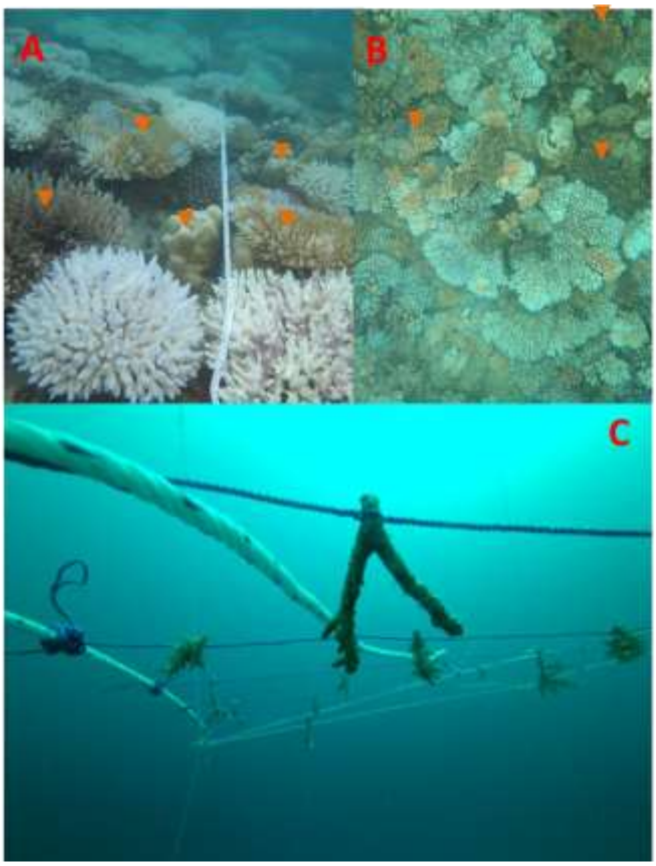


***Figure 10**. A and B - Differential tolerance to thermal anomalies; C- Trial shallow water nurseries (Indonesia)*

Marine research team summary

Within the marine research team a specific zone was identified within which corals have natural high tolerance to thermal anomalies. This zone should be strictly protected and the coral that is present should not be damaged. Ensuring no boats anchor in this region or that any other damaging practices (e.g. fisheries activity) occur should be a priority. The location should be considered a refuge environment. Future research plans will focus on expanding coral biomass in this region (see Figure 10).

TEAM 2: Social Science Research Team

The islands of Seychelles are renowned worldwide as a major international tourist destination. However, the marine environment fulfils many other roles for local communities, providing people with the essential resources for income and food security. This research highlights the extent to which subsistence as well as small scale commercial ('artisanal') fishing is practiced within these communities and the contribution this makes towards sustainable daily livelihoods. The social science research programme was directed towards examining the nature of casual fisheries within local communities using socio-economic interview techniques. Below is a summary of research results for 2017.

Data Collected:
117 household surveys and 14 hotel owner interviews

Objective 1: Quantifying the full range of fishing-related pressures associated with local communities

The household surveys conducted across the major settlements on Praslin indicated that 29% (n=34) of households engage in subsistence fishing. With a population of around 8,500 in 2,500 households in the 2010 census, this equates to approximately 2,500 people in around 700 households being directly involved in subsistence fishing on Praslin alone. Given that official data indicates an artisanal fishing sector numbering approximately 1,700 people in the entire Seychelles, this survey sheds new light on the total fishing pressure being exerted by local households for domestic consumption purposes.

Objective 2: Examining the nature of casual fishing within local communities

Within the subsistence fishing households, jack fish (Carangidae) was cited as the most commonly caught fish by over 50% of respondents, followed by rabbit fish (Siganidae) which was caught by 21% of respondents and grouper (Serranidae) which was cited by 8%. Hand line fishing from boats was practised by almost 80% of respondents, with other techniques including shore based line fishing (18%) and a small number of trap, harpoon and net fishers. Only five respondents (15%) indicated they did not own any equipment and therefore borrowed boats or fishing gear, whilst none of those who owned boats or gear would expect payment in return for lending it out. In terms of fishing frequency, over a third of fishers (35%) would fish more than four times a week, followed by an equal proportion fishing a few times a month or less than once a month. Almost all fishers indicated they would spend between half a day and a full day fishing.

Fishing households reported an average weekly spend of Rs100 (£5.6) on fish, compared to almost Rs250 (£14) within non-fishing households, although the variation within the data meant that there was no significant difference between the two groups. However, if it is assumed that each (of the 700) fishing households effectively saved around Rs150 per week through subsistence fishing, this would place an annual economic value of around Rs5.46M (£305,000) on the Praslin subsistence fishery. Whilst there are no up to date published catch data from the artisanal fishery to place this figure into context, 2012 data from catch assessment surveys on Praslin were estimated at 396 metric tonnes, equating to an economic value of Rs53.5M (£2.9 million) - based on the 2012 value of Rs135 per kg of fresh fish (SFA 2012). While fish prices between 2012 and 2017 are not the same, these figures do highlight the probable significance of subsistence fishing (equating to around 11% of artisanal fishing). Furthermore, the total economic value of subsistence fishing equates to the total annual income of around 100 artisanal fishers[2].

This survey therefore presents a picture of regular subsistence fishing involving a significant number of gear owning households on Praslin targeting a limited range of reef-based species with a considerable total economic value. As these individuals are not engaged in any commercial activity, their activities are not reflected in the official artisanal fishery statistics which are based on creel-type surveys[3].

Objective 3: Examining the impact of the hotel and restaurant sector on nearshore fisheries

The hotel and restaurant sector on Praslin reported a total annual visitor consumption of between 140-180 tonnes of fish per year, depending upon hotel occupancy rates. The upper limit represents approximately 25% of the estimated Praslin artisanal fishery annual catch which is in the order of 700 tonnes/yr. As would be expected, the hotel and restaurant sector exhibits a distinct preference for species favoured by tourists. All owners interviewed listed jobfish as a favoured species, followed by snapper, jackfish and parrotfish, which were sourced from local fishermen. Tuna, marlin and sailfish were always purchased from suppliers on Mahe.

Most hotel owners operated a complex informal system of direct purchasing from local fishermen, often relying upon established trading relationships and networks of contacts. No hotels used middlemen or single fishers, preferring to buy fish directly from a group of fishermen according to daily or weekly demand. Only one hotel reported purchasing fish from the local market (roadside stall). All hotels reported positive relations with local fishers, in some cases preferring to pay a

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2 National Bureau of Statistics. Formal employment and earnings. Victoria: National Bureau of Statistics; 2010.

3 Creel-type surveys refers to where a surveyor approaches anglers or landing sites and asks questions of the fisher on what species were targeted, the number of species caught and the number of hours spent fishing.

slightly higher rate to ensure that fishers in return would give the hotel owner the first choice of the catch. Shortages associated with the monsoon season (April-July) were addressed through building up stocks in advance.

Whilst the hotel and restaurant sector represents a significant demand for locally caught fish, there is little evidence that this impacts the availability of fish for local residents. Fishers would generally only sell particular species to the hotels, whilst local consumers have a wider range of preferences. Very few hotels purchase directly from the roadside stalls used by local consumers which would place them in direct competition.

Finally, the reliance on local fishers increases the likelihood of multiplier effects operating within the island economy as a result of tourists' demand for fish.

Social science research team summary

The research conducted on Praslin in 2017 broke new ground in terms of helping to understand the varied pressures on nearshore fisheries, and continued an excellent record of hard work being put in by Research Fellows each year. This year we collected almost 120 household surveys and interviewed almost all the hotel and restaurant outlets on Praslin. The dedication, professionalism and above all the enthusiasm of the Research Fellows ensured that the fieldwork ran smoothly and we were able to deliver a range of classes, talks and practical guidance on marine environmental issues in the evenings. The presentations delivered by each team showcased the amount of work put in and the extent to which serious data analysis had taken place.

COMMUNICATIONS

- **Journal articles:**
  - Camp EF, Suggett DJ, Gendron G, Jompa J, Manfrino C, Smith DJ (2016) Mangrove and seagrass beds provide different biogeochemical services for corals threatened by climate change. *Frontiers in Marine Science*.
  - Clifton J, Osman E, Suggett DJ, Smith DJ (in review) Resolving conservation and development tensions in a small island state: a governance analysis of Curieuse Marine National Park, Seychelles. Submitted as part of Special Issue for '*Marine Policy*'
  - Gardner S, Suggett DJ, Camp E, Voolstra C, Kahlke T, Osman E, Smith DJ (in prep) Mass bleaching-driven changes in coral microbial communities are regulated by local environmental conditions.

- Adaptive capacity in nearshore social-ecological systems: enhancing resilience to climate change. *Global Environmental Change*
- Food insecurity and social capital: insights from small island developing states. *World Development*

- **Conferences & Seminars:**
  - Clifton J. Socio-economic characteristics of coral reef user communities. Curieuse Coral Reef Ecology Networking Session, April 2017, Praslin, Seychelles.
  - Aggressive conservation to protect reefs from thermal induced bleaching. Curieuse Coral Reef Ecology Networking Session, April 2017, Praslin, Seychelles.
  - Smith DJ. Corals in marginal habitats are better adapted to survive acute environmental change, Indonesia 2017
  - Winton D and Smith D. What are the advances in citizen science for coral reef research? European Coral reef Symposium, Oxford UK
  - Greenwood B. The role of the coral microbiome in dictating the coral niche. European Coral reef Symposium, Oxford UK
  - Al Mealla R. Reef accretion and the trade-offs of a thermally tolerant symbiont. European Coral reef Symposium, Oxford UK

- **Wider Media and Press Coverage:**
  - https://www.scimex.org/newsfeed/survey-reveals-unexpected-level-of-seychelles-coral-bleaching
  - https://www1.essex.ac.uk/news/event.aspx?e_id=10330
  - https://www.essex.ac.uk/news/2017/10/17/a-safe-haven-for-corals-within-the-red-sea
  - https://www1.essex.ac.uk/hrc/news_and_seminars/seminarDetail.aspx?e_id=11607
  - https://books.google.co.uk/books?id=WLtADwAAQBAJ&pg=PA4&lpg=PA4&dq=coral+reef+seychelles+bleaching+essex+university&source=bl&ots=y8vIdmn1l8&sig=U8ew4WtuE_JYkzZcwApyMBXSvbQ&hl=en&sa=X&ved=0ahUKEwiZrIDx7s3YAhWpAsAKHabYBWk4ChDoAQg_MAI#v=onepage&q=coral%20reef%20seychelles%20bleaching%20essex%20university&f=false

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Camp EF, Suggett DJ, Gendron G, Jompa J, Manfrino C & Smith DJ (2016). Mangrove and seagrass beds provide different biogeochemical services for corals threatened by climate change. Frontiers in Marine Science 3:52. doi:10.3389/fmars.2016.00052.

SFA (2012). Seychelles Fishing Authority Annual Report. Victoria, Mahé, Seychelles, 90pp. ISSN 1659-715X http://www.sfa.sc/Downloads/Publications/AnnualReport/Annual%20Report%202012.pdf