SAVING PHILIPPINE REEFS 2017 REPORT

Siquijor Province, central Philippines
(A compilation of Municipality Reports)

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Saving Philippine Reefs 2017 Report
Siquijor Province, central Philippines
(A compilation of Municipality Reports)

April 22-30, 2017

A Project of the Coastal Conservation and Education Foundation (CCEF)
(Formerly Sulu Fund for Marine Conservation)

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Reports from the Saving Philippine Reefs Expedition 2017 in Siquijor Province, central Philippines

Produced by the Coastal Conservation and Education Foundation, Inc. (CCEF)
Cebu City, Philippines

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CCEF is a non-profit organization concerned with coral reef conservation and fisheries management through marine protected areas.

Report Layout: A.P. Maypa and M. R. Baird

Front cover photo by Michelle Baird (“Pajama fish in Nonoc Reef”).

Back cover Photo by Agnes Corine Sabonsolin (“Toes in the Air,” a squat shrimp)

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1.0 Message from the Saving Philippine Reef Project Principal Investigator

Greetings from CCEF!

As we continue with our efforts in coral reef conservation and marine protected areas sustainability, we share with you the results of our Saving Philippine Reefs field surveys from selected marine sanctuaries and adjacent fished reefs in Siquijor Province, central Philippines.

The 2017 SPR Report format is quite different from our previous SPR reports. Here we can see how our different SPR data sets are being utilized by the CCEF-Siquijor Team, the Province and its local governance bodies to address concerns and issues concerning coral reef conservation, marine protected area sustainability and fisheries stocks recovery. For example, part of the 2017 SPR data set was used in the Nonoc Marine Sanctuary (NMS) and adjacent fished reef status report , included here, to address the 0.4 ha coral damage in the reef adjacent to NMS. This report was submitted to the LGU of Larena Municipality, Barangay Nonoc and the Department of Environment and Natural Resources office of Siquijor Province last June to July 2017 to find solutions and call for action to stop or mitigate the damage. Further, part of our SPR data was also useful in evaluating the effectiveness of the coral reef rehabilitation initiative of CCEF, for example, in the case of Caticugan Marine Sanctuary, Siquijor Municipality. Because of the long-term partnership and the many initiatives of CCEF in Siquijor Province, we can see how our monitoring data are utilized together with previous data sets from different CCEF projects or different institutions to achieve our conservation and management goals.

In CCEF and Siquijor Province, we sustain our long-term MPA monitoring through different projects over time with similar goals and through CEEF-LGU partnerships. We especially thank the support of the SPR Research Volunteers in 2017 (to those who were able to participate in the expedition and those who did not make it to the field) for adding on another point our monitoring data for 8 MPAs. We also thank the hard working CCEF staff and 2017 SPR local volunteers. We also extend our thanks to the Siquijor CRM Section staff of the Office of the Provincial Agriculturist, the Philippine National Police Provincial Monitoring Team members and the AFP Central Command and Task Force Deter for making SPR 2017 a successful expedition.

I wish you all another successful expedition for 2018.

Sincerely,

Alan T. White, Ph.D.
Principal Investigator, SPR
and CCEF President

2.0 About SPR

The Saving Philippine Reefs Project had its beginnings i in 1980's when Dr. Alan White and colleagues started to survey the coral reef health including its fish and invertebrate fauna in Tubbataha (now officially called, "Tubbataha National Marien Park"). From then on, SPR became a yearly expedition to selected reefs around the Philippines (e.g., in Calamianes, Batangas, Bohol and Negros Island) organized by CCEF to assist MPA managers and local many local government units in managing and sustaining their coral reefs and MPAs. This project is supported by the Volunteer Researchers from around the world contributing individually what they can do to achieve a common goal in marine conservation and food security.

In 2017, the SPR Expedition was carried out in Siquijor Province, central Philippines where 21 MPAs had been established to date. SPR assisted in monitoring 8 MPAs (Fig.2.1). The same SPR Volunteer Researchers also contributed in increasing the coral cover of one of the typhoon-damaged reef in the area, i.e., Olang Marine Sanctuary by assisting in stabilizing coral fragments as part of the coral reef rehabilitation and reef fish recovery initiative of CCEF and Siquijor Province.

Over the years, CCEF continues to implement the SPR project in different areas to contribute in improving MPA management, supporting MPA sustainability and good practices and, influence in the formulation of policies supporting marine conservation and food security.

2.1 The SPR 2017 Team

International Volunteers

Laurent, Boillon (Austraila)
Julia Chichowski (USA)
Tom Castopoulus (Australia)
Mark Copley (USA)
Alastair Pennycook, Ph.D. (UK)
Rina Haupfield (USA)
Jordan Tucker (USA)

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Moonyeen Nida Alava, MSc.
Jonathan Apurado, M.Sc.
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Danielle Mark Fukuda, MSc. Candidate
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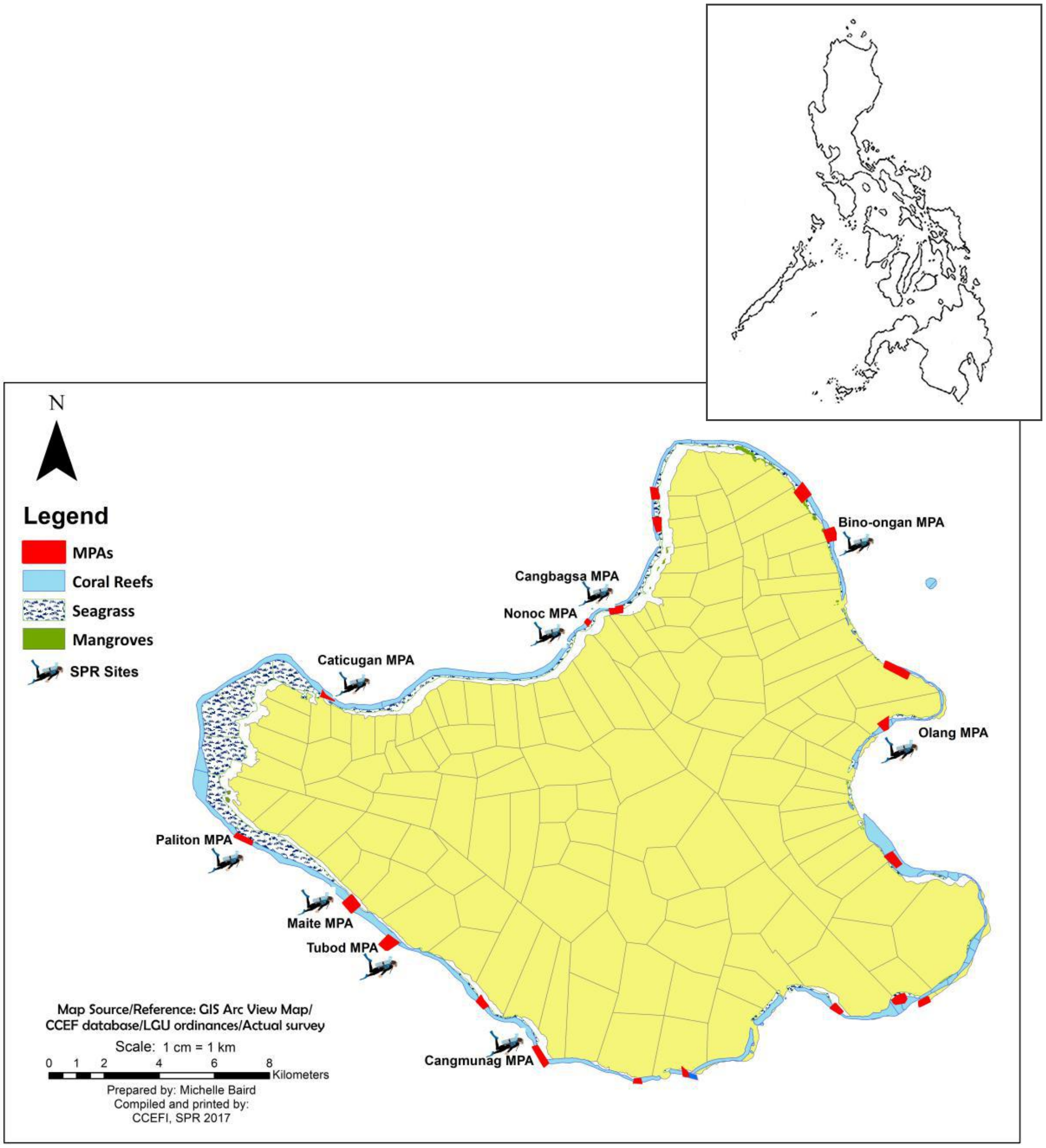
Armed Forces of the Philippines, Camp Lapu-Lapu Central Command and Task Force Deter

Tech. Sgt. Gregorio Jumula
2Lt. Platoon Leader Christian Samson and Squad (CPL Warson Alvata, CPL Edwin Vallite, CPL Jimcele Donato, CPL John Rel Emejas, PFC Jayson Va-al, PFC Jade Tallo, PFC Jay Harris Fontanilla, PFC Glenn Philip Skrasar

Laurent Boillon

2.2 The SPR Survey Sites



Map of Siquijor Island in the central Philippines, showing the 21 marine sanctuaries (MPAs) and the 8 SPR MPA 2017 sites.

3.0 The CCEF-Siquijor Province CRM Partnership

The CRM partnership of CCEF with Siquijor Province started in the year 2002. This partnership contributed to the establishment of most MPAs in the province (there are 21 MPAs in Siquijor Province to date), and in the creation of the Siquijor MPA Alliance (Siquijor Province Coastal Resource Management Alliance or SPCRMA) supporting the “One Province, One Team” movement initiated by Siquijor Province itself. CCEF also empowers local partners on enforcement, resource assessment and MPA monitoring and management.

CCEF’s first engagement with the province of Siquijor was through the Local Governance for Coastal Management Project in Central Visayas from 2002 to 2010. The project was supported by the David and Lucile Packard Foundation and achieved the implementation of CRM plans and establishment of MPAs in Southern Cebu and Siquijor Province. Another project entitled “Ecogov IQS Task Order: Strengthening the Southwest MPA Cluster in Cebu and the Siquijor Provincial MPA Network” from 2008-2009 was supported by the United States Agency for International Development (USAlD) and Development Alternatives, lnc., strengthened the joint town councils through capacity-building trainings that enhanced MPA-network management.

From 2009 to 2010 CCEF continued its partnership with the Province, through a mangrove rehabilitation and reforestation project supported by the United States-Department of State. Further, the United States-National Oceanic and Atmospheric Administration also supported CCEF in implementing a project from 2010 – 2012, which developed an effective MPA network conservation plan for Siquijor Province.

From 2012-2014, through the support of Deutsche Gesellschaftfiir international Zusammenarbeit and Adaptation to Climate Change in Coastal Areas (GIZ-ACCCoast) and UNICO Conservation Foundation in Australia, the projects, “Consolidating MPA Network Planning for Resilience in Siquijor Project” and Enhancing Resiliency and Climate Change Adaptation through Coral Reef Rehabilitation and Reef Fish Recovery using Marine Protected Area (MPA) as a Tool” were implemented in Siquijor Province. A Provincial Coastal Resource Management Learning Center located in Larena was established while MPA establishment, MPA management and monitoring trainings continued. In addition, a province-wide coral bleaching response framework, and a protocol for coral rehabilitation and reef fish recovery (CRR-RFR) in typhoon-damaged areas were developed in eight priority MPA sites. These work were continued by 2014-2016 through a project aimed to mitigate the adverse impacts of typhoons due to climate change and the anthropogenic activities on coral reefs, supported by GIZ under the Protected Areas Management Enhancement Project (PAME) and the UNICO Foundation of Australia, Two resilient reefs were established as MPAs in the municipality of Lazi and San Juan.

By 2015, the “ProReef Project” supported by UNICO Conservation Foundation, in partnership with the “Reef Fish Recovery in Typhoon-Damaged Reefs” project of Silliman University-Institute of Environmental and Marine Sciences (SUIEMS) supported by the Foundation for the Philippine Environment (FPE) were implemented. Both these projects documented coral recovery processes and drivers. It also supported enhancement of the CRR-RFR protocol development for rubble areas that was started in 2013. To date, CCEF continues its partnership with Siquijor Province and other institutions to address concerns in CRM, CRR-RFR, marine conservation and food security through Project SUSTAIN (Strengthening and Up-scaling through trainings, Alliance building, Institutionalization and Networking of MPAs in Siquijor Province) supported by UNICO Conservation Foundation in Australia.

4. SITE REPORTS

4.1. Marine Sanctuaries of San Juan Municipality, Siquijor Province: 2005-2017

Aileen P. Maypa[1,2], Michelle R. Baird[1], Denzyl Divinagracia[2], Reaan G.O.Catitig[1], Darell T. Pasco[3], Jonathan Apurado[1], Al Jiereil M. Lozada[1,] Evangeline E. White[1] and Alan T. White[1]

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Abstract

Siquijor Province is a small island Province, located in the central Philippines with 21 marine sanctuaries established to date. The monitoring of marine protected areas (MPAs) in Siquijor Province has been sustained through the partnerships of the Province with its Municipality and Barangay local government units (LGUs), with the various projects of the Coastal Conservation and Education Foundation (CCEF) over the years. In 2017, the Saving Philippine Reefs Project (SPR) with volunteers from Australia and the USA, surveyed eight MPAs in Siquijor Province. This report includes the status of four MPAs in San Juan Municipality. The major results and patterns are: (1) percentage of live hard coral cover in MPAS ranges from fair to good, (2) a declining pattern in the percentage of coral over time was observed in all MPAs and adjacent fished reefs, except in Maite and, (3) the reef fish densities and biomass is generally low in all four MPAs. Recommendations on how to improve and sustain MPA management are also provided.

Introduction

Marine protected area (MPA) popularly called, “marine sanctuary” or “fish sanctuary” in the Philippines and, is a widely used tool for marine biodiversity conservation, fisheries benefits, resilience against climate change adverse impacts and for supplemental livelihood through MPA ecotourism. To date, the estimated number of established MPAs in the Philippines is 1,800 (Cabral et. Al. 2014).

Siquijor Province is a small island Province, located in the central Philippines with a land area of 327 km^2 and a population estimated at 95,984 (PSA 2015). The Province has 21 marine sanctuaries established to date. A majority of these MPAs are managed by the Barangay or Municipality LGUs or co-managed by a People’s Organization (PO). A few are solely managed by POs. Regular monitoring of MPAs is crucial to the management and its sustainability. The results of which provide the managers information inorder to address concerns and problems and, how to move forward. The monitoring of MPAs in Siquijor Province has been sustained by the partnership of Siquijor Province along with its Barangay and Municipality LGUs, with CCEF’s various projects over the years. Among those supporting institutions are:

Citation: Maypa, A.P, M.R. Baird, D. Divinagracia, R.G.O. Catitig, D.Pasco, J. Apurado, AJ Lozada,· E. E. White and A.T. White. 2018. Marine Sanctuaries of San Juan Municipality, Siquijor Province: 2005-2017. A CCEF-SPR Technical Report submitted to the Municipality of San Juan. Coastal Conservation and Education Foundation and UNICO Conservation in Australia, Cebu City, Philippines.14p.

USA-NOAA through James Cook University, GIZ-ACCCoast, GIZ-PAME, the Foundation for the Philippine Environment (FPE) and UNICO Conservation Foundation in Australia. In 2017, the Saving Philippine Reefs Project (SPR) with volunteers from Australia and the USA, surveyed eight MPAs in Siquijor Province. This report includes the status of four MPAs in San Juan Municipality. We also provide recommendations on how to improve MPA management including reef recovery from Crown- of-Thorns infestation and bleaching from previous years.

The Saving Philippine Reefs Project is an annual project of CCEF which started in the 1980s, composed of selected CCEF staff and international volunteers trained in coral reef and MPA monitoring methods. This project aims to contribute to MPA sustainability and coral reef conservation in the Philippines and in Siquijor Province. The SPR project of CCEF is headed by Dr. Alan T. White, a well known scientist in the field of Coastal Resource Management in the Philippines and around the world.

Methods

The MPA Monitoring Team

Marine biologists from the Coastal Conservation and Education Foundation (CCEF) and Silliman University-Institute of Environmental and Marine Sciences (SUIEMS), the Provincial monitoring team of Siquijor Province (PROMOTE) composed of trained MPA management body members, People's Organization (PO), Local Government Units (LGU), Fisherfolk and members of the Philippine National Police (PNP) repeatedly trained overtime in coral reef monitoring by CCEF compose the MPA Monitoring team. In 2017, the SPR Volunteers together with the CCEF team carried out the coral reef surveys.

Substrate cover

The percentage cover of the substrate was evaluated using the Point – Intercept Transect Method (PIT; Uychiaoco et al. 2010) since the year 2005 in Tubod Marine Sanctuary. Substrate data was collected at every 0.25 m point along the 50 m transect line. Three to five 50 m replicate transects were laid sequentially parallel to the reef crest at 8-10 m depth both in the sanctuary and adjacent fished reef (AFR). Permanent markers were placed at the 0 m, 25 m and 50 m point of each transect. In instances of lost or stolen markers, especially those in the AFR, replacements were installed. During the 2017 SPR survey, the number of replicates exceeded our permanent transects. The following data were collected: (1) percent cover of living coral (hard coral per life form and soft coral, e.g., in English et al. 1997); (2) percent cover of non-living substrate (e.g., rock, rubble, sand, silt, dead coral) and, (3) percent cover of other living substrate (e.g., seagrass, algae, sponges). We also noted indicator invertebrates (giant, lobsters, Triton shells, Crown of thorns starfish and others) the causes of reef damage where appropriate but reported separately. Substrate percent cover was computed per category using standard scientific and methods and presented graphically. Standard statistical tests were also used when appropriate.

San Juan Municipality has five established marine sanctuaries (Fig.4.1.1). The SPR team only monitored four. Catulayan Marine Sanctuary, established MPA in 2015, was not included in this survey. The status of this MPA is reported in Baird et al. 2015.

Reef Fish Relative Abundance and Biomass

Fish density, length and species were estimated using a 50 x 10 m visual census (FVC; n = 3 to 5) technique done by a single observer or two observers whose fish length estimates were calibrated except in 2017 during the Saving

Philippine Reefs (SPR) surveys where four observers (AP Maypa, D Divinagracia, J Apurado and AT White) collected the fish data. Substrate transects were utilized for UVC (English et al. 1997). All fish species within the 500 m^2 sampling area were recorded. The abundance of large numbers of numerically dominant and visually obvious fish species were recorded using the Log4 abundance category developed by the Great Barrier Reef Marine Park Authority (GBRMPA in Russ and Alcala, 1989). Fish relative abundance using density and biomass were computed using standard scientific methods and presented graphically. Standard statistical tests and data transformations were used when appropriate.

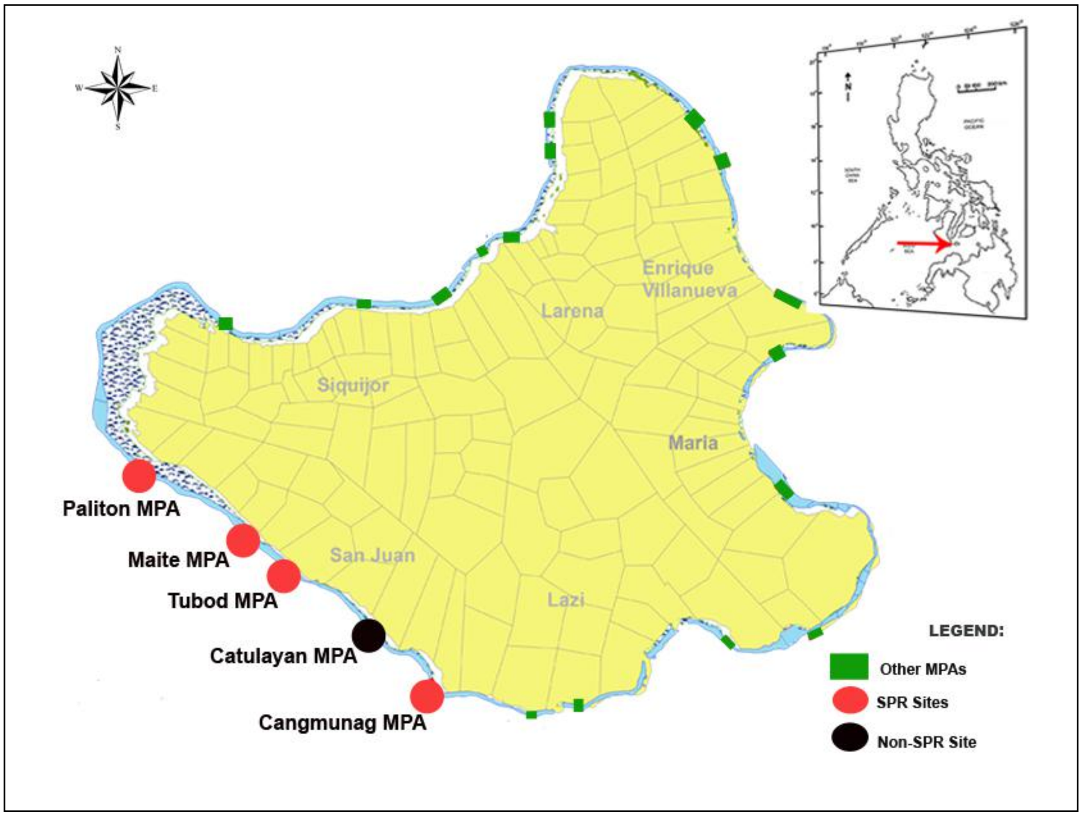


Figure 4.1.1. Map of Siquijor Island showing the five marine sanctuaries in San Juan Municipality and SPR sites. Cartography by M. Baird.

Results and Discussion

CANGMUNAG MARINE SANCTUARY

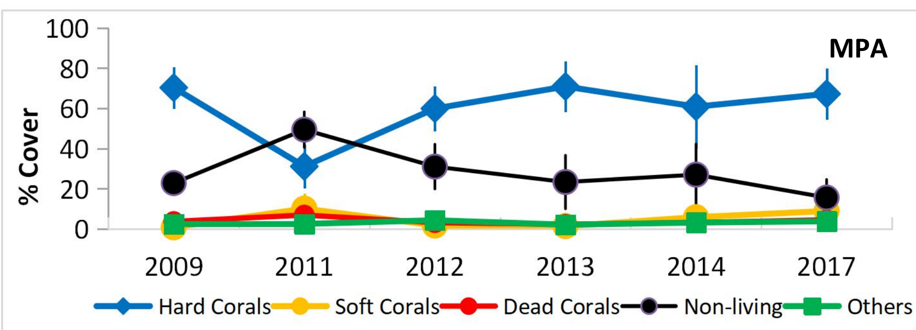
Site Description and Management Information

Cangmunag Marine Sanctuary (CMS) is a 12 ha MPA established in 2009 through a municipal ordinance (MO 2009-004). This sanctuary is located in the southern most part of the Municipality of San Juan adjacent to Barangay Lower Cabangcalan of the Municipality of Lazi. The sanctuary is co-managed by a fisherfolk organization (Lamogan Fisherman Association) and the Barangay officials of Cangmunag.

The reef flat to reef slope of CMS was fairly complex in topography. It is highly rugose and dominated by massive coral (*Porites spp.*) which provided diverse habitats to many marine organisms. A good coral cover in the year 2017 was documented by SPR – CCEF.

Substrate

A high percentage of live hard coral cover (LHC) was recorded at the 8-12 m depth of Cangmunag Marine Sanctuary at 67.20 ± 12.77% in the year 2017. This is classified as "good" using the criteria of Gomez et. al. (1994) (Fig. 4.1.2). The good LHC remained at status quo since the establishment of this MPA in 2009. The observed significant decline of LHC inside the MPA in 2011 (31.10 ± 10.77%; $p = 0.001$, $F = 7.51$, $DF = 4$; Tukey's *post hoc:* 2011 < all years) can be attributed to methodology artefact, *i.e.*, different transect locations due to lost permanent markers. These markers were replaced thereafter. The most dominant coral lifeforms were massive and branching corals at 41 ± 15.97% and 22.6 ± 7.55%, respectively. Rubble and sand made up most of the non-living component. Similarly, LHC outside the sanctuary was also in good condition at 63.30 ± 29.23% and, massive and branching coral lifeforms were also most abundant.



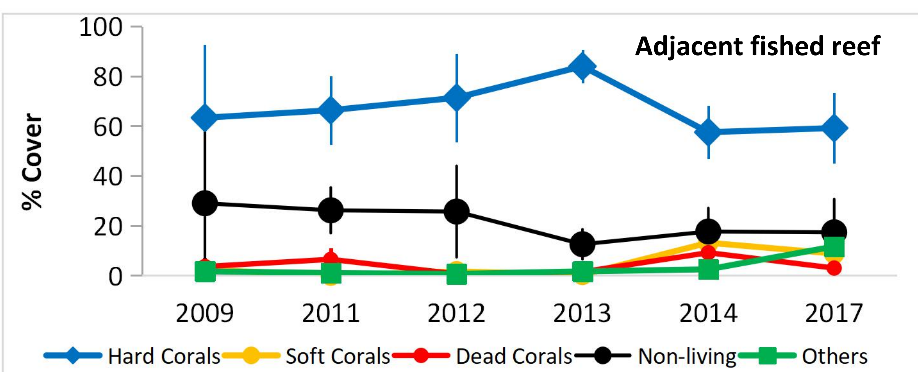


Figure 4.1.2. Substrate components (mean ± SD) and changes over the years in Cangmunag Marine Sanctuary and adjacent fished reef in San Juan Municipality,

Reef Fish

Density. Damsels, wrasses and small parrotfish made up the bulk of the "All reef fish" category in CMS (Fig. 4.1.3). It ranged from 297 ± 90.51 to 1,815.33 ± 439.76 fish/500 m^2 from the years 2009 to 2017. The lowest density recorded was in the year 2012 and the highest was in 2014 which was significant ($p = 0.036$, $F = 3.48$, $DF = 4$). The SPR survey in the year 2017 recorded 981 ± 3.78 fish/500 m^2, a value considered low given the good condition of the reef and, when compared to other MPAs in San Juan with similar reef conditions (e.g., Paliton Marine Sanctuary). Further, target fish (commercially important fish species such as groupers, snappers, emperors, fusiliers, jacks, parrotfish and others) density was also very low and highly variable (range: 10.6 ± 12.93 fish/500 m^2 in 2009 to 217.67 ± 151.86 fish/500 m^2 in 2014). The SPR survey in 2017 recorded 100 ± 23.17 fish/500 m^2 which is significantly lower than the density in year 2014, yet, similar to the rest of the years. In 2014, a school of *Pterocaesio tile* (fusiliers) was responsible for the observed high density.

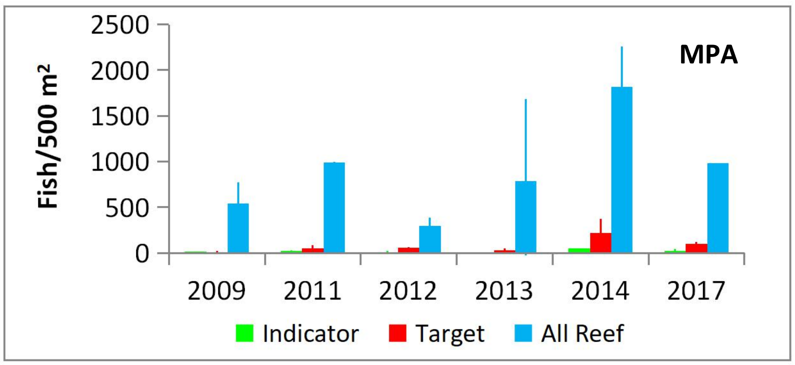


Figure 4.1.3. Changes in reef fish density (mean ± SD) over time in Cangmunag Marine Sanctuary (CMS), San Juan Municipality, Siquijor Province.

Biomass. Fish biomass on the other hand was only measured starting 2011 (Fig. 4.1.4). The lowest recorded was during the SPR survey in 2017 (4.21 ± 3.78 fish/500 m^2) and the highest was in 2012 (26.22 ± 7.27 fish/500 m^2). Both 2014 and 2017 biomass were significantly lower when compared with the 2012 value ($p = 0.018$, $F = 5.42$, $DF = 3$). Larger sizes of *Naso unicornis* (to 45 cm) and *Scarus* spp./*Chlorurus* spp. (30 - 35 cm) were responsible for the high biomass recorded in the year 2012. Such large size class of the aforementioned species observed in 2012 were no longer sighted in 2017. Moreover, there was no significant difference in the biomass of target fish between the MPA and non - MPA for all years, except in the year 2012. These results indicate none very weak MPA enforcement. Strengthening its MPA enforcement should be prioritized by the management to improve its fish stocks.

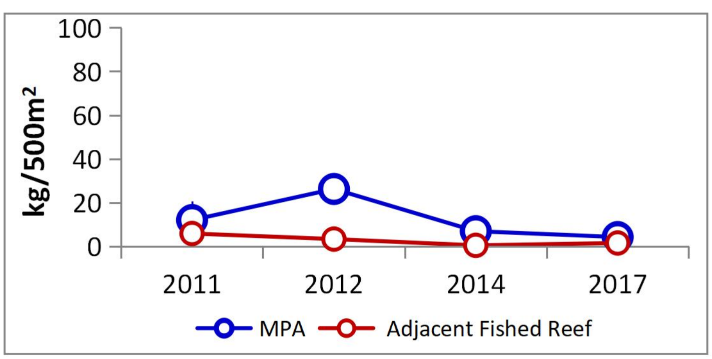


Figure 4.1.4. Changes in target reef fish biomass (mean ± SD) over time in Cangmunag Marine Sanctuary (CMS) and adjacent fished reef (AFR) in San Juan Municipality, Siquijor Province.

Diversity. A total of 82 species of fish which included 8 species of butterflyfish was listed n Cangmunag Marine Sanctuary. Further, species richness was 45.5 ± 6.14 species/500 m^2. This value was lower than the adjacent fished reef with 54 ± 11.53 species/500 m^2 but not statistically different.

MAITE MARINE SANCTUARY

Site Description and Management Information

Maite Marine Sanctuary (MMS) is a 6.3 ha MPA established in 2009 through a municipal ordinance (MO 2009-003). This MPA, although small, is popular to both local and international tourist divers. Its complex coral reef topography can also provide a range of diverse habitats to marine organisms. A seargrass bed was also found in the shallow zone. This MPA is co-managed by two People's Organizations (PO) led by strong and able women, i.e., Maite Resource Development association (MRDA) and Maite Fishefolk Association (MFA). Both POs are also responsible for the 24 hour MPA patrol. In 2013, Maite Marine Sanctuary was awarded as the "Best Managed MPA" and "Best Managed Association" in Siquijor Province by the CCEF – Siquijor Marine Protected Area Network (SIMPRANET) supported by USA - NOAA. By 2016, under the Isla de Fuego MPA Awards, Maite Marine Sanctuary was again awarded as the "Most Enterprising and Active MPA in Generating Livelihood." The following institutions and government agencies assisted in the establishment of this sanctuary: the United States Peace Corps Volunteer, CCEF, Office of Provincial Agriculturist (OPA) and the local government through the Municipal Agriculture Office (MAO) of San Juan.

Substrate

A high percentage of live hard coral cover (LHC: 63.75 ± 12.97%)), classified as "good" was also recorded in MMS reef crest (9-10 m) in the year 2017 (Fig. 4.1.5). This cover cover has been maintained since the establishment of this MPA in 2008. The observed decline of LHC inside the MPA in 2011, is again, attributed to different transect locations due to lost makers. Rubble and rock made up most of the non-living component. In contrast, the LHC outside the sanctuary is in excellent condition category when looking at the mean value (80.16 ± 14.58%). However, when the LHC cover in the MPA was compared with the AFR statistically, no significant differences resulted, indicating high variability in LHC values in the AFR between sample transects. Coral branching and massive lifeforms dominated both the MPA and non-MPA reefs.

It is important to note that in the year 2015, a crown-of-thorns (COT) infestation occurred in many coral reefs in Siquijor Province including those in San Juan, thus, MMS and surrounding reefs. Our team collected an approximate of 500 pieces of COTs (a team of 10 divers/snorkelers) within an hour back in 2015. This COT collection effort lasted for about a week. The most negatively affected reefs were those in the shallows where the temperature was higher compared to the deeper zones. Coral cover declined significantly in the former zones. In contrast, no COT impact was observed in the reef crest to slope where our transect stations were located.

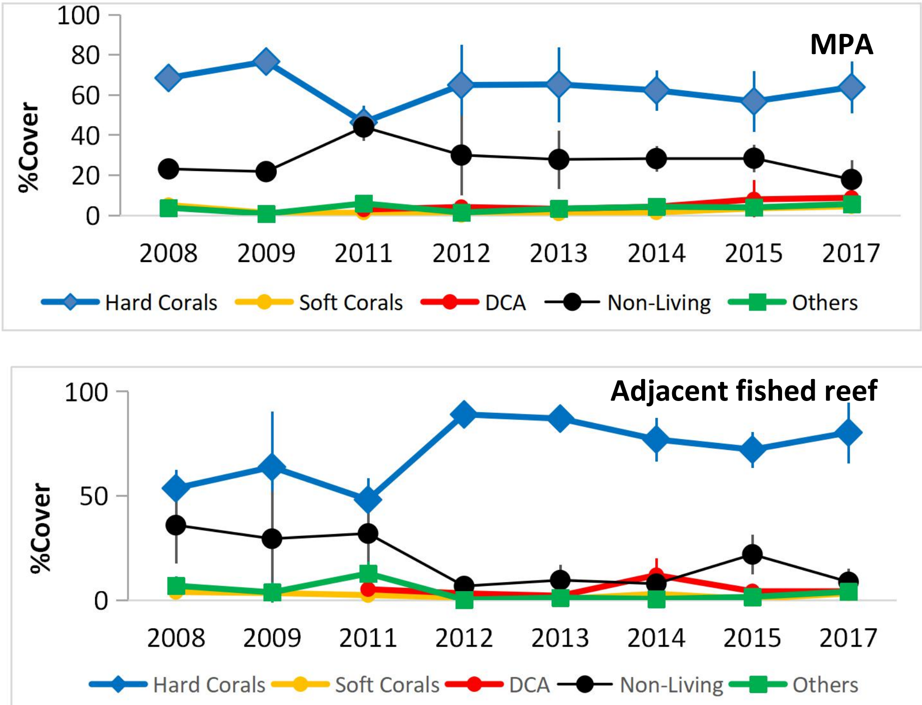


Figure 4.1.5. Substrate components (mean ± SD) and changes over the years in Maite Marine Sanctuary (MMS) and adjacent fished reef (AFR) in San Juan Municipality, Siquijor Province.

Reef Fish

Density. Figure 4.1.6 compares the target fish densities in Maite Marine Sanctuary (118 ± 45.84 fish/500 m^2) and its adjacent fished reef (19.67 ± 9.29 fish/500 m^2). An obvious significant difference was seen between the two sites in the years 2015 and 2017, where the densities in the MPA were 5-6 fold higher. Target reef fish species in the sanctuary included species of groupers (*Cephalopholis* spp., *Epinephelus* spp.), surgeonfishes (*Naso* spp., *Acanthurus* spp.), parrotfishes (*Scarus* spp., C*hlorurus* spp.), Snappers (*Lutjanus* spp.) and goatfishes (*Parupeneus* spp., *Mulloidichthys* flavolineatus).

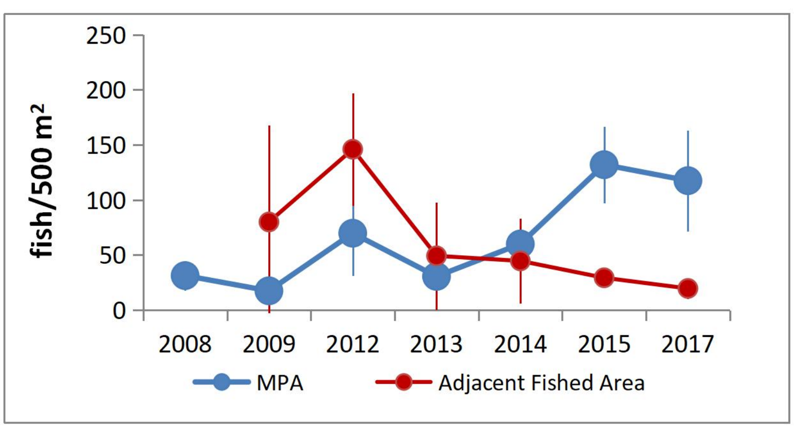


Figure 4.1.6. Changes in reef fish density (mean ± SD) over time in Maite Marine Sanctuary (MMS) and adjacent fished reef (AFR) in San Juan Municipality, Siquijor Province.

Biomass. In comparing the fish biomass between the MPA and non-MPA an obvious difference can be seen only in 2017 where the former is higher than the latter (Fig. 7). Biomass for 2017 inside the MPA is at 13.55 ± 10.31 kg/500 m^2 while it is only 1.64 ± 1.61 kg/500 m^2 the adjacent fished reef. While the recorded biomass inside the sanctuary is low for a well guarded MPA, it is important to note the large schools of parrotfish (dominated by *Scarus dimidiatus* and *S. rivulatus*), *Naso unicornis* and *Siganus guttatus* have been observed repeatedly over the years in the shallow area (5-3 m).

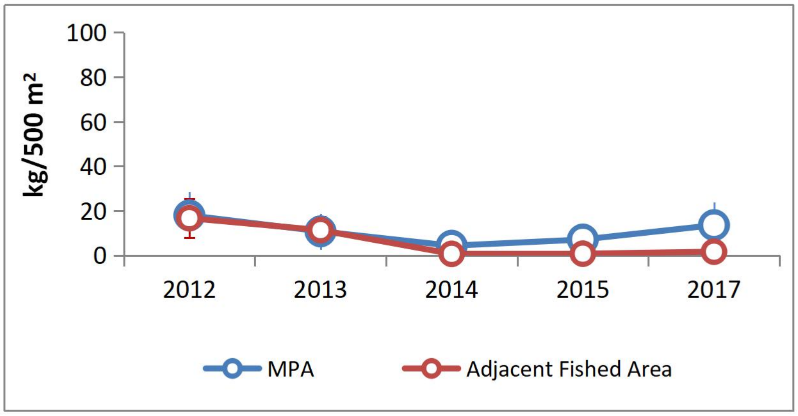


Figure 4.1.7. Changes in target reef fish biomass (mean ± SD) over time in Maite Marine Sanctuary (MMS) and adjacent fished reef (AFR) in San Juan Municipality,

Diversity. A total of 101 species of fish which included 11 species of butterflyfish in Maite Marine Sanctuary was listed. In the adjacent fished reef a total of 65 fish species with 8 butterflyfish species were recorded. Species richness in the sanctuary was 57.75 ± 10.53 species/500 m^2 which was lower than the adjacent fished reef with 34.67 ± 2.87 species/500 m^2.

PALITON MARINE SANCTUARY

Site Description and Management Information

Paliton Marine Sanctuary (PMS) is a 6.2 ha MPA established in 2008 through a municipal ordinance (MO 021 – 2008). It has a wide intertidal zone covered with a thick multi-species seagrass bed, followed by a coral reef that drops off to a steep wall. The "Paliton Wall" is a popular dive site to both local and international tourists. Paliton Marine Sanctuary is managed by a People's Organization, named after a grey rudderfish (*Kyphosus* spp.), i.e., "Ilak Fisherfolk Association." In 2016, this sanctuary was awarded as the "Most Popular MPA to Ecotourism," by the Isla de Fuego MPA Awards in Siquijor Province. To date, PMS earns the highest MPA revenue among the 21 MPAs in the Province.

Substrate

A fair percentage of live hard coral cover (LHC: 30.99 ± 8.31%) was documented in PMS reef crest (8-9 m) in 2017 (Fig. 4.1.8). This fair to good LHC remained at status quo since 2008. The observed slight decrease in LHC coupled with increase in dead coral from 2014 to 2015, was due to the COTs infestation. This is however not statistically significant.

Similarly, a fair LHC (37.14± 14.54%) was recorded in the AFR in 2017. Our data suggested that LHC in MMS is slowly degrading over time, within 11 years from 67.67 ± 5.75% in 2006 to 55% in 2017. In contrast, the impact of protection can be seen in the increasing LHC in the sanctuary from 13.50 ± 6.06% in 2006 to 40% in 2007.

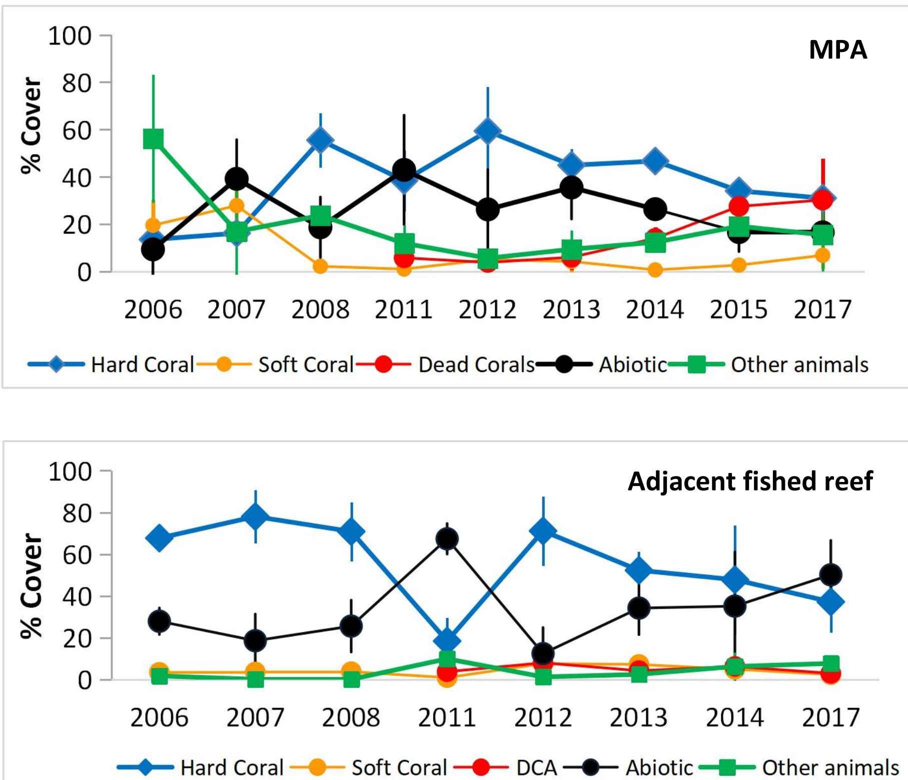


Figure 4.1.8. Substrate components (mean ± SD) and changes over the years in Paliton Marine Sanctuary (PMS) and adjacent fished reef (AFR) in San Juan Municipality,

Reef fish

Density and biomass. A fluctuating pattern in target reef fish densities over time is shown in Figure 4.1.9A for both PMS and AFR. When compared statistically, the target reef fish density in the sanctuary (98.25 ± 62.96 fish/500 m^2) is not significantly different from the AFR (33.33 ± 6.42) in the year 2017. These results indicate a need to strengthen MPA enforcement and/or a need to implement a carrying capacity study in PMS since the density of divers inside the sanctuary may likely be negatively affecting fish densities. Alternatively, illegal fishing in AFRs may also influence the patterns seen.

In terms of target fish biomass in PMS, a declining pattern can be seen overtime and no significant difference was found when the 2017 biomass from both PMS and AFR were compared (Fig. 4.1.9B). This can be attributed to the variability of values in both areas and fluctuating densities and size of target species inside the sanctuary. Notice that by 2014 and onward, the biomass in both areas are similarly low (< 10 kg/500 m^2). “Chlorine fishing” is one of the widely used and, new form of illegal fishing in Siquijor Province. This destructive fishing method bleaches the coral reefs and other marine organisms to death. The Siquijor Province Bantay Dagat Task Force has apprehended a number of chlorine fishers in the area, yet, many are still using it because of its “quick catch” nature similar to cyanide fishing. Moreover, compressor fishers coming from Bohol and locally targeting marine sanctuaries in the area were also reported.

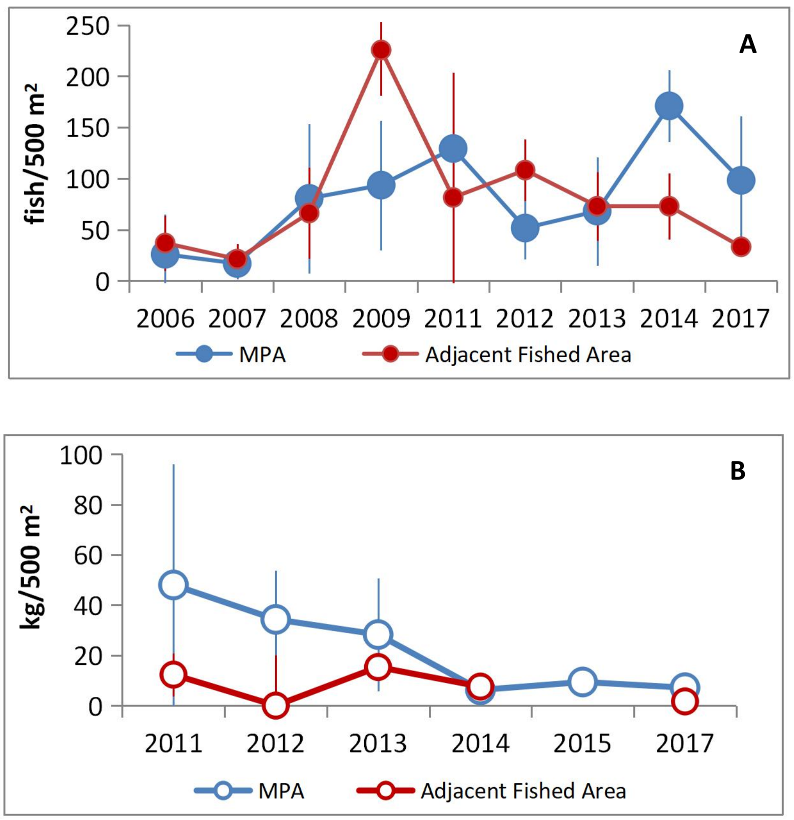


Figure 4.1.9. Target reef fish (A) density and (B) biomass (mean ± SD) changes over time in Paliton Marine Sanctuary (PMS) and adjacent fished reef (AFR), San Juan Municipality, Siquijor Province.

Diversity. A total of 93 species of fish including 10 species of butterflyfish in Paliton Marine Sanctuary was listed. Species richness in the sanctuary is 59 ± 17 species/500 m^2, a value higher than the adjacent fished reef with only 38.33 ± 8.73 species/500 m^2 .

TUBOD MARINE SANCTUARY

Site Description and Management Information

Tubod Marine Sanctuary (TMS) is a 8.1 ha MPA that includes a sparse seagrass bed followed by a a coral reef. This sanctuary was established in 1989 with the assistance of the Central Visayas Regional Project

(CVRP). However, MPA management was not sustained after establishment and this sanctuary was turned over to the local government unit (LGU, Barangay Tubod). In 2003, CCEF and the Rtn Martin "Ting" Matio Foundation Inc. through the Siquijor Coastal Resource Enhancement Project (SCORE), provided technical assistance in reactivating and strengthening of the management of this sanctuary. A Municipal ordinance supported the establishment of Tubod Marine Sanctuary by 2003 (15-2003). The project also built the LGU capacity on MPA planning, monitoring and enforcement. Presently, this sanctuary is managed by a PO called, "Tubod Fisherfolk Association," in partnership with some volunteers and the Coco Grove Resort.

Substrate

Similar to PMS, a fair percentage of live hard coral cover (LHC: 46.38 ± 19.72%) was recorded in TMS reef crest to slope (10 -11 m) in 2017 (Fig. 4.1.10). In contrast, data from the years 2005 and 2006 in this sanctuary showed a good to excellent LHC at 73.8% and 78.3%, respectively. A declining LHC trend from 2005 to 2017 is shown. This is coupled with the increase of dead corals and non-living substrate. Bleaching of corals along the reef crest to slope has been observed consistently in this MPA for the past years during our surveys. The likely causes are improper disposal of swimming pool water with chlorine from nearby resorts or chlorine fishing, COTs infestation in 2015 and increase in sea surface temperatures during pulses of ENSO (El Niňo Southern Oscillation). A similar pattern can bee seen in the AFR.

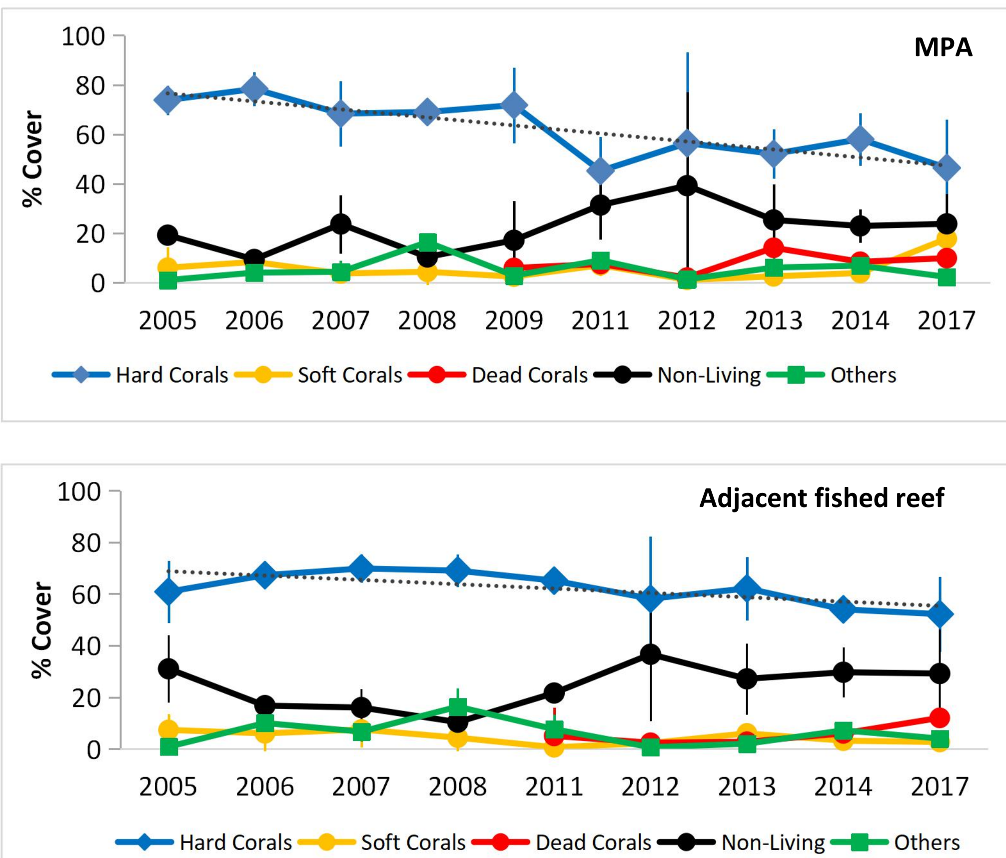


Figure 4.1.10. Substrate components (mean ± SD) and changes over the years in Tubod Marine Sanctuary (TMS) and adjacent fished reef (AFR) in San Juan Municipality, Siquijor Province.

Reef fish

Density. Damsels, fairy basslets, wrasses and parrotfish make up the bulk of the "All reef fish" category in Tubod Marine Sanctuary (Figure 4.1.11). It ranged from to 501.67 ± 130.71 to 2,825.2 ± 1,406.53 fish/500 m^2 from the years 2005 to 2017. The lowest density recorded was in the year 2007 and the highest was in 2011. Overall pattern of this category is fluctuating Further, target fish (*Cephalopholis* spp. *Epinephelus* spp., *Siganus* ssp., *Scarus* spp. and *Chlorurus* spp.) density was also low (range: 21 ± 6.56 fish/500 m^2 in 2006 to 292.83 ± 430.28 fish/500 m^2 in 2009. The SPR survey in 2017 recorded 86.75 ± 30.66 fish/500 m^2 which is not significantly different from the values in other years.

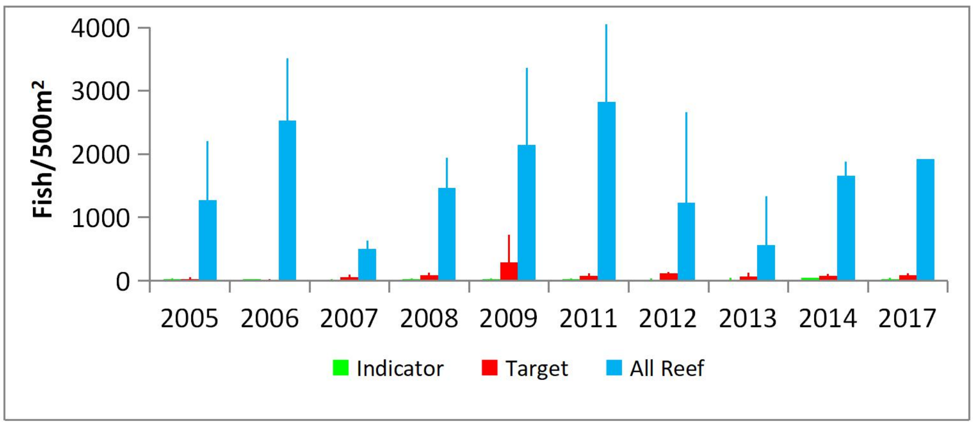


Figure 4.1.11. Changes in reef fish density (mean ± SD) over time in Tubod Marine Sanctuary (TMS), San Juan Municipality, Siquijor Province.

Biomass. Target fish biomass declined significantly from 32.4 ± 18 kg/500 m^2 in 2012 to 4.9 ± 5.63 kg/500 m2 in 2014 and 5.84 ± 4.41 in 2017 (Fig.4.1.12). The biomass values in the latter two years are not significantly different with those in the adjacent fished areas. Our data from 2012 and previous years indicate that species of the Genus *Lutjanus* (locally known as "maya-maya") and *Lethrinus* (locally known as "katambak") and *Naso unicornis* (locally known as "bagis-songhan") with sizes up to 35 and 40 cm, were common. These were not recorded by 2014 and during the present survey. This observed decline in fish biomass coincided with the observed %LHC degradation. Poaching in the MPA is likely happening in Tubod Marine Sanctuary. Chlorine and/or compressor fishing has been reported in the area too by the Provincial Bantay Dagat Task Force team.

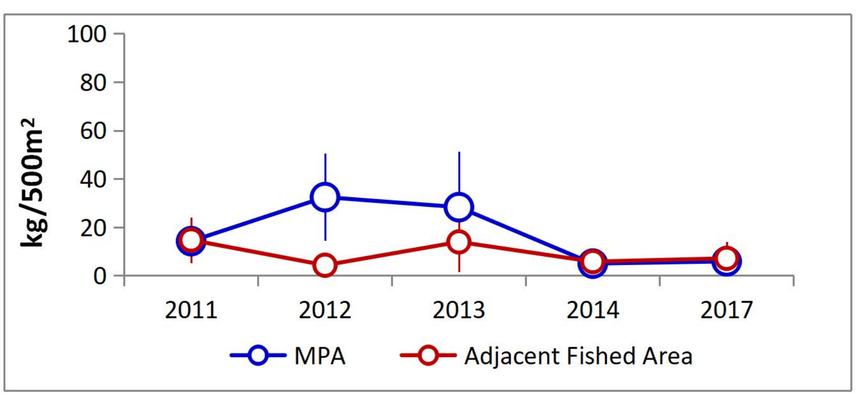


Figure 4.1.12. Changes in target reef fish biomass (mean ± SD) over time in Tubod Marine Sanctuary (TMS) and adjacent fished reef (AFR) in San Juan Municipality, Siquijor Province.

Conclusions and Recommendations

1. The LHC in the marine sanctuaries of San Juan Municipality surveyed under the SPR project in 2017, ranged from fair to good. A similar cover was documented in Catulayan Marine Sanctuary in 2015, the youngest MPA in San Juan established in 2015 under the CCEF GIZ-PAME Project (Baird et al. 2015). It is important to note that the San Juan reefs are currently in a "better condition" compared to the rest of the reefs in Siquijor Province. It is sheltered from strong typhoons which usually occurs during the northeast monsoon season from November to mid March.

2. A declining pattern in LHC over time was observed in all MPAs and AFRs, except in Maite. Several factors are the likely cause the observed decline, e.g., improper disposal of swimming pool water with chlorine from nearby resorts or chlorine fishing, COTs infestation in 2015 and increase in sea surface temperatures during pulses of ENSO. It is therefore important to continue monitoring these sanctuaries, at least annually. Physical causes of damage must be properly identified and appropriate measures to prevent further coral reef degradation must be made. Reporting to proper authorities, if necessary, should be made. Continued monitoring of coral reef health will benefit coral recovery.

3. Reef fish densities and biomass was generally low in all surveyed San Juan MPAs. Poaching in MPAs using compressor fishing and chlorine fishing, have been reported repeatedly in San Juan Municipality and vicinity. Some apprehensions were made but some poachers also got away. The latter is a destructive fishing method whose use by the illegal fishers in Siquijor Province and was only discovered by the Provincial and MPA Bantay Dagats in the recent years. It was also reported by fisherfolks that encroachment of commercial fishing vessels in municipality waters deplete the fish stocks in coral reef areas, immediately, leaving them with nothing to catch. Strengthening of MPA enforcement and the coastal law enforcement at the Province is currently being addressed through the formation of the Siquijor Province Coastal Resource Management Alliance (SPCRMA) . This body is an inter-LGU alliance and the parties are composed of the Province and its six municipalities pooling their resources to achieve a "One Province, One Team" SPCRMA Task Force that will mitigate destructive and illegal fishing province - wide. At the same time, strengthening of MPA and Municipality enforcement teams is also going on. The previous CCEF - UNICO supported SUSTAIN Project (Strengthening and Up-scaling through Trainings, Alliance Building, Institutionalization and Networking of MPAs from 2017-early 2018) and the on-going Project ISDA (Isda Siguru-on, Damgong Makab-ot pinaagi sa Alyansa) in partnership with Siquijor Province, supported by both FPE and UNICO Conservation Foundation is assisting Siquijor Province in the formation of SPCRMA through the Office of the Provincial Agriculturist, CRM Section (Maypa et al. 2017).

4. Yet, with all the aforementioned projects mentioned that are assisting Siquijor Province in the SPCRMA formation, a big need right now of the Provincial Bantay Dagat Task Force (PBTF) is a patrol boat that is solely dedicated for MPA enforcement and CLE. Currently, the PBTF which is now the SPCRMA-Task Force, uses borrowed boats every time they patrol. The good news is, after many years without a patrol boat, and after a couple of years of lobbying by CCEF and OPA - CRM, just recently after the formal MOA signing of the SPCRMA, Siquijor Province called for a patrol boat proposal from SPCRMA.

Acknowledgments

This is a contribution of the the CCEF - SPR Project, Project SUSTAIN, Project ISDA and UNICO Conservation Foundation to MPA sustainability, coral reef conservation and food security in Siquijor Province. We thank all the institutions that supported the various projects of CCEF in Siquijor Province which sustained the monitoring of MPAs over the years. Many thanks to PROMOTE and the continued partnership of Siquijor Province through the Office of the Provincial Agriculturist, the Province and its Municipality- and B-LGUs, especially the MAO of San Juan (A. Maginsay) and its staff. Special thanks to UNICO Conservation Foundation in Austrailia for its long-term support to CCEF projects, and to all the 2017 SPR volunteers from USA and Australia for their love and support to the reefs of Siquijor Province. The able management and coordination of the SPR Project is carried out by E.White.

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4.2 Impacts of the coral reef rehabilitation and reef fish recovery initiatives in Caticugan Marine Sanctuary from 2013 to 2017

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Many coral reefs were severely destroyed in the central Philippines along the tracks of the sequential strong typhoons in the years 2011 (Sendong), 2012 (Pablo), 2013 (Yolanda) and 2014 (Queenie and Ruby). Sharp declines in the abundance and biomass of commercially important fish species (target species) were also documented in typhoon-impacted MPAs in Siquijor Province. Reef fish declines and species loss threatened the livelihood and food security of many fisherfolks and coastal communities. To mitigate this large scale coral reef damage in Siquijor Province, efforts over time were invested in coral reef recovery research and coral reef rehabilitation – reef fish recovery (CRR-RFR). This was carried out in eight priority MPAs starting year 2013 to present. This initiative was implemented by the Coastal Conservation and Education Foundation (CCEF) in partnership with Siquijor Province and local government units, many supporting agencies and institutions. The eight priority MPAs identified for coral reef recovery research and CRR-RFR included Caticugan Marine Sanctuary (CMS-Si) under the Municipality of Siquijor. This Marine Sanctuary is becoming popular to tourist snorkelers and divers, both local and international over the recent years with the improvement of its access road and its sheltered location during the southwest monsoon months. Caticugan Marine Sanctuary is also known for its active Bantay Dagat and strict enforcement. Live hard coral cover (LHC) in CMS-Si ranged from poor (< 25%) to fair (25-49.9%) and an increasing trend was observed in the rehabilitation area (3.89 ± 3.01% in January 2014 to 33.23 ± 1.09% in November 2017). Reef fish densities also improved in the rehabilitation station from 2014 to 2017. Comparison of target reef fish biomass between stations revealed a significant treatment effect. Fish biomass in the rehabilitation area was consistently higher over time, except in the year 2017, when compared to the biomass in the control and adjacent fished stations. This report evaluates the effectiveness and impacts of the CRR-RFR projects supported collaboratively by aforementioned agencies and Siquijor Municipality to mitigate the degradation of coral reef habitats and improve fisheries stocks to contribute to the larger goal of food security for Siquijodnons.

Introduction

The coral reef is a major marine ecosystem where humans depend on for food, livelihood and employment (White and Cruz-Trinidad 1998). The Philippines has a coral reef area of 26.000 km^2 which is estimated to yield 351.000 - 429,000 tons of fish annually. Millions of Filipinos and people across the Coral Triangle depend on this ecosystem for food and income which includes small-scale and subsistence fishers to commercial fishers and, recreational to educational tourists (White and Cruz-Trinidad 1998, ADB 2014).

Marine protected area ecotourism is now a popular objective for many MPAs in the Philippines aside from biodiversity conservation and fisheries benefits. In some cases, these MPAs are able to provide a stable source of income for some coastal communities. Apo Island is one success story, among many in the central Philippines. The recorded annual tourism revenues of this small island (74 ha), since the year 1999 to present is approximately more than PhP 5 million (Cadiz and Calumpong 2000, DENR-AIPLS data, unpublished). Apo Isald Protected Landscape and Seascape (AIPLS) has two no-take marine sanctuaries, i.e., a 24 ha in the southeast and a 1.8 ha in the northwest. In Siquijor Province, the popular reefs to snorkelers and divers are Paliton, Tubod, Maite and Tulapos and Caticugan Marine Sanctuaries. The annual gross revenue of the 18.3 ha Paliton Marine Sanctuary (includes a seagrass bed and a coral reef) in the Municipality of San Juan, ranged from PhP 7,000 to 276,000.00 from 2008 to 2015 (Paliton Marine Sanctuary Marine Management Council data).

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Many coral reefs in the central Philippines have been severely damaged in the past recent years due to the adverse effects of climate change, which included sequential strong typhoons. Sharp declines in abundance and biomass of commercially important reef fish species were documented in typhoon-impacted MPAs in Siquijor Province. Coral damage in the eastern side of the island reached to more than 90% after typhoon Pablo (Maypa et al. 2013, Maypa et. al. 2014). Reef fish declines and species loss threatens the livelihood and food security of many fisherfolks and coastal communities. Reef fish catch are likely to decrease rapidly when coral reefs are gone. Natural coral reef recovery can take 20-50 years in severe typhoon - damaged areas (Grigg and Maragos 1974, Stoddart 1974, Pearson 1981, Dulvy et al. 1995). Fisheries loss from a 1 km^2 area of a moderately productive reef was estimated at 128 t, in cases of blast fishing or human disturbance (White and Cruz-Trinidad 1998).

To mitigate the large scale coral reef damage in Siquijor Province, a large effort over time was invested in coral reef recovery research and coral reef rehabilitation – reef fish recovery (CRR-RFR). This was carried out in eight priority MPAs starting year 2013 to present. This initiative was implemented by the Coastal Conservation and Education Foundation (CCEF) in partnership with Siquijor Province (Office of the Provincial Agriculturist, OPA) through various projects supported by different funders over time, i.e., UNICO Conservation Foundation in Australia from 2013 to present, Siquijor Province – Provincial Disaster Risk Reduction Management Council, GIZ-ACCCoast which is a German Cooperative Agency in 2014-2015, Silliman University – Institute of Environmental and Marine Sciences with the support of the Foundation for the Philippine Environment in 2015-2016, under the leadership of Dr. Aileen Maypa and the collaborative efforts of her team, Mr. Darell Pasco of CRM-OPA and PROMOTE (Provincial Monitoring Team) and the support of all the municipalities and MPA management bodies of the Province.

The eight priority MPAs identified for coral reef recovery research and CRR-RFR included Caticugan Marine Sanctuary under the Municipality of Siquijor. This Marine Sanctuary is becoming popular to tourists. Both the numbers of local and international snorkelers and divers increased over the recent years with the improvement of its access road. Its sheltered location during the southwest monsoon months (June – September) makes it a good alternative over the more popular San Juan MPAs in the south western side. Caticugan Marine Sanctuary is known for its active Bantay Dagat and strict enforcement. A MPA Champion, Jesus Barbadillo has been instrumental in the continued enforcement of this MPA , especially during its early years after establishment. Further, the active support of the Municipality of Siquijor to its MPAs, including CMS through the Office of the Municipal Agriculturist is well known. From 2013 to 2016, the previous mayor of Siquijor Municipality, who is known as an environmentalist and, is now the incumbent Vice Governor of Siquijor Province supported the CRM and CRR-RFR initiatives in CMS. Thus, this report evaluates the effectiveness and impacts of the CRR-RFR projects supported collaboratively by aforementioned agencies and Siquijor Municipality to mitigate degraded coral reef habitats and improve fisheries stocks and, contribute to the food security of the Siquijodnons.

Methods and Materials

Study site

Caticugan Marine Sanctuary (CMS-Si) is a 13.5 ha marine protected area (MPA) established in 1989 by a Municipal Ordinance (MO), which was later revised to MO 415 in 2003. A multi-species seagrass bed can be found at the shallow area of this sanctuary. This is followed by a fringing coral reef. Coral massive lifeforms dominated the shallow reef flat while branching corals dominated the reef crest to slope prior to the devastating typhoons in the years 2011 and 2012. Coral damage in the sanctuary was recorded at 73% during a reef damage assessment conducted by CCEF in 2013 (Maypa et al. 2014). Substrate and coral fragment stabilization were carried out in this MPA in 2014-2015 as part of the CRR-RFR initiative. However, due to the observed recovery in reef fish densities which was fairly fast compared to other MPAs, we did not deploy any reef fish habitats, instead, we continued our annual reef monitoring with recommendations to the MPA management body to continue strict enforcement and protection.

The MPA Monitoring Team

Marine biologists from the Coastal Conservation and Education Foundation (CCEF) and Silliman University-Institute of Environmental and Marine Sciences (SUIEMS), members of the Provincial monitoring team of Siquijor Province (PROMOTE) composed of trained MPA management body members, People's Organization (PO), Local Government Units (LGU), Fisherfolk and members of the Philippine National Police (PNP) repeatedly trained in coral reef monitoring methods by CCEF, compose our monitoring team. In addition, the data used in this report for 2017 were selected transects from the SPR (Saving Philippine Reefs Project of CCEF) in May for the Marine Sanctuary control station and adjacent fished reef (AFR). The rehabilitation station data was collected by the CCEF Siquijor Team in November of the same year.

Substrate cover

The percentage cover of the substrate was evaluated using the Point – Intercept Transect Method (PIT; Uychiaoco et al. 2010) since the year 2005. Substrate data was collected at every 0.25 m point along the 50 m transect line. Three to five 50 m replicate transects were laid sequentially parallel to the reef crest at 7-10 m depth both inside CMS-Si and AFR at the northern side. By 2015-2016, the Line-Intercept Method (LIT) was used under the SUIEMS-FPE Project. This method has a higher resolution than PIT. Our transect areas were permanently marked using iron stakes with floaters or floaters tied to dead corals or rocks along the transect line. Lost makers were replaced. In the year 2013 when we started our coral reef recovery research and rehabilitation, we established control (natural recovery) and experimental (coral rehabilitation) stations which we repeatedly monitor for recovery over time using three 50 m transects in each station. In 2017, the volunteers of the Saving Philippine Reefs Project of CCEF (SPR) assisted in data collection for the control and adjacent fished areas in April while the CCEF – Siquijor team monitored the rehabilitation station in November of the same year. In assessing the following data were collected: (1) percent cover of living coral (hard coral per life form and soft coral, e.g., in English et al. 1997) and corals where identified to species level under the SUIEMS-FPE project in 2015-2016/2017; (2) percent cover of non-living substrate (e.g., rock, rubble, sand, silt, dead coral) and, (3) percent cover of other living substrate (e.g., seagrass, algae, sponges). We also noted indicator invertebrates (giant, lobsters, Triton shells, Crown of thorns starfish and others) the causes of reef damage where appropriate but reported elsewhere. Substrate percent cover was computed per category using standard scientific methods presented graphically. Comparison of % live hard coral cover (LHC) between treatments (control vs. rehabilitation) used Two-Way Repeated Measures ANOVA. All data were explored and tested for normality using Anderson-Darling Test using Minitab 14 and Mauchly's Sphericity Test in SPSS. Percentage live hard coral data was log transformed as a remedy for non-normality.

Coral Reef Fish Relative Abundance and Biomass

Fish density, length and species were estimated through an underwater visual census (UVC) technique using 50 x 10 m transects (n = 3 to 5), done by a single observer or two observers whose fish length estimates were calibrated. Substrate transects were utilized for UVC (English et al. 1994). All fish species within the 500 m^2 sampling area were recorded. The abundance of large numbers of numerically dominant and visually obvious fish species were recorded using the Log4 abundance category developed by the Great Barrier Reef Marine Park Authority (GBRMPA in Russ and Alcala, 1989). Fish relative abundance using density and biomass were computed using standard scientific methods and presented graphically. Comparison of fish densities and biomass between time within a treatment (station) used One-Way/Two-Way Repeated Measures ANOVA or One-Way ANOVA where appropriate. All data were explored and tested for normality using Anderson-Darling and Anderson-Darling Test in Minitab 14 or

Mauchly's Sphericity Test in SPSS for variance equality. Data was either log or square root transformed as a remedy for non-normality. To evaluate changes in species richness, a Paired T-Test was used to compare before (2014) and after (2017) the CRR-RFR initiative. This report documents fish densities in CMS-Si since the year 2005, however, UVC data with fish sizes were only available starting 2011, thus, the biomass was only available for computation starting this year.

Results

Live hard coral cover and substrate condition

Live hard coral cover (LHC) in CMS-Si ranges from poor (< 25%) to fair (25-49.9%) in 2017, based on the LHC categories of Gomez et al. (1994; Fig. 4.2.1). An increasing trend was observed in the rehabilitation area which started with a 3.89 ± 3.01% in January 2014 before our CRR-RFR initiatives, to 33.23 ± 1.09% by November 2017, four years later. Increase in LHC form January 2014 to November 2017 is 19.1 ± 4.61% and is significantly higher (Repeated Measures ANOVA, station*time: $p = 0.001$, $F = 6.66$, DF = 4) compared with the LHC in the control station. This increase in LHC is also accompanied by a decrease in the non-living component (rubble, dead coral, sand and others) component from 74.26 ± in February - March 2014, to 52.93 ± 8.44% by November 2017. In contrast, LHC in the control station remained at status quo from 10.32 ± 8.93% in February-March 2014 to 6 ± 4.52% by May 2017. No significant differences in LHC were found over time. On the other hand, the 2017 LHC in the adjacent fished area is also fair at 28.25 ± 1.06%. An increasing trend was also observed from May 2015 (11.67 ± 4.39%) to May 2017, though not statistically significant due to high variability between replicates.

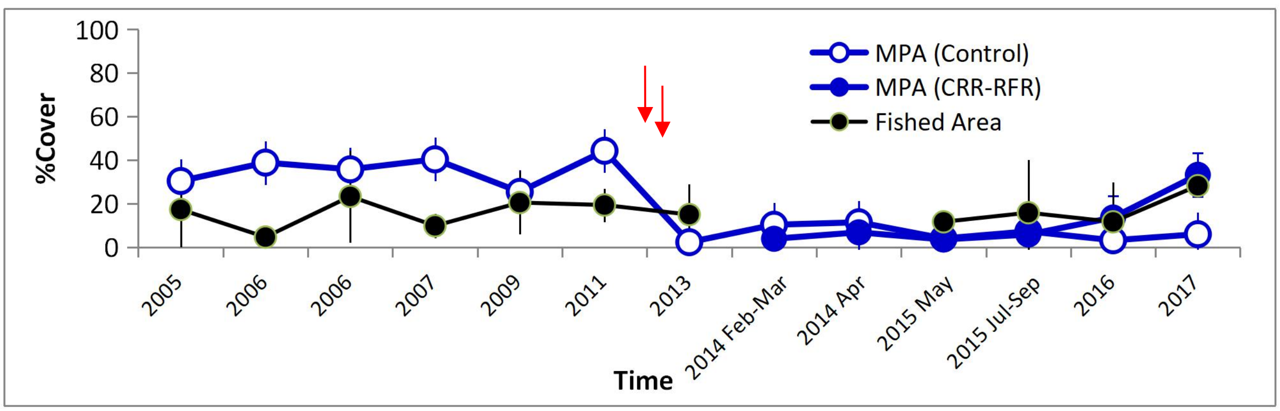

Figure 4.2.1. Changes in %live hard coral cover in Caticugan Marine Sanctuary (CMS-Si) and adjacent fished reef (AFR) in Siquijor Municipality, from 2005 to 2017. Rehabilitation and control stations were established inside the CMS by 2014 at the start of the coral rehabilitation-reef fish recovery (CRR-RFR) initiative. Red arrows indicate typhoons.

Reef fish densities, biomass and species richness

Reef fish densities improved in the rehabilitation station from 2014 to 2017 (Fig. 4.2.2). Indicator fish (e.g., some butterfly fish species and Moorish idol) densities increased significantly ($p = 0.036$, $F = 3.46$, DF = 5) over time from 5 ± 3 fish/500 m^2 in the year 2014 to 8.67 ± 0.57 fish/500 m^2 by 2017.

Similarly, target fish densities (commercially important species, e.g., snappers, emperors, groupers, parrotfish, goatfish, fusiliers and others) also increased significantly ($p = \leq 0.001$, $F = 11.35$, $DF = 5$) overtime up to year 2016 and declined by 2017. The density of all reef species also showed a significant increase overtime from 1,415.33 ± 218.15 fish/500 m^2 in year 2014 to 2,817.67 ± 929.72 fish/500 m^2. In contrast, the target fish density in the control station (without rehabilitation) appeared to decline overtime from 290 ± 277.65 fish/500 m^2 in the year 2015 to 112.67 ± 28.11 fish/500 m^2. Fish density values between transects in the control area were also very variable as reflected by the large standard deviation values.

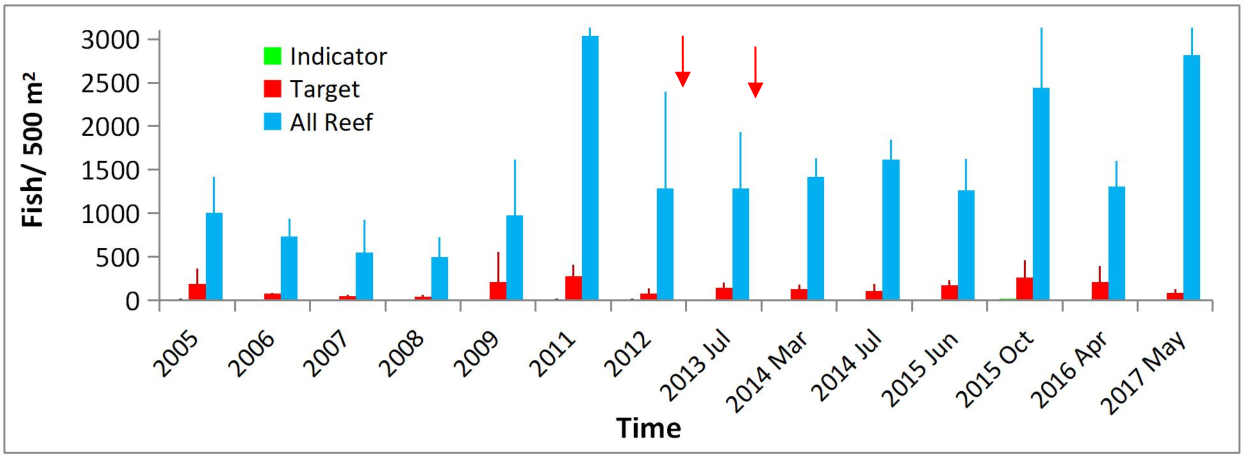

Figure 4.2.2. Changes in fish densities in Caticugan Marine Sanctuary (CMS-Si), Siquijor Municipality, from 2005 to 2017. Rehabilitation and control stations were established inside CMS by 2014 at the start of the coral rehabilitation-reef fish recovery (CRR-RFR) initiative. This graph shows the rehabilitated area fish densities starting 2014. Red arrows indicate typhoons.

Reef fish Biomass and Species Richness

Comparison of target reef fish biomass between stations revealed a significant treatment effect (treatment: $p = 0.016$, $F = 13.76$, $DF = 2$). Fish biomass in the rehabilitation area was consistently higher over time when compared to the biomass in the control and adjacent fished areas, except in the year 2017 (Fig. 4.2.3). No significant effects were seen for time and the interaction between time and treatment factors. In the rehabilitation area, fish biomass appeared to increase from 15.09 ± 32.48 ± 32.05 kg/500 m^2 in March 2014 to 32.47 ± 32.04 kg/500 m^2 by October 2015, yet, declined by the years 2016 (23.34 ± 15.13 kg/500 m^2) and 2017 (10.42 ± 6.95 kg/500 m^2). Both fish biomass in the control and adjacent fished area remained very low over time.

Changes in reef fish species richness was also evaluated in the rehabilitation area for two time periods, i.e., at the start of the rehabilitation initiative in March 2014 (56 ± 3.6 species/500 m^2) and after, in November 2017 (71 ± 12.16 species/500 m^2) using a paired T-test. Although the latter value appeared to be higher than the former, but statistically it is not significant. Alternatively, when comparing species richness between treatments in 2017, the rehabilitation station (71 ± 12.16 species/500 m^2) was significantly higher compared with the control (43 ± 1.73 species/500 m^2) and adjacent fished area (40.33 ± 5.77 species/500 m^2) ($p = 0.005$, $F = 14.09$, $DF = 2$; Tukey's Test: Rehabilitation > Control = Adjacent fished area).

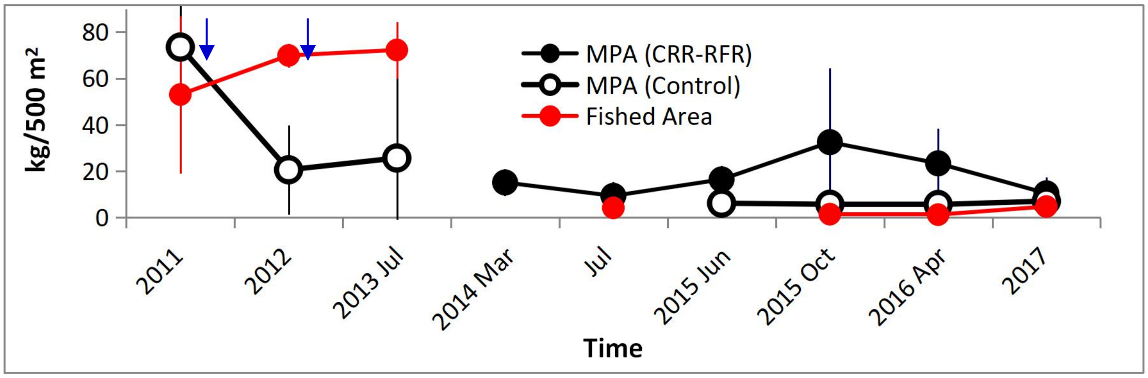

Figure 4.2.3. Changes in fish biomass in Caticugan Marine Sanctuary (CMS-Si) and adjacent fished reef (AFR) in Siquijor Municipality, from 2011 to 2017. Rehabilitation and control stations were established inside the CMS by 2014 at the start of the coral rehabilitation-reef fish recovery (CRR-RFR) initiative. Blue arrows indicate typhoons.

Discussion

Coral reef rehabilitation is a double-edged sword. It can be very useful when utilized appropriately but can also be destructive when misused. Coral rehabilitation must only be implemented if the need is established (Young 2000, Edwards and Gomez 2007). Coral rehabilitation for typhoon impacted reefs requires previous knowledge of the reef targeted for rehabilitation, a damage assessment and a well thought rehabilitation plan while considering ecological, biological and physical factors that may influence the project (Maypa et al., in review). In Siquijor Province, our full CRR-RFR protocol was implemented in MPAs with a high level of coral damage (75 -100%; Maypa et al. 2014). Caticugan Marine Sanctuary was considered to have a mid level damage at 73% based on our damage assessment in the year 2013, thus, we only implemented the substrate stabilization and coral fragment stabilization protocol in this area (see Maypa et. al 2014 and Maypa et al., in review for more information on the protocol).

Coral recovery

Our results show the positive impacts of our CRR-RFR initiative in Caticugan Marine Sanctuary over time both in coral and reef fish stocks recovery. The significantly higher % live hard coral cover (LHC) in the rehabilitation area compared with the control area, shows that natural recovery is not occurring or is likely very slow in the area without rehabilitation, thus, no significant changes can be detected after 4 years. Documented recovery in typhoon impacted reefs can take 5-50 years, depending on the type and extent of damage (Grigg and Maragos 1974, Stoddart 1974, Pearson 1981, Dulvy et al. 1995). In areas where anthropogenic disturbance compounds typhoon damage, recovery may not occur (Hughes 1994). These results then establish the need for CRR-RFR in this sanctuary and its vicinity. In contrast, the %LHC in the adjacent fished area is fair, similar to the rehabilitation station % LHC cover. The faster recovery of the fished area compared to the control station in the sanctuary may be attributed to the difference of coral species present in each location. In the AFR, we noted that more fast growing and aggressive coral species dominated the station (e.g., branching *Acropora* and foliose *Montipora* species), while massives and branching *Porites* lifeforms dominated Caticugan Marine Sanctuary. The latter species have slower growth rates compared to the former (Dullo 2005).

Reef fish stocks recovery

This study showed a significant improvement of fish densities for all categories over time in the rehabilitation station, while those in the control and fished area were at status quo. This, again, indicates CRR-RFR effectiveness. The increasing trend of target fish density is good news to fisherfolks. However, the decline documented in 2017 must be noted for the purpose of improvement in enforcement. Although CMS-Si is well known for its strict enforcement, there were incidences of poaching in the past that occurred due to limitations like, poaching during bad weather made it difficult for the *Bantay Dagats* to detect the illegal activity, considering the distance from the guard house to the reef. Moreover, the enforcement paraphernalia of CMS-Si can benefit if improved, e.g., a better and faster patrol boat and more powerful search light.

Moreover, the significant treatment effect for reef fish biomass when comparing the rehabilitation, control and adjacent fished stations, wherein the rehabilitation area showed consistent high biomass over time (except in the year 2017), again, is another evidence of CRR-RFR effectiveness. Lastly, CRR-RFR also improved reef fish species diversity shown by a significantly higher species richness in the rehabilitation area compared to the rest of the stations by 2017.

Recommendations

1. Caticugan Marine Sanctuary will benefit from a continued strict enforcement while the reef is recovering from the typhoon damage of previous years.
2. Improvement of enforcement paraphernalia in CMS-Si will be best so as to increase its capacity against the more powerful boats of the poachers.
3. Increase in Bantay Dagat manpower by making this item "regular" under the Municipality of Siquijor, can always benefit deserving enforcers and this sanctuary. Currently, the "Caticugan Bantay Dagat Model" wherein two casuals are paid full time by the Municipality of Siquijor appears to be a better arrangement compared to most MPAs in the Province where only one Bantay Dagat is paid PhP 500.00/month as an honorarium (D. Pasco, CRM Chief and Chief Bantay Dagat of the Province, pers. comm.). The CCEF – OPA-CRM team is advocating for the improvement of Bantay Dagat compensation in the Province so as to improve overall MPA enforcement, thus, marine biodiversity and fisheries stocks. Bantay Dagats with regular status are crucial to the sustainability of MPAs in the Province.
4. Continued support from Siquijor Municipality in MPA monitoring is a must, at least annually, so that MPA managers can benefit from science-based information on their MPA status to guide them with their management. In this connection, we mention here that Siquijor Municipality has now three established MPAs and one proposed (Candanay Norte Anduhaw Marine Sanctuary) and all these MPAs will benefit from a strong support from the Municipality. Clustering these MPAs for enforcement and resource sharing purposes will further benefit the fisheries stocks and food security of the Municipality.
5. The importance and benefits of being part of the Siquijor Province Coastal Resource Management Alliance (SPRCMA) is something that Siquijor Municipaliy , lead by its Municipal Council (Sangguniang Bayan) needs to understand. Out of the 6 municipalities, only Siquijor Municipality refused to join the Alliance formally formed in August 2018 primarily to join the resources of the Province and its municipalities to mitigate illegal fishing, protection of coastal habitats and sustainable management of marine resources.

Acknowledgments

This is a contribution of Coastal Conservation Education Foundation and UNICO Conservation Foundation to improving coral reefs and to food security through the use of tools such as coral reef rehabilitation-reef fish recovery (CRR-RFR) and marine protected areas (MPAs). This is also a contribution of Siquijor Municipality and Siquijor Province to good eco-governance. We thank the long-term partnership and support of Siquijor Province through the Office of the Provincial Agriculturist – CRM Section. Special thanks to PROMOTE and the Municipality of Siquijor and its active MAO (C. Maglinte) and FT (J. Pactor). The data used in this report were collected through the following projects of CCEF over the years: 2005 – 2010 (the Local Governance Coastal Resource Management Project funded by the David and Lucille Packard Foundation), 2011 - 2013 (Siquijor Marine Protected Area Network, SIMPANET in partnership with ARC and funded by NOAA), 2014 – 2017 (Coral Reef Rehabilitation and MPA monitoring funded by UNICO Conservation Foundation), 2014 – 2015 (various projects including coral reef rehabilitation supported by GIZ - ACCoast), 2015-2016 (SUIEMS-FPE in partnership with CCEF - UNICO) and 2017 (SPR).

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4.3 Nonoc Marine Sanctuary, Larena, Siquijor Province Status Report 2005 - 2017: Implications to the coral reef damage in the Adjacent Reef

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Abstract

The coral reef is a major marine ecosystem that humans depend on for food, livelihood and employment. Marine protected areas (MPAs) are popular and widely used tools for marine biodiversity conservation, fisheries management and to mitigate coral reef degradation. Nonoc Marine Sanctuary (NMS) is a coral reef marine protected area, 4.13 ha in size and established in 1996. The percentage live hard coral cover (LHC) in NMS is fair at approximately 30% in the years 2015 to 2017. The increase in coral cover by 2015 is an improvement from the year 2013. Coral cover declined significantly to almost 50% after the typhoons in 2011 and 2012 (from 40.87 ± 20.66% in 2012 to 22.67% ± 8% in 2013). Moreover, LHC in the Adjacent Northern Reef (ANR) declined sharply from 44% ± 3.68 LHC in May 2015 to 23.69 ± 0.59% by June 2017. This is a 50% decrease from the 2015 LHC. Damage patterns in recent years suggest that anchor, boat grounding and pier construction are the most likely cause of the observed coral damage. In addition, Siltation from the pier appeared to increase the turbidity of the area over time. Keeping in mind the coral damage from typhoon Pablo in 2012, a combined and repeated coral damage from human activities will impede any potential coral reef recovery. If degradation is continued, loss of habitats for fish and other marine organisms is likely, thus, threatening food security in the area. Recommendations to prevent further habitat degradation in the ANR and improvement of NMS management are provided.

Introduction

The coral reef is a major marine ecosystem that humans depend on for food, livelihood and employment (White and Cruz-Trinidad 1998). A coral reef area of 26,000 km^2 in the Philippines is estimated to yield 351,000 - 429,000 tons of fish annually. Millions of Filipinos and people across the Coral Triangle depend on this ecosystem for food and income. This includes small-scale and subsistence fishers to commercial fishers and, recreational to educational tourists (White and Cruz-Trinidad 1998, ADB 2014).

Among the many success stories on coral reef and marine protected area ecotourism in the central Philippines is Apo Island. This is a small island, 74 ha in size, with a total coral reef area of 106 ha (Russ and Alcala 1999). The recorded annual tourism revenues since the year 1999 to present is approximately more than PhP 5 million from its 24 ha marine protected area (MPA) and adjacent reefs (Cadiz and Calumpong 2000, DENR-AILPS data). In Siquijor Province, the popular reefs to divers and snorkelers are are Paliton, Tubod, Maite, Tulapos and Caticugan Marine Sanctuaries. The annual gross revenue of the 18.3 ha Paliton Marine Sanctuary (includes a seagrass bed and a coral reef) in the Municipality of San Juan, ranged from PhP 7,000 to 276,000.00 annually, from 2008 to 2015 (Paliton Marine Sanctuary Marine Management Council data).

However, many coral reefs were severely destroyed in the central Philippines along the tracks of the sequential strong typhoons in the years 2011 (Sendong), 2012 (Pablo), 2013 (Yolanda) and 2014 (fish s vith u was a cies l atch

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are likely to decrease rapidly when coral reefs are gone. Natural coral reef recovery can take 20-50 years in severely damaged areas (Grigg and Maragos 1974, Stoddart 1974, Pearson 1981, Dulvy et al. 1995). In cases of blast fishing or human disturbance where a previously healthy reef classified as moderately productive is destroyed, loss in sustainable fish yield from an area of 1 km^2 is approximately 128 t (White and Cruz-Trinidad 1998).

Marine protected areas are popular and widely used tools for marine biodiversity conservation, fisheries management and to mitigate coral reef degradation (Gell and Roberts 2003). Recently, MPAs are advocated for coral reef resilience brought about by climate change (Mumby 2007, Green and Bellwood 2009, Maypa et al., in review), and as an alternative livelihood tool for those MPAs that are able to generate enough revenues from tourism and related activities (e.g., Cadiz and Calumpong 2002, White et al. 2000, Gravestock et al. 2008). Conservation benefits from MPAs such as biodiversity increase, abundance, biomass and reproductive potential as animals increase in size, are well documented within its boundaries (Gell and Roberts 2003, Halpern et al. 2003, Lester et. al 2009, Babcock et al. 2010) and in adjacent reefs (Russ et al. 2004, Abesamis 2006, Maypa 2012). This report aims to: (1) document the status of Nonoc Marine sanctuary (NMS) and its adjacent reefs (2) track the coral and reef fish changes overtime to provide recommendations useful for the improvement and management of NMS and the coral reefs of Larena Municipality in general, (3) report the coral reef damage on the northern reef adjacent to NMS and, (4) provide recommendations to mitigate coral damage/habitat degradation and improvement of MPA management and enforcement.

Methods

Study site

Nonoc Marine Sanctuary (NMS) is a 4.0 ha marine protected area (MPA) established in 1996 by a Municipal Ordinance (MO) 18, which was later revised to MO 04 in 2004. The marine sanctuary is located in a cove south of Cangbagsa Marine Sanctuary. A sparse seagrass bed can be found at the shallow area followed by an extensive coral reef flat both in NMS and its adjacent northern reef, which is a fishing ground. Nonoc Marine Sanctuary and surrounding reefs were hit by typhoons Sendong (2011) and Pablo (2012). Reef damage was classified as low (< 50%) using the coral reef damage categories of Maypa et al. (2014) in the year 2013. This MPA was part of our coral reef rehabilitation priority site from 2013 to 2015. However, due to the observed fast recovery in terms of increase in coral cover in 2014, no further rehabilitation tools were installed in this site after 2014. We continued our annual reef monitoring in NMS and recommended to the MPA management body to continue protecting and strictly enforcing this MPA.

The MPA Monitoring Team

Marine biologists from the Coastal Conservation and Education Foundation (CCEF) and Silliman University-Institute of Environmental and Marine Sciences (SUIEMS), the Provincial monitoring team of Siquijor Province (PROMOTE) composed of trained MPA management body members, People's Organization (PO), Local Government Units (LGU), Fisherfolk and members of the Philippine National Police (PNP) repeatedly trained overtime in coral reef monitoring by CCEF compose the MPA Monitoring team. In 2017, the SPR Volunteers together with the CCEF team carried out the coral reef surveys.

Substrate cover

The percentage cover of the substrate was evaluated using the Point – Intercept Transect Method (PIT; Uychiaoco et al. 2010) since the year 2005. Substrate data was collected at every 0.25 m point along the 50 m transect line. Three to five 50 m replicate transects were laid sequentially parallel to the reef crest at 7-10 m depth both inside NMS and its adjacent reef at the northern side. However, in 2015-2016, the Line-Intercept Method (LIT) was used under the SUIEMS-FPE Project. This method has a higher resolution than PIT. In 2017, selected transects (those that coincided with the marked transect stations) from the SPR survey inside Nonoc Marine Sanctuary were included in this report. The following data were collected: (1) percent cover of living coral (hard coral per life form and soft coral, e.g., in English et al. 1997); (2) percent cover of non-living substrate (e.g., rock, rubble, sand, silt, dead coral) and, (3) percent cover of other living substrate (e.g., seagrass, algae, sponges). We also noted indicator invertebrates (giant, lobsters, Triton shells, Crown of thorns starfish and others) the causes of reef damage where appropriate but reported separately. Substrate percent cover was computed per category using standard scientific and methods and presented graphically. Standard statistical tests were also used when appropriate.

Coral Reef Damage Assessment

Coral reef damage was assessed at the Adjacent Northern Reef (ANR) using LIT and GIS. Selected points of the damage area were located using marker buoys secured by scuba divers. The GPS point of each buoy were recorded and plotted using ArcGIS© and GoogleEarth©. A GIS map was generated and included in this document.

Coral Reef Fish Relative Abundance and Biomass

Fish density, length and species were estimated using a 50 x 10 m visual census (FVC; n = 3 to 5) technique done by a single observer or two observers whose fish length estimates were calibrated. Substrate transects were utilized for UVC (English et al. 1994). All fish species within the 500 m^2 sampling area were recorded. The abundance of large numbers of numerically dominant and visually obvious fish species were recorded using the Log4 abundance category developed by the Great Barrier Reef Marine Park Authority (GBRMPA in Russ and Alcala, 1989). Fish relative abundance using density and biomass were computed using standard scientific methods and presented graphically. Standard statistical tests were also used when appropriate. Fish diversity or fish species richness is not included in this report.

Results and Discussion

Substrate

Nonoc Marine Sanctuary (NMS)

The percentage live hard coral (LHC) cover in Nonoc Marine Sanctuary was fair at approximately 30% in 2015 to 2017 (Fig. 4.3.1) based on the categories of Gomez et al. (1994). Although non-living substrate such as rubble and dead coral dominated the area, coral recovery appeared faster here compared to other typhoon-damaged reefs with high level of damage (> 70%) in Siquijor Province, e.g., in Olang Marine Sanctuary in Maria and Binoongan Marine Sanctuary in Enrique Villanueva. What appeared to be an increasing pattern in coral cover from 2013 to 2015 can be an improvement, though statistically not significant. In 2013, coral cover declined significantly to almost 50% after the typhoons in the years 2011 and 2012 (from 40.87% in 2012 to 22.67% in 2013). It was observed that the foliose coral, *Montipora* sp., which appeared to be a fast growing species, dominated the LHC in the area. This MPA will benefit from a strict enforcement so as to facilitate further coral recovery in the future years.

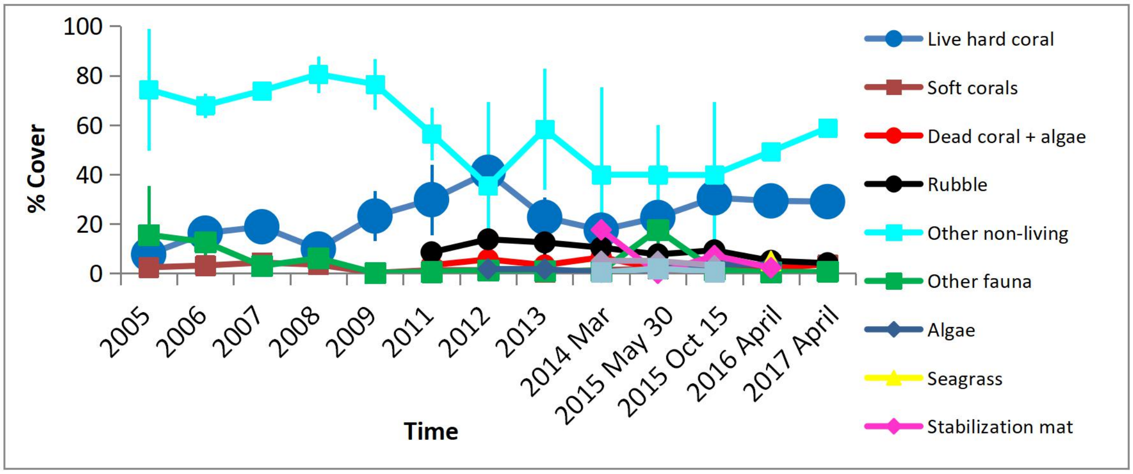

Figure 4.3.1. Changes in the substrate cover (%) of Nonoc Marine Sanctuary (NMS), Larena, Siquijor Province from 2005 to 2017. Data source: CCEF-MPA Database (2005-2014), SUIEMS-FPE Project (2015-2016) and CCEF-SPR (2017).

Adjacent Northern Reef (ANR) and coral damage

In addition to monitoring NMS, we also regularly assess a fished area. This is the reef adjacent to NMS, on its northern boundary to serve as the control for the MPA. When all human disturbance and extraction are banned in a MPA, assuming that it is well enforced, the expectation is for the MPA to have higher and more diverse flora and fauna in addition to better habitats compared to the adjacent exploited reef.

Live hard coral cover in the ANR was historically higher compared to NMS (Fig. 4.3.2). In the year 2008, LHC was excellent at 70.8%. *Acropora* spp. (branching corals) dominated the reef flat and slope. After typhoon Pablo in 2012, LHC declined sharply to poor (25% ± 24.1 %) by 2013. We documented signs of coral recovery through a significant increase in May 2015 (44% ± 3.68%).

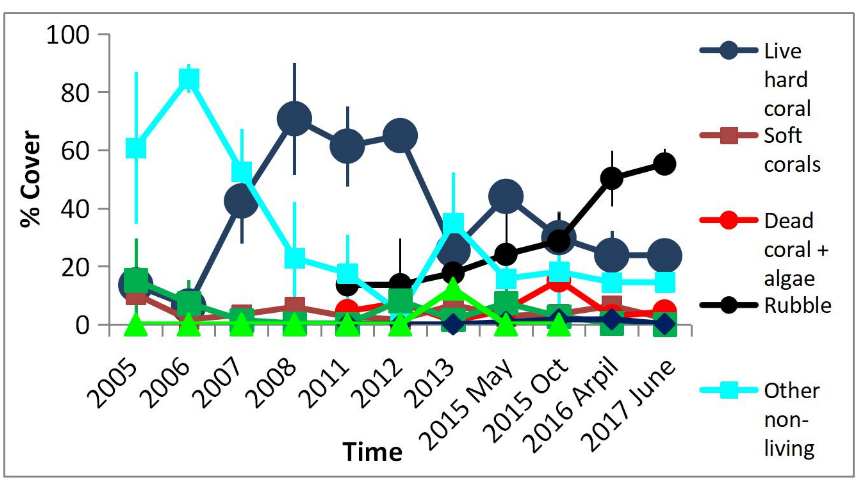

Figure 4.3.2. Changes in the substrate cover (%) of the Reef Adjacent to Nonoc Marine Sanctuary (ANR), Larena, Siquijor Province from 2005 to 2016. CCEF-MPA Database (2005-2014), SUIEMS-FPE Project (2015-2016) and CCEF-SPR (2017).

However, LHC declined again after 2015, to 23.69 ± 0.59% by June 2017. This is a significant 50% decrease from the 2015 LHC (One-Way Repeated Measures ANOVA: $p = 0.015$, $F = 6.58$, $DF = 3$). This is also in contrast with the increasing LHC pattern observed in the MPA. In 2017, dead coral and rubble substrate dominated the area. Photos of coral damage in the ANR are shown in Figure 4.3.3. Damage patterns in recent years suggest that anchor, boat grounding and pier construction as the most likely cause of the observed coral damage. In addition, increase in turbidity in the general reef area has been observed over time. Siltation from the pier likely contributed to this phenomenon.

Figure 4.3.3. Coral reef photos from Nonoc Marine Sanctuary (NMS) and Adjacent Northern Reef (ANR) from 2015 to 2017. (A) Foliose coral in NMS, (B) Branching corals in ANR in 2015, (C) the ornate Pajama fish (*Sphaeramia nematoptera*) living in coral branches in ANR in 2015 (D) coral damage in ANR in 2016, (E-F) coral damage in ANR in 2017. Photos A-C by A.P. Maypa, D-F by M. Baird.

Keeping in mind the coral damage from typhoon Pablo in 2012, a combined repeated coral damage from human activities will impede a potential coral reef recovery. If degradation is continued, loss of habitats for fish and other marine organisms is likely, threatening food security in the area. According to White and Cruz Trinidad (1998), the total net fishery loss from blast fishing is USD 86,300.00/km^2 over a 25 year period. Coral damage from anchor and boat grounding is very similar to blast fishing when repeated over time in the same reef and affecting a larger area that results into the dominance of a rubble substrate, i.e., in the context of habitat loss. The area of coral damage in the ANR was estimated at 0.4 ha (4,000 m^2 or 0.004 km^2), shown in Figure 4. When applying the estimate of White and Cruz-Trinidad (1988), fishery loss alone at ANR will amount to USD 345.2 (PhP 17,260.00) annually. When computed over a 25 year period, it is estimated at PhP 431,500.00. Similarly, when using estimates for coral rehabilitation at PhP 79.00/m^2 (Maypa et al. 2014) the estimated cost for "repairing" this reef damage is PhP 316,000.00.

Another major concern for NMS management that is presented in Figure 4.3.4, is the discrepancy in the location of the current MPA and the actual technical description in the MPA ordinance. At present, NMS is located in a shallow area, when the ordinance describes a deeper MPA. It is important that NMS management and Nonoc Barangay Council work with the Coastal Resource Management (CRM) Chief of the Province so that revisions of the MPA ordinance can proceed. We recommend that NMS retain the current location of the MPA and to extend its boundaries northward to include the damaged areas for protection to facilitate faster recovery.

Reef fish abundance and biomass

Nonoc Marine Sanctuary (NMS) and the Adjacent Northern Reef (ANR)

The overall reef fish fauna of NMS was numerically dominated by damselfishes (family Pomacentridae locally known as *palata*) and wrasses (family Labridae locally known as *labayan*) at 1216.75 ± 732.05 fish/ m^2. Both target fish density (16 fish per 500 m^2; Fig. 4.3.5) and biomass (1.5 kg/500 m^2; Fig. 4.3.6) were very low. The target fish in NMS were mostly small parrot fish (*Chlorurus* spp. and *Scarus* spp.) and larger labrids (e.g., *Oxycheilinus* spp., *Choerodon* and *Hymnogymnus* spp.). Poscivorous species such as snappers, lethrinids and jacks were not common considering that NMS is a 21 - year old MPA. A fluctuating pattern in both fish densities and biomass was observed in NMS and this pattern is very similar to the trends observed in the fished area (Fig. 4.3.7). This indicates that MPA enforcement is none to very weak. This MPA can improve a lot through capacity building and strengthening of its management and enforcement team.

In the ANR, target fish density and biomass was expected to be lower compared to the adjacent MPA since it is a fishing ground. However, the densities and biomass were similar in both sites. Further, the densities of all reef fish over time declined sharply from October 2015 (3,653.66 ± 1,362.68 fish/500 m^2) to May 2017 (919/33 ± 0.26 fish/500 m^2) (Fig. 4.3.7). This decline in small reef fishes is likely due to the repeated coral damage in the area mentioned above. Although statistical tests did not result to any significant difference in all reef fish densities from October 2015 to May 2017, this declining pattern needs further monitoring. When coral reefs are destroyed and homogenized to a flat rubble substrate the reef loses its structure and complexity which are crucial reef fish habitats (e.g., some fish take shelter in holes and crevices between coral species or some fish prefer to hide in between coral branches). Thus, abundance and biomass of reef fish also declines rapidly leading to biodiversity loss

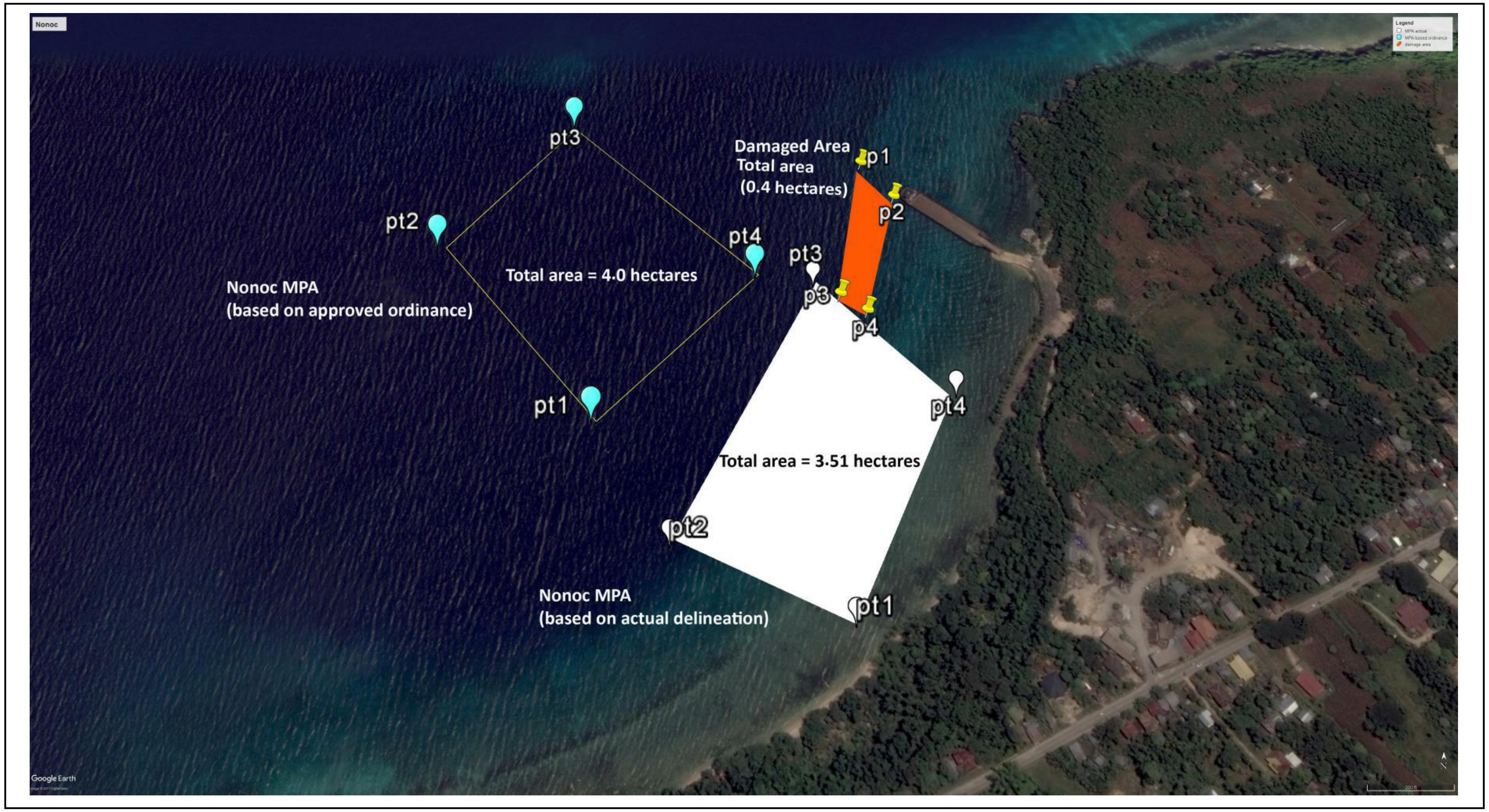

Figure 4.3.4. A map showing the location of the coral damage in the reef adjacent to the Nonoc Marine Sanctuary at 0.4 ha (red area) relative to the position of the current Nonoc Marine Sanctuary (white area) and Nonoc actual marine sanctuary based on its technical description (area without fill). Cartography by M. Baird.

(Graham et al. 2006, Maypa 2007, Maypa et al. 2014). Coral reef recovery in severely damaged reefs can take 20-50 years without rehabilitation (Pearson 1981, Dulvy et al. 1995). Loss of sustainable fishing yield from a moderately productive reef from blast fishing is approximately 128 t/km^2 (White and Cruz-Trinidad 1998).

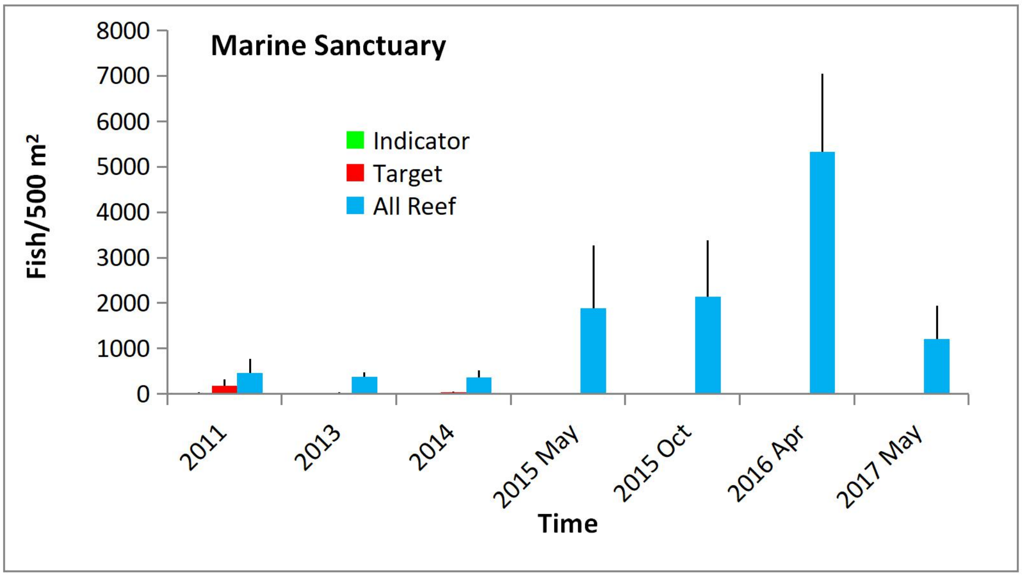

Figure 4.3.5. Changes in the reef fish densities in Nonoc Marine Sanctuary (NMS), Larena, Siquijor Province from 2011 to 2017. Data source: CCEF-MPA Database (2011-2014), SUIEMS-FPE coral reef recovery in typhoon-damaged reefs project (2015-2016), CCEF-CCEF-SPR (2017).

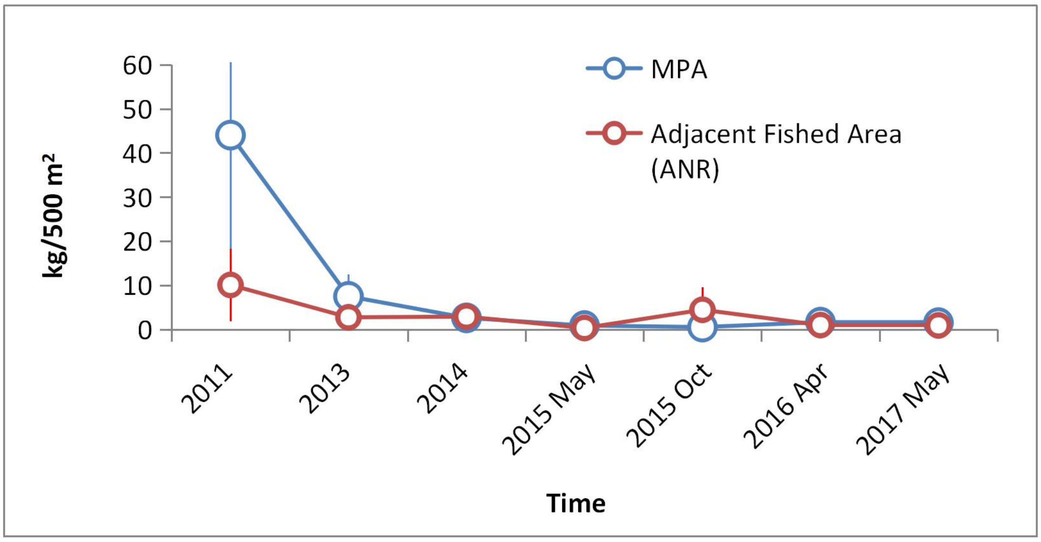

Figure 4.3.6. Changes in the target reef fish biomass in Nonoc Marine Sanctuary and adjacent fished reef (ANR) in Larena, Siquijor Province from 2011 to 2017. Data source: CCEF-MPA Database (2011-2014), SUIEMS-FPE coral reef recovery in typhoon-damaged reefs project (2015-2016), CCEF-SPR (2017).

Marine protected areas are proven effective tools for biodiversity conservation and fisheries management (Gell and Roberts 2003). It is also used to mitigate habitat degradation combined with other tools proven to be scientifically sound (e.g., in Maypa et. al. 2014). Moreover, a MPA can be used as an alternative livelihood tool for those MPAs that are able to generate enough revenues from tourism and related activities (e.g., Cadiz and Calumpong 2002, White et al. 2000, Gravestock et al. 2008). Nonoc Marine Sanctuary has a potential to achieve all of the MPA expectations stated above. However, this MPA has to improve in its enforcement and management. Capacity building activities such as refresher MPA management and coastal law enforcement trainings will benefit NMS management.

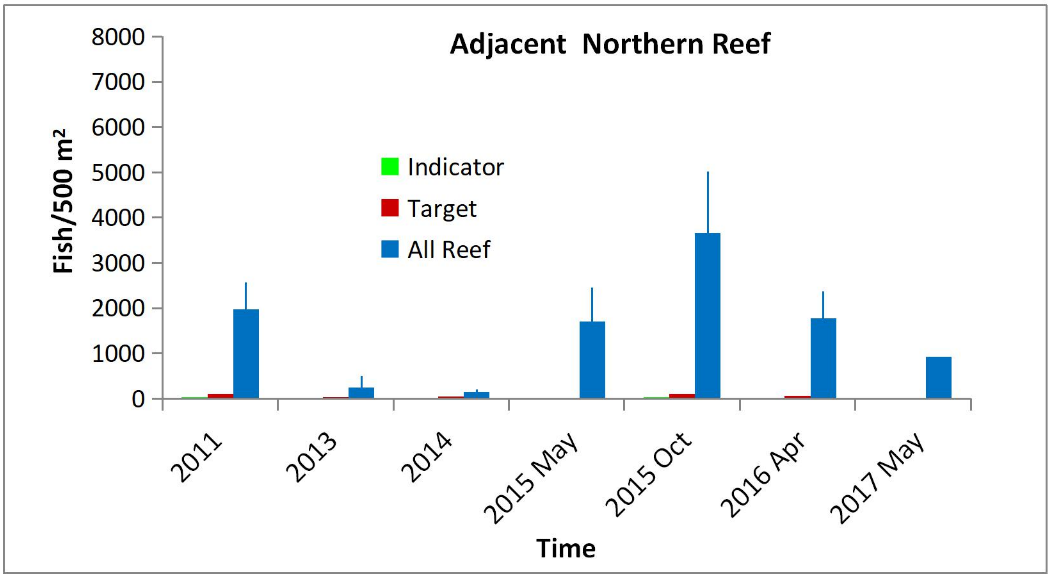

Figure 4.3.7. Changes in the reef fish densities in the Adjacent northern Reef of Nonoc (ANR) Marine Sanctuary, Larena, Siquijor Province from 2011 to 2017. Data source: CCEF-MPA Database (2011-2014), SUIEMS-FPE coral reef recovery in typhoon-damaged reefs project (2015-2016), CCEF-SPR (2017).

Recommendations

1. Enforcement of NMS is crucial to improve the reef fish stocks and facilitate coral recovery from typhoon damage. The very low target fish densities and biomass inside this 21-year old MPA reflects none to very weak enforcement status. The reef fish stocks in NMS reflect a 5 year old MPA considering its coral damage from the previous typhoons. Steps to strengthen the MPA management an enforcement team is a must.

2. Ecotourism revenue is often used as a sustaining financial mechanism for many MPAs in the Philippines. With proper planning and enforcement, NMS ha a lot of potential for this venture considering its beach, reef topography and diversity. Our monitoring team also documented many species of nudibranchs and small ornate reef fishes unique to NMS and ANR. This biodiversity is especially interesting to macro photographers.
3. Reports confirm that the pier fronting ANR is active and operational. This is likely the cause of the repeated coral damage documented in the northern reef adjacent to the MPA (i.e.,

ANR) over the years. Patterns of damage indicate anchor and boat damage and, possibly pier construction. We strongly recommend that Nonoc Marine Sanctuary be extended to include the damaged reef to facilitate coral reef recovery, including reef fish recovery which can take approximately 5-10 years without rehabilitation. This will allow coral reef recovery overtime thereby restoring the fish habitats that may eventually improve the reef fish stocks in the area. In addition, it will benefit the LGU of Larena and DENR-Siquijor if the legitimacy of the aforementioned pier is investigated and, the operations that result to coral damaged must be stopped. Based on DAO 03-30, "coral reefs characterized by one or any combination of the following conditions: with 50% and above live coralline cover; spawning and nursery grounds for fish; act as natural breakwater of coastlines," are classified as **"environmentally critical area."** The live coralline cover of ANR is originally estimated at 70.8%.

4. Amending the MPA ordinance of NMS is strongly recommended to correct the location of the approved MPA. This is also necessary prior to the suggested extension of the MPA.

5. Siltation in the ANR has been observed over the recent years. Siltation is detrimental to corals and many marine organisms that need light and filter feed. The newly constructed pier at ANR is likely the source of siltation thus, this matter needs urgent investigation. Measures should be taken and put in place by the Nonoc Barangay Council to prevent further reef degradation.

Acknowledgments

This is a contribution of CCEF Project SUSTAIN, Saving Philippine Reefs and Project ISDA to sustaining marine protected areas and improving coral reef management and protection in Siquijor Province, central Philippines. We thank Siquijor PROMOTE and the previous CCEF-REMOTE team for assisting in the long-term MPA monitoring in Siquijor Province. We thank the CCEF-SPR 2017 for the 2017 FVC data used in this report. Special thanks to the continued partnership of Siquijor Province with CCEF through the Office of the Provincial Agriculturist and, the UNICO Conservation Foundation for its continued support to CCEF and the coral reefs of the central Philippines.

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4.4 Cangbagsa Marine Sanctuary, Larena Municipality

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Abstract

Cangbagsa Marine Sanctuary (CMS-L) in Larena Municipality is 12.42 ha, established in 2013. It is managed by the Barangay Council together with the fisherfolk and a private resort present in the area. The biophysical monitoring of this sanctuary and with the rest of the MPAs in the Province, is done by the Coastal Conservation and Education Foundation (CCEF) in partnership with the Province through Provincial Monitoring Team (ProMoTe). In 2017 Saving Philippine Reefs (SPR) surveyed Cangbagsa and Nonoc sanctuaries in Larena as part of the eight SPR sites. The results of this monitoring in 2017 showed that the percentage live hard coral cover (LHC) in CMS-L and in the adjacent fished area (AFR) are relatively fair in condition with 33.75 ±2 0.86% and 32.33 ± 7.18%, respectively. The decline in LHC (15.5±2.83%) observed in 2014 was a cumulative impact of extreme weather events that happened in 2013 and 2014. All reef fish density ranged from 265 ± 258.26 to 1,855.33 ± 1,035.17 fish/500 m^2 while target fishes, densities were consistently low over the years (range: 35.33 ± 25.15 to 126 ± 79.62 kg/500 m^2). Moreover, biomass of target fish in both sanctuary and AFR were relatively low at 8.44 ± 7.02 and 2.05 ± 2.88 kg/500 m^2, respectively. In terms of diversity, 87 species of fish were recorded during the 2017 monitoring. Species richness was 40.0 ± 8.2 species/500 m^2 in the sanctuary and adjacent fished reef was 39.33 ± 13.57 species/500 m^2.

Introduction

Coral reefs are diverse marine ecosystems which supports 25% of the marine organisms utilized as food by humans. Coral reefs are also habitat and nursery areas of many marine organisms. However, coral reefs and other marine ecosystems are facing pressure from both anthropogenic activities and natural disturbances (e.g., mass bleaching, crown-of-thorns infestation and strong typhoons). The establishment of a marine protected area (MPA) is a widely advocated approach for managing resources, improvement of fishery productivity, biodiversity conservation (Laffoley et al, 2008) and increase in coral reefs resilience to climate change. Furthermore, MPAs also provide economic benefits to communities through fisheries benefits and ecotourism such as diving and snorkeling (Sala et al. 2013). Currently, about 1,800 MPAs are established in the Philippines (Cabral et al. 2014).

Siquijor Province is a 5th class province in Central Visayas. It is found within the Bohol Strait just 30 km away from Negros Island. It is classified as one of the smallest province in terms of land area (343.50 square kilometers) and population (95,984; 2015 census). Currently, there are 21 MPAs established covering a total area of 234 hectares or less than 16% of the entire coral reef area in the Province (Baird et al., unpub). Out of 21 MPAs, four are located in Larena Municipality namely: Nonoc, Taculing-Cangmalalag, Sandugan and Cangbagsa Marine Sanctuaries. The first three MPAs mentioned above were established in 1989 through the Central Visayas Regional Project (CVRP) funded by the World Bank. Cangbagsa Marine Sanctuary was only established in 2013 under the Coastal Conservation and Education Foundation (CCEF) project funded by the GIZ's Adaptation to Climate Change in Coastal Areas (ACCCoast). This 12.42 hectares marine sanctuary is currently managed by the Barangay Cangbagsa through their barangay councils. To date, CCEF in partnership with the Province continuously provide support to strengthen the management and enforcement of MPAs in the area.

The Saving Philippine Reefs Project (SPR) is an annual project of CCEF which started in the 1980s, composed of selected CCEF staff and international volunteers trained in coral reef and MPA monitoring methods. This project aims to contribute to MPA sustainability and coral reef conservation in the Philippines.

Methods

Substrate cover. Scuba surveys were carried out in the deep area (6-10m) parallel to the reef crest using the Point-Intercept Transect Method (PIT; Uychiaoco et al. 2001). Transects were laid on sections of a reef flat, reef crest or slope. Substrate data was collected at every 0.25 m point along a 50 m transect line. Data gathered during scuba surveys were the same type as those collected during snorkel surveys. Three to five 50 m replicate transects were laid sequentially parallel to the reef crest both inside the sanctuary and its adjacent fished reef. Permanent markers using rope with floaters were placed at the 0 m, 25 m and 50 m point of each transect. Markers lost were replaced. During the SPR survey in 2017, transects were laid in the sampling station but the number of replicates exceeded our permanently marked transects. In assessing the following data were collected: (1) percent cover of living coral (hard coral per life form and soft coral, e.g., in English et al. 1997); (2) percent cover of non-living substrate (e.g., rock, rubble, sand, silt, dead coral) and 3. percent cover of other living substrate (e.g., seagrass, algae, sponges). We also noted indicator invertebrates (giant, lobsters, Triton shells, Crown of thorns starfish and others) the causes of reef damage where appropriate but reported separately. Substrate categories were compared between and within years whenever appropriate and, presented graphically. Sites with surveys that have low replication (n<2) were excluded from statistical analyses. Moreover, transects with huge variation or difference were also excluded in the analysis.

Table 1. Status of coral reefs in four categories (Gomez, 1991).

Hard coral cover (%)	Status
0-24.9	Poor
25-49.9	Fair
50-74.9	Good
75-100	Excellent

Site Description and Management Information

Cangbagsa Marine Sanctuary(CMS-L) is located in the north western side of the municipality of Larena with a total area of 12.42 ha (Fig. 4.4.1). It is divided into two zones, a core zone and buffer zone. This sanctuary was established in 2013 through the Municipal Ordinance No. 06 series of 2013. Cangbagsa marine sanctuary includes two major ecosystems (i.e. seagrass bed and a coral reefs). The establishment of Cangbagsa MPA was done through a participatory process, wherein the barangay, community, municipality, province and the project worked together for its approval. Based on the ordinance, the barangay is mandated to create the marine management committee (MMC) which will be responsible in the management of the sanctuary. This MMC will be represented by the different sectors such as representatives from the fisherfolk, academe, non-goverment agency (NGO), people's organization, Municipal Agriculturist Office (MAO), Municipal Fisheries and Aquatic Resource Management Councils (MFARMC), and Office of the Provincial Agriculturist (OPA). Since the MMC in Cangbagsa is not yet functional, the sanctuary is currently being managed by Barangay Cangbagsa. Meanwhile, the members of the barangay council, barangay tanods and fisherfolk are responsible in the guarding of the sanctuary together with the private resort located adjacent to the sanctuary (Flora's Dive Resort). Larena Municipality has four established marine sanctuaries and SPR only were monitored two in 2017.

Results and Discussion

Substrate

Results of baseline assessment conducted in 2012 showed that LHC in the reef slope (9-10m) in CMS-L was fair (33.75±20.86%). Percentage live hard coral cover in Cangbagsa from 2013 to 2013 is the same, and declined in 2014 (15.5±2.83%). This was attributed to the weather disturbances such as typhoons and strong monsoons. In our monitoring, branching and foliose corals were the most affected corals observed inside the sanctuary. The results of our 2017 monitoring showed that the LHC in CMS-L is slowly recovering from the damage and is now in fair condition with 32.33±7.18%. Meanwhile, dead coral, rock, sand and rubble dominated the non-living cover. Similarly, LHC in AFR was also fair with 32.33±7.18%. Moreover, a high percentage of non-living substrate was observed in this area (60.17±14.11%) compared to sanctuary (46.5±4.65%). In 2013, when most of the sanctuaries in north and northeastern side of the province were severely damaged by typhooon Pablo, only a low percentage of corals was negatively impacted in CMS-L. A high percentage of rubble and dead corals observed in fished area from the damage caused by Tropical Depression Wilma in 2013.

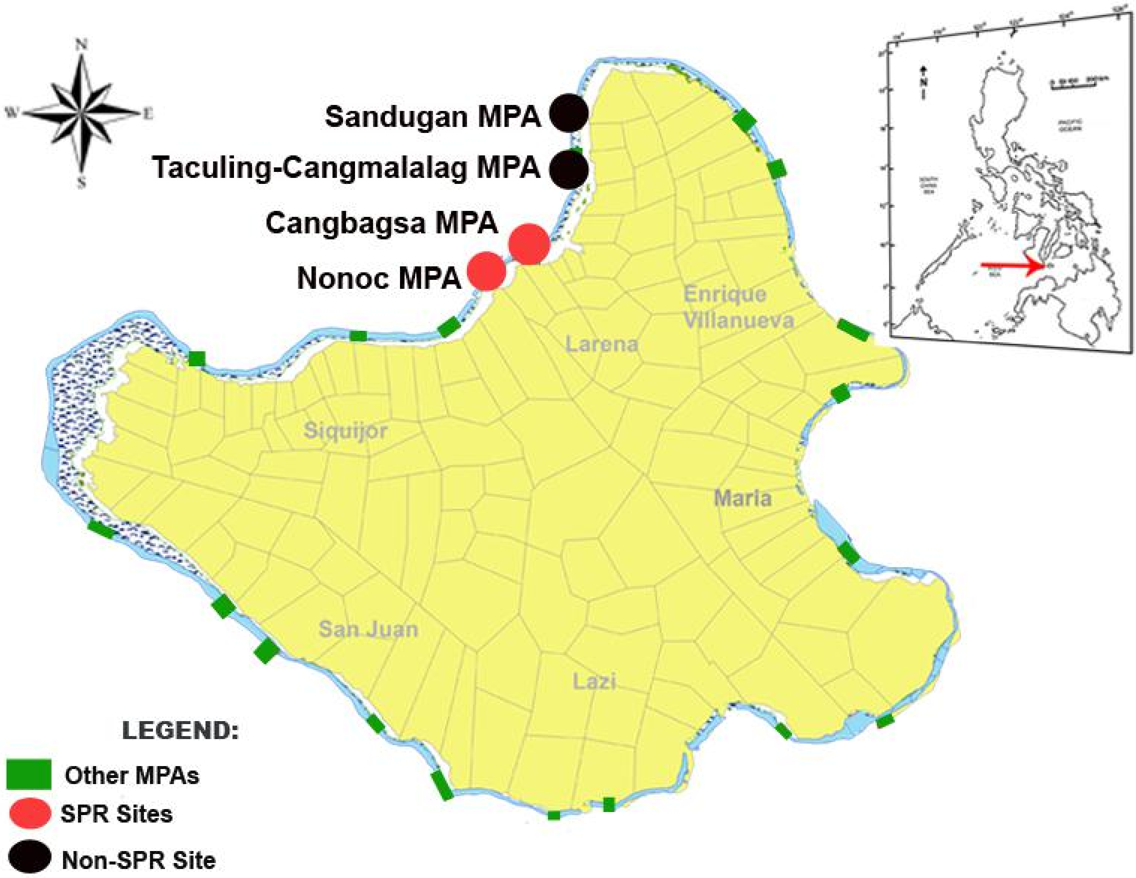

Figure 4.4.1. Map of Siquijor Island showing the four marine sanctuaries of Larena Municipality and SPR sites. Cartography by M. Baird.

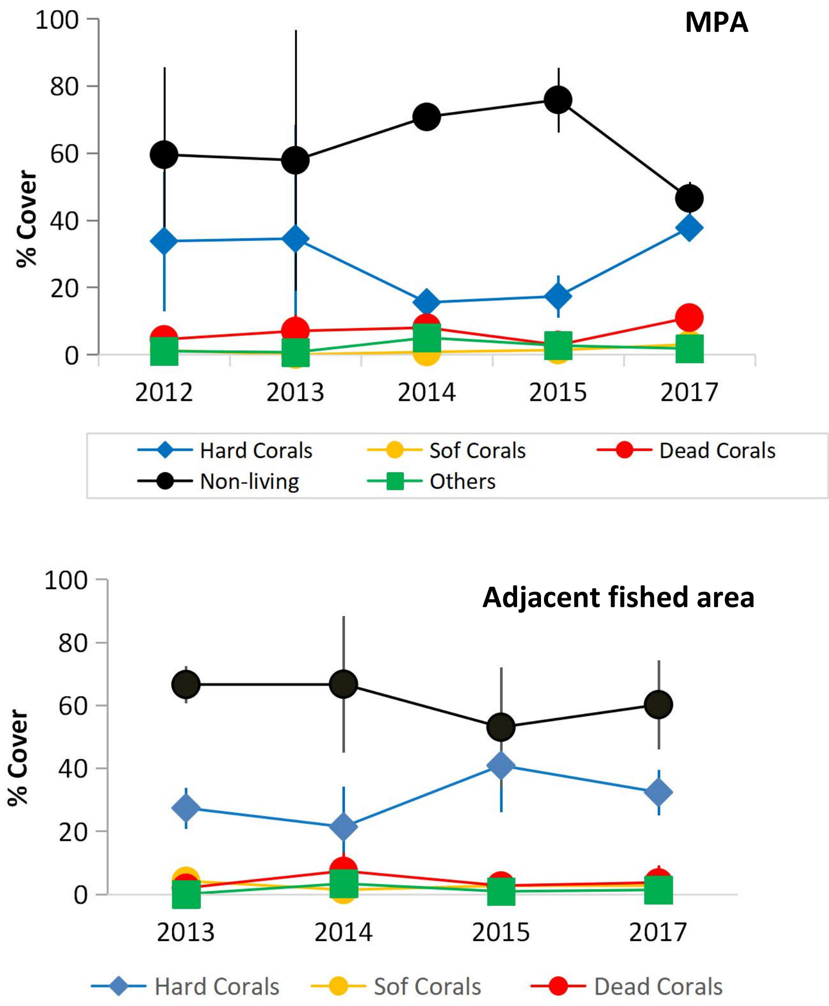

Figure 4.4.2. Substrate components (mean ± SD) and changes over the years in Cangbagsa Marine Sanctuary (CMS-L) and its adjacent fished reef (AFR) in Larena Municipality, Siquijor Province.

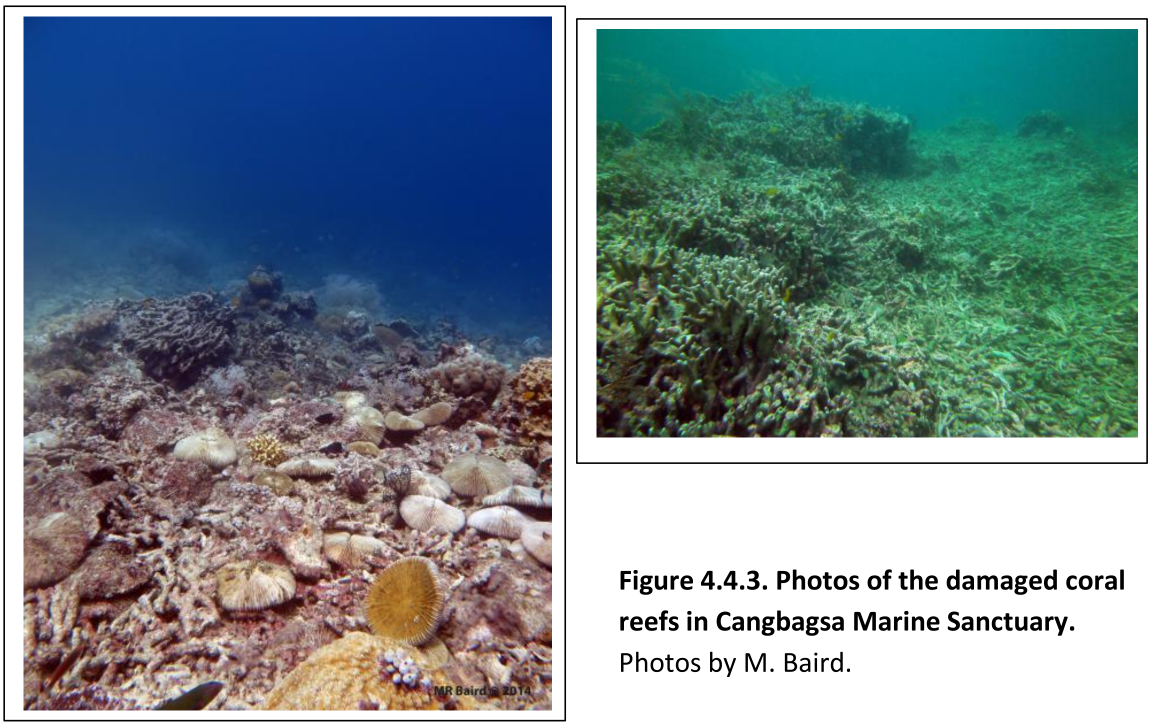

Figure 4.4.3. Photos of the damaged coral reefs in Cangbagsa Marine Sanctuary. Photos by M. Baird.

Reef fish

Density. Damsels, wrasses and surgeonfish make up the bulk of the "All reef fish" category in Cangbagsa Marine Sanctuary (Fig. 4.4.4). This ranged from 265 ± 258.26 to 1,855.33 ± 1,035.17 fish/500 m^2. The lowest was recorded in the year 2013 and the highest was in 2015. For target fish, densities were fairly low over the years (range: 35.33 ± 25.15 to 126 ± 79.62 kg/500 m^2) and variable within the year. Schools of surgeonfishes and fusiliers make up most of the bulk of the target fish density in 2017.

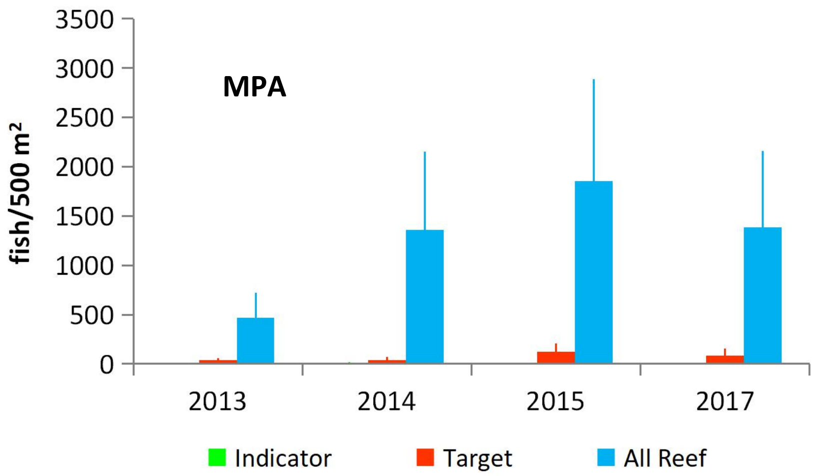

Figure 4.4.4. Changes in reef fish density (mean ± SD) over time in Cangbagsa Marine Sanctuary (CMS-L), Larena Municipality, Siquijor Province.

Biomass. Target fish biomass in Cangbagsa Marine Sanctuary and its adjacent fished reef is low (Fig. 4.4.5). No significant difference were found between the values of both areas over the years. The lowest recorded in the sanctuary was 2.97 ± 2.79 kg/500 m^2 in 2014 and the highest was 20.34 ± 17.69 kg/500 m^2 in 2013. The low fish biomass observed in 2014 can be attributed to disturbance in coral reefs brought by Tropical Depression Wilma passed through central Visayas in November 2013. This also coincided with the LHC decline both in CMS-L and in the AFR. Moreover, these results indicated none to very weak MPA enforcement. Strengthening of MPA enforcement must be prioritized by the management to improve its fish stocks.

Diversity. A total of 87 species of fish which included 8 species of butterflyfish was listed in Cangbagsa Marine Sanctuary. Further, species richness was 40.0 ± 8.2 species/500 m^2. This value was a bit higher than the adjacent fished reef with 39.33 ± 13.57 species/500 m^2.

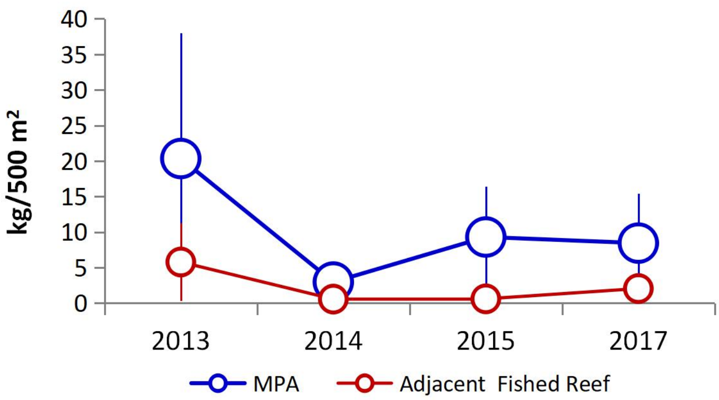

Figure 4.1.7. Changes in target reef fish biomass (mean ± SD) over time in Cangbagsa Marine Sanctuary (CMS-L) and adjacent fished reef (AFR) in Larena Municipality, Siquijor Province.

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ANNEX 1. Common live hard corals in Cangbagsa Marine Sanctuary and adjacent fished areas

Foliose corals (*Echinopora spp.*) in Cangbagsa Marine Sanctuary adjacent fished area.

Branching corals (*Porites cylindrica*) dominated the live hard coral inside the sanctuary.

4.5 Binoongan Marine Sanctuary, Enrique Villanueva, Siquijor Province

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Abstract

Binoongan Marine Sanctuary (BMS) was established in 2012 by a Municipality Ordinance. It is known for its strong sense of *Bayanihan* and strict MPA enforcement. Percentage live hard coral cover (LHC) in the reef slope was poor (< 15%) from 2013 to 2017, with high percentages of sand, rocks and rubble classified into "non-living" substrate. This MPA was negatively impacted by typhoon Bopha (aka Pablo) in the year 2012. By 2015 a Crown-of-Thorns starfish infested BMS along with reefs in other municipalities in Siquijor Province, causing further decline in LHC. Yet, all reef fish category in BMS was high at 2,372.33 ± 1,10.29 fish/500 m^2 when compared to other MPAs in Siquijor Province. Target fish biomass was also high, at 86.67 ± 52.55 kg/500 in September 2017, in contrast to the lower biomass (31. 86 ± 27.07 kg/500m^2) recorded in April by the SPR team. Species of surgeonfish (*Acanthurus* spp.), unicorfish (*Naso* spp.) and snappers (*Macolor macularis, Lutjanus* spp.) dominated the density of commercially important fish at the reef slope. In contrast, target fish biomass in the adjacent fished reef was consistently low (< 10 kg/500 m^2) from the years 2013 to 2017. A total of 112 species of fish was recorded in BMS which included 8 species of butterflyfish. Coral reef rehabilitation efforts in BMS reef flat (6-7 m) started in the year 2014 by CCEF. Recommendations to sustain MPA management and improve enforcement are provided.

Introduction

Binoongan Marine Sanctuary (BMS) is a young MPA, established in 2012 by a Municipal Ordinance (MO 2012-87) and is known for its strong sense of *Bayanihan* and strict MPA enforcement (Maypa 2015) up to the year 2017. In 2013, the coral cover in BMS along with the entire eastern side of Siquijor Island, was severely damaged by typhoons Sendong in 2011 and Pablo in 2012. Live coral cover in BMS reef flat to reef slope was reduced to 17% (30% coral damage) while the branching corals in the reef flat were transformed into rubble (Maypa et al. 2013). A coral reef rehabilitation was implemented in the reef flat (6-7 m) since the year 2014 by CCEF supported by the GIZ-ACCCoast and UNICO Conservation Foundation in 2014 (Maypa et al. 2014, Maypa et al. 2015). Binoongan Marine Sanctuary is LGU managed by the Barangay Council, under the leadership of Bragangay Captain, M. Tedlos-Legazpi. To complement CCEF's coral reef rehabilitation efforts, protection of "resilient reefs (i.e., coral reefs along the typhoon track, yet damage was low to none) was proposed under the GIZ-PAME Project from 2015-2016 (Maypa and Baird 2016). To date, the extension of the southern boundary of BMS to a total of 16 ha included more resilient coral reefs (reefs that were not damaged by previous typhoons) in the deeper area. The 2017 survey by the Saving Philippine Reefs Project of CCEF aims to complement existing MPA monitoring data sets in the previous years from different CCEF projects or from different institutions to contribute in the management and sustainability of MPAs in Siquijor Province.

Citation: Maypa, A.P., M. R. Baird, D. Divinagracia, R.G.O. Catitig, D. Pasco and A.T. White. 2016. Binoongan Marin Sanctuary, Enrique Villanueva, Siquijor Province. A Technical Report submitted to the Municipality of Enrique Villanueva and Province of Siquijor. SPR and Project ISDA, Coastal Conservation Education Foundation, Unico Conservation Foundation in Australia and Foundation for the Philippine Environment (FPE). Cebu City, Philippines. 7p.

Methods

The MPA Monitoring Team

Marine biologists from the Coastal Conservation and Education Foundation (CCEF) and Silliman University-Institute of Environmental and Marine Sciences (SUIEMS), the Provincial monitoring team of Siquijor Province (PROMOTE) composed of trained MPA management body members, People's Organization (PO), Local Government Units (LGU), Fisherfolk and members of the Philippine National Police (PNP) repeatedly trained overtime in coral reef monitoring by CCEF compose the monitoring team. In April 2017, the SPR Volunteers together with the CCEF team carried out the coral reef survey.

Substrate cover

The percentage cover of the substrate was evaluated using the Point – Intercept Transect Method (PIT; Uychiaoco et al. 2010) in the years 2011-2012. Substrate data was collected at every 0.25 m point along the 50 m transect line. Three to five 50 m replicate transects were laid sequentially parallel to the reef crest at 8-10 m depth both inside the sanctuary and its adjacent fished reef. Permanent markers were placed at the 0 m, 25 m and 50 m point of each transect. Lost makers were replaced. In the year 2013 to present the Line Intercept Method was used (English et. al. 1997) and in 2017, during the SPR survey, the number of replicates exceeded our permanently marked transects, thus, this report only used those transects that coincided with our permanent transect markers. In assessing, the following data were collected: (1) percent cover of living coral (hard coral per life form and soft coral, e.g., in English et al. 1997); (2) percent cover of non-living substrate (e.g., rock, rubble, sand, silt, dead coral) and, (3) percent cover of other living substrate (e.g., seagrass, algae, sponges). We also noted indicator invertebrates (giant, lobsters, Triton shells, Crown of thorns starfish and others) the causes of reef damage where appropriate but reported separately. Substrate percent cover was computed per category using standard scientific and methods and presented graphically. Standard statistical tests were also used when appropriate. Only the surveys at the reef slope (11-13 m) are reported here and the coral rehabilitation surveys by the CCEF-SUIEMS-PROMOTE team are reported elsewhere.

Enrique Villanueva Municipality has two established marine sanctuaries (Fig.4.5.1). The SPR team only monitored one. Tulapos Marine Sanctuary was not included in this survey.

Reef Fish Relative Abundance and Biomass

Fish density, length and species were estimated using a 50 x 10 m visual census (FVC; n = 3 to 5) technique done by a single observer or two observers whose fish length estimates were calibrated except in 2017 during the Saving Philippine Reefs (SPR) surveys where four observers (AP Maypa, D Divinagracia, J Apurado and AT White) collected the fish data. Substrate transects were utilized for UVC (English et al. 1997). All fish species within the 500 m^2 sampling area were recorded. The abundance of large numbers of numerically dominant and visually obvious fish species were recorded using the Log4 abundance category developed by the Great Barrier Reef Marine Park Authority (GBRMPA in Russ and Alcala 1989). Fish relative abundance using density and biomass were computed using standard scientific methods and presented graphically. Standard statistical tests and data transformations were used when appropriate.

Results and Discussion

Substrate

Live hard coral cover percentage (LHC) in Binoongan Marine Sanctuary was poor in 2017, from the reef flat to slope (9.75 ± 12.37%) (Fig.4.5.1). High percentages of sand, rocks and rubble classified into "non-ling" substrate were also recorded. As previously mentioned, this MPA was severely damaged by typhoon Bopha (aka Pablo) in the year 2012. By 2015 a Crown-of-Thorns starfish

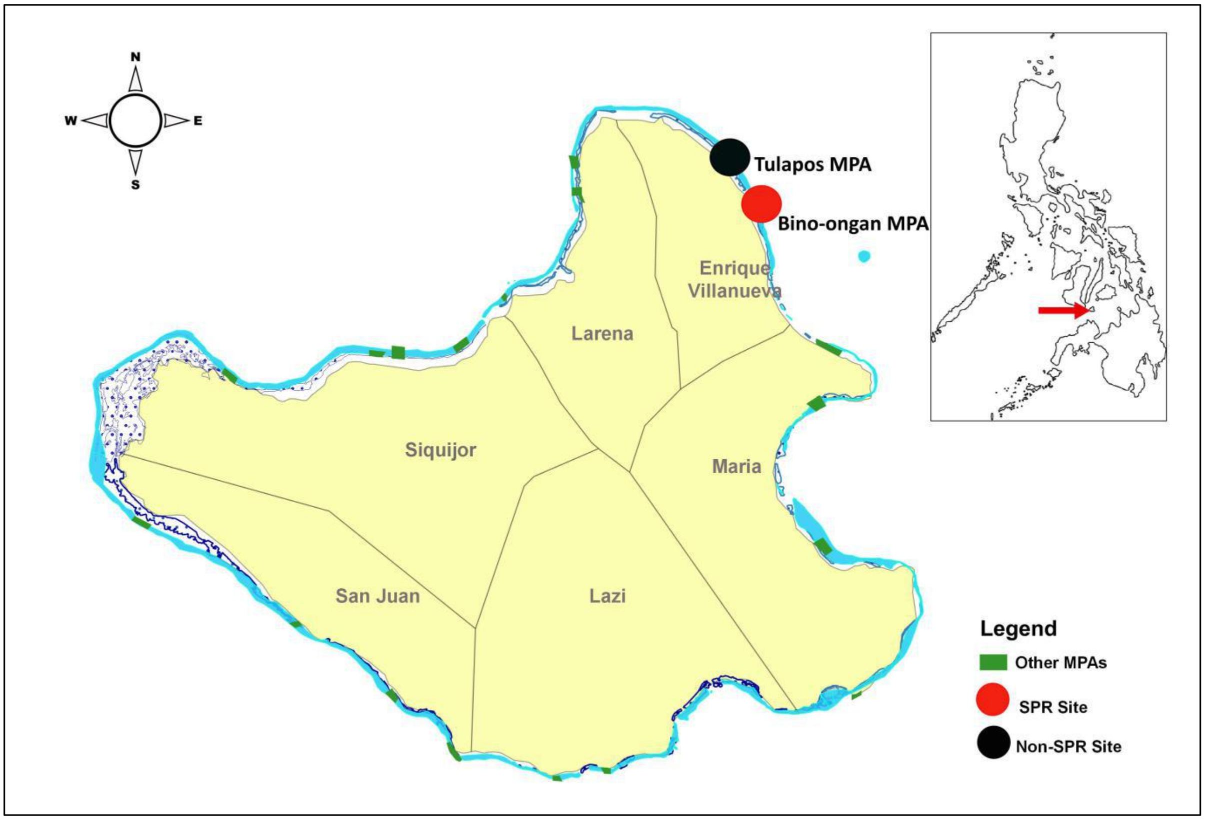

Figure 4.5.1. Map of Siquijor Island showing the two marine sanctuaries of Enrique Villanueva Municipality. Cartography by M. Baird.

infested many reefs in Siquijor Province including BMS, further causing more decline in the LHC. However, the reef complexity of BMS in the reef slope is still fairly high (rugosity index: 0.15 ± .09 in 2017) compared to other typhoon-damaged reefs in the area, due to the rocks and dead corals in the area. However, caution must be taken with what appears to be a declining LHC over time since it is already poor in condition. Regular monitoring of the LHC and benthic condition must be made in this MPA. Similarly, LHC in the adjacent fished reef is also poor (14.5 ± 4.24%).

Reef Fish

Density. Damsels, fairy basslets and small wrasses numerically dominate the "All reef fish" category in BMS. The density for this category in BMS is high when compared with other surveyed MPAs in Siquijor

Province, at 2,372.33 ± 1,10.29 fish/500 m^2 (Fig. 4.5.3). Further, target fish density is also high, at 335 ± 228.86 fish/500 m^2. Species of surgeonfish (*Acanthurus* spp.), unicorfish (*Naso* spp.) and snappers (*Macolor macularis, Lutjanus* spp.) dominate the density of commercially important fish at the reef slope. A fairly good density of rudderfishes, sweetlips and parrotfishes of different species were also recorded within our transects. In contrast, target fish density in the adjacent fished reef is low (56 ± 28.84 fish/500 m^2).

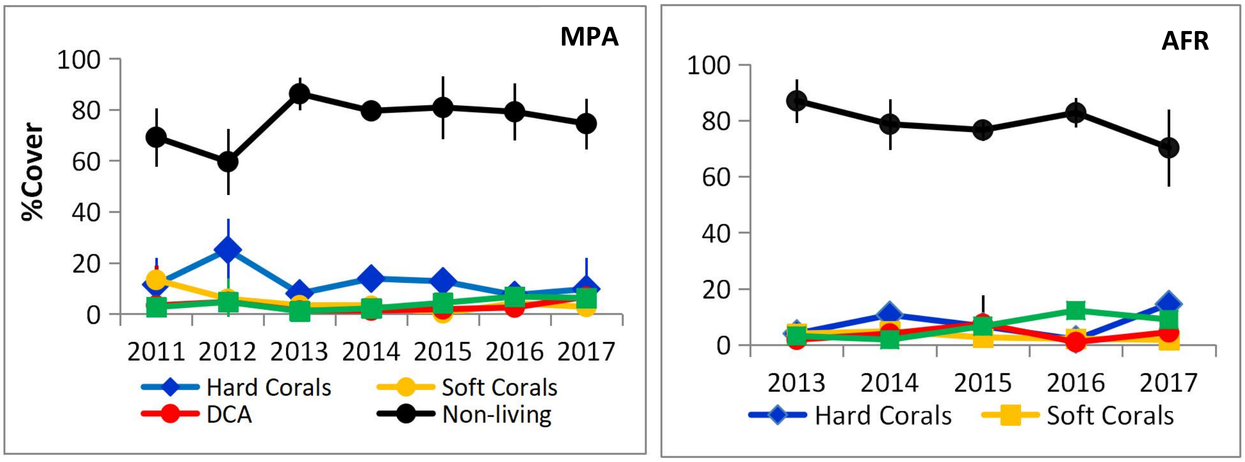

Figure 4.5.2. Substrate components (mean ± SD) and changes over the years in Biniingan Marine Sanctuary (MPA) and its adjacent fished reef (AFR; 10 - 13 m depth) in Enrique Villanueva, Siquijor Province.

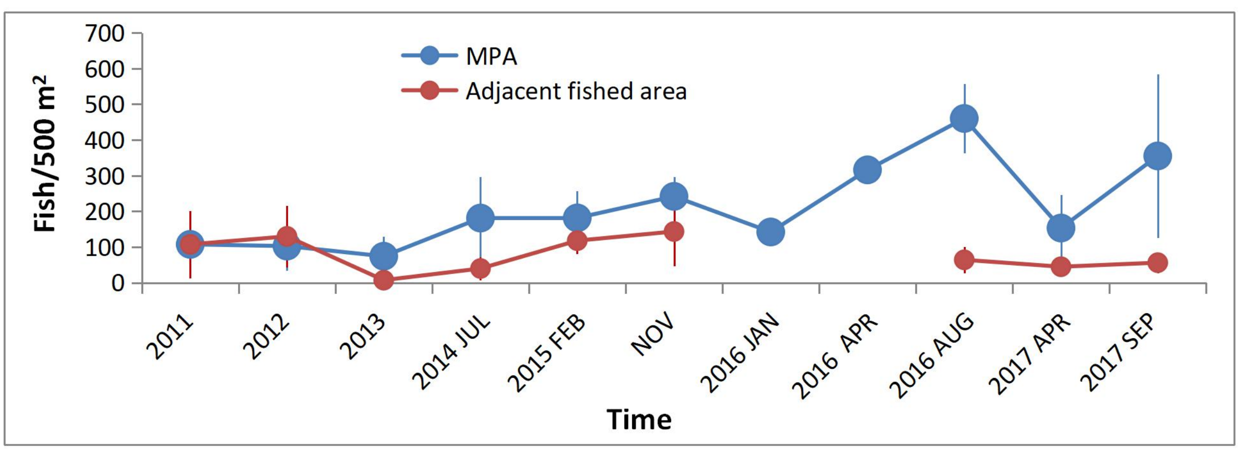

Figure Figure 4.5.3. Changes in target fish densities (mean ± SD) in Binoongan Marine Sanctuary and (MPA) adjacent fished area (AFR).

Biomass. The overall trend of the target fish biomass in BMS is increasing over time while the biomass in the adjacent fished area is declining. Biomass inside BMS in September 2017 was 86.67 ± 52.55 kg/500 m^2 while it was only 6.53 ± 5.29 kg/500m^2 in the adjacent fished reef (Fig. 4.5.4). In BMS, a significant increase from 2013 was observed by January 2016 (p = ≤ 0.001, F =5.57, DF = 13). The schools of *Acanthurus* spp., *Naso* spp. and *Macolor macularis* of different size classes (10 to > 30 cm) and the larger *Plectorhinchus* spp, *Lutjanus* spp., *Scarus* spp., *Chlorurus* spp. and *Kyphosus* spp. with sizes more than 30 to 40 cm. The lower density and biomass value (31. 86 ± 27.07 kg/500m^2) recorded in April 2017 during the SPR survey, was most likely due to the many divers disturbing the fish during the census.

Although the coral cover of BMS is very low, it has the highest target fish biomass among the 21 MPAs in Siquijor Province. This biomass is comparable to Apo Island Marine Sanctuary (Maypa et al. 2015), a MPA known for its strict protection. Similarly, BMS is also known for its strict protection and good leadership by its incumbent Barangay Captain. The involvement of the Binoongan youth sector in MPA activities and enforcement has been observed in this MPA.

Diversity. A total of 112 species of fish, which was the highest among the 8 sites surveyed. This also included 8 species of butterflyfish was listed BMS. Further, species richness was 64.33 ± 11.93 species/500 m^2, also the highest among the 8 sites. An even higher value (103.67 ± 17.62 species/500m^2) was recorded in August 2016 (Maypa and Baird 2016). In contrast, the BMS adjacent fished reef had the lowest total number of fish species listed (55 and one butterflyfish). Species richness was at 51.67 ± 5.51 species/500 m^2.

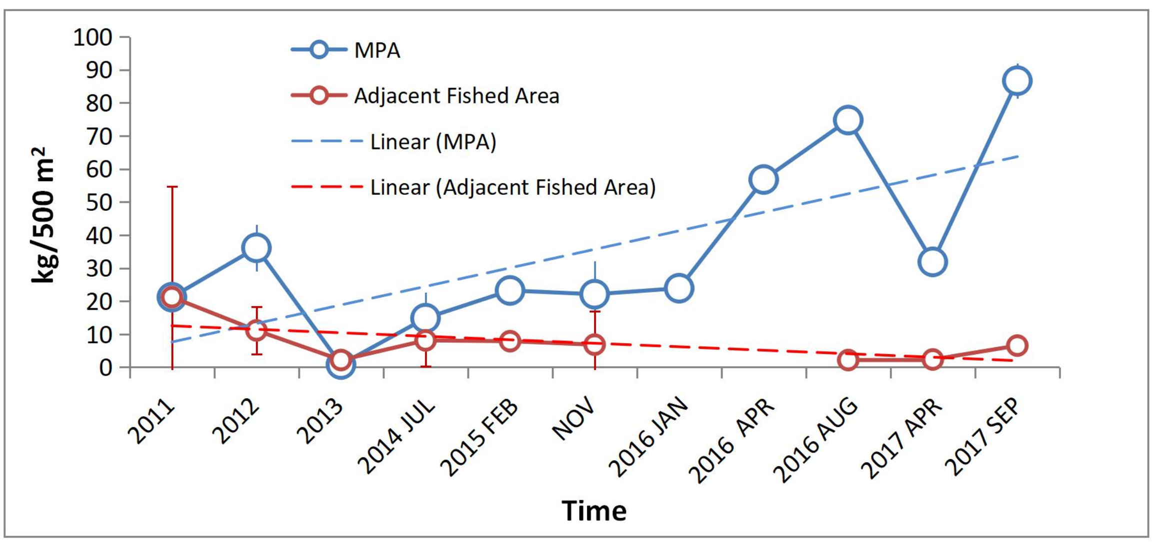

Figure Figure 4.5.4. Changes in biomass fish densities (mean ± SD) in Binoongan Marine Sanctuary and (MPA) adjacent fished area (AFR).

The improvement and recovery of reef fish stocks in BMS over time, through increase in density and biomass, despite coral reef damage from typhoons, is likely to be a function of strict enforcement, combined with ecological factors and life history traits of species/species groups in the MPA. It is predicted that species with life history traits that indicate high vulnerability will recover slower compared to species with life history traits having lower vulnerability (Abesamis et. Al. 2014). A direct relationship between body size and vulnerability (Cheung et al. 2005), and between trophic level and vulnerability (Pauly et al. 1998, Cheung et al. 2005) has been documented. Planktivores (*Acanthurus* spp. and *Naso* spp.) made up the bulk of the fish biomass in BMS which are known to have moderate vulnerability (Abesamis et al. 2014) compared to high vulnerability piscivorous species with larger body sizes such as *Caranx ignobilis, Plectropomus s*pp. or *Lutjanus rivulatus.* However, it is important to note that *Naso* spp. and *Acanthurus* spp. live longer than 30 years, thus, likely to be less productive than expected of their small body sizes (Choat and Robertson 2002). Further, recovery of fish stocks in MPAs is also dependent on the size of the remaining population prior to closure, i.e., the minimum viable population (Green et al. 2005, Abesamis et al. 2014).

Recommendations

Binoongan Marine Sanctuary is young in age and is still recovering from typhoon-damage. Yet this five year old MPA has achieved major MPA expectations, in fisheries benefits and conservation. The following are recommendations for management improvement:

1. Continue the strict enforcement, however, more support from the local government unit (LGU) is needed for the honorarium of the Bantay Dagats, especially for the night shift guards.
2. CCEF-SUSTAIN Project with the support of the UNICO Conservation Foundation just donated a 30-ft pumpboat to BMS for the purpose of ecotourism and MPA enforcement strengthening. Every year, reports of sightings of compressor fishers from Bohol have been reported in this MPA. On the other hand, ecotourism has been identified as one livelihood enterprise of the MPA management body and the Binoongan Women's Association (BWA). Recently, BWA has been earning from their cooking and catering ventures since their Basic Cooking Skills and Training in 2017 provided by CCEF-SUSTAIN Project, supported by UNICO Conservation Foundation. However, their ecotourism activities that involves the use of the pumpboat has not not started yet.
3. Community support in BMS has been observed as a function of good leadership. It will benefit BMS management and Binoongan Barangay to develop second liners and engage and empower more its youth sector in MPA management and in CRM in general.
4. Continue supporting the coral reef rehabilitation and reef fish recovery efforts in BMS to augment fish habitats and prevent reef fish stocks decline while the corals are recovering.
5. Continue MPA monitoring at least annually and closely monitor reef fish stocks recovery.
6. It is important that collaborative efforts among stakeholders be continued for MPA sustainability.

Acknowledgments

This is yet another contribution of the the SPR Project, CCEF and UNICO Conservation Foundation to MPA sustainability, coral reef conservation and food security in Siquijor Province. We thank all the institutions that supported the various projects of CCEF in Siquijor Province, which sustained the monitoring of MPAs over the years. Many thanks to PROMOTE and the continued partnership of Siquijor Province through the Office of the Provincial Agriculturist, the Province and its Municipality- and B-LGUs, especially the MAO of Enrique Villanueva (C. Hora) and Fisheries Technician (T. Maglinte), Mayor G. Paling and SB. Many thanks too to Brgy. Capt. M. Teblos-Legazpi and its Brgy. Council, to the Binoongan Marine Management Group (BMMG) and the newly formed Binoongan Women's Association (BWA). Special thanks to UNICO Conservation Foundation in Austrailia for its long-term support to CCEF projects, and to all the 2017 SPR volunteers from USA and Australia for their love and support to the reefs of Siquijor Province. The able management and coordination of the SPR Project is carried out by E.White.

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4.6 Macroinvertebrate Biodiversity Assessment in Siquijor Island, central Philippines

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Abstract

The biodiversity of macroinvertebrates in nine selected sites in Siquijor Island were assessed last April 22-30, 2017 as part of the Saving Philippines Reefs Expedition. The diversity and density of macroinvertebrates were surveyed using a 2 m x 20 m belt transect while the species list in each site included macroinvertebrates found outside the transects. A total of 117 species of macroinvertebrates were recorded from all sites (H_{max} = 4.76). The most specious phylum is Porifera with 32 species, followed by phylum Mollusca and Chordata with 27 and 20 species, respectively. Paliton Marine Sanctuary (PMS) has the highest diversity (*H'*= 3.43) and species richness (*R*= 62) while Cangbagsa Marine Sanctuary (CMS-L) has the lowest diversity (*H'*= 1.83), species richness (*R*= 26) and mean density (35.16 individuals/40m^2 SE ±0.68). The site with the highest mean density of macroinvertebrates was the adjacent fished reef of Nonoc Marine Sanctuary (density = 298.66 ± 1.69 individuals/40m^2). Several species of charismatic and commercially important macroinvertebrates were also documented from all sites.

Introduction

Coral reefs are complex and productive ecosystems that encompasses the highest functional diversity of any marine ecosystem and serve many ecological and economic functions (Dollar 1982, Crosby et al. 2002, Bremner et al. 2003, Arias-Gonzalez et al. 2011, Stella et al. 2011). However, coral reef ecosystems are subject to a high frequency of recurrent disturbances (Hughes and Connell 1999); these disturbances may be natural, anthropogenic or a combination of both. Climate change also poses a great threat to the coral reef ecosystem (Hoegh-Guldberg 2011).

Invertebrates account for a significant percentage of species found in coral reefs. According to Stella et al. (2011), there are at least 165,000 described species of invertebrates that are associated with coral reefs and many of these invertebrates live in close association with scleractinian corals, relying on corals for food, for a habitat, settlement cues, a substratum on which they graze on or a combination of all four. These organisms also serve several functions in the reef; they can be prey to larger organisms, predators, grazers and suspension feeders (Gili and Coma 1998, Nystrom et al. 2000, Stella et al. 2011). Unfortunately, the taxa that accounts for the greatest diversity in coral reefs have received the least attention from the scientific community. Majority of the studies on coral reef disturbances are focused on the more conspicuous organisms, like fishes, corals, charismatic organisms, and the commercially significant ones. Given the documented global threats, the rapid degradation of coral reef ecosystems and climate change, the data on coral reef invertebrates and the effects of coral degradation and climate change on these organisms are very little. According to Stella et al. (2011) to be able to fully assess the effects on reef biodiversity due to coral reef degradation, it is necessary to focus on the largest component of reef biodiversity - the invertebrates.

Siquijor Province experienced two consecutive typhoons, Sendong (Typhoon Washi) in 2011 and Pablo (tropical storm Bopha) in 2012, which severely damaged the coral reefs in the island. An assessment was conducted by the Coastal Conservation and Education Foundation (CCEF) last 2013 to assess the damage done by the typhoons in the reefs of Siquijor and result showed that live coral cover (LHC) in most of the marine protected areas significantly decreased and that the damage is estimated to be at 40-99% (Maypa et al. 2013). In 2015, CCEF and the Silliman University—Institute of Environmental and Marine Sciences (SU-IEMS) continued the survey and monitoring in 8 typhoon-damaged marine protected areas in Siquijor Province. Result showed that there was a total of 157 species of macroinvertebrates, 28 of which are commercially important or charismatic species, and the maximum diversity index for all the sites surveyed was 5.06. The speed and extent of recovery in coral reef varies depending on the extent of the damage, the frequency of the disturbances and the rate of recruitment (Dollar 1982, Hughes and Connell 1999, Gardner et al. 2005) and recovery can be observed in over a five-year period (Dollar 1982) or may take up to even more than 20 years (Coles et al. 2007).

As part of the annual Saving Philippine Reefs Expedition, 8 selected marine sanctuaries in Siquijor Province were surveyed last April 22-30, 2017. Macroinvertebrate surveys were done to determine the species composition, density and diversity of these organisms. The data from this survey can be used to update the existing data on the macroinvertebrates found in Siquijor and can be further used for the continuing conservation efforts of the island's marine biodiversity.

Methods

Survey

Survey was done using SCUBA at depths from 8-10m. Surveys were done using a 20 m x 2 m belt transects (n = 6 per site) modified from Hill and Wilkinson (2004). The survey area was 40 m^2 per replicate . Macroinvertebrates found outside the sampling area were also recorded and included in the overall species list of each site.

Macroinvertebrate species composition and density

Macroinvertebrates, except for the hard and soft corals, were identified on site and the number of individuals observed for each species was recorded. If on site identification was difficult, photographs and descriptions of the macroinvertebrates were taken. Books by Colin and Arneson (1995), Debelius (1998), Schoppe (2000), Coleman (2008), Humann and DeLoach (2010), and Gosliner et al. (2008) were used as an aid for identification and were verified using the World Register of Marine Species (www.marinespecies.org, 2015).

The density of macroinvertebrates (number of individuals/40m^2) in each site was taken. Macroinvertebrates found outside the belt transects were also recorded and included only in the species list.

Macroinvertebrate Diversity and Evenness

The diversity of macroinvertebrates was analyzed using the Shannon-Weiner Diversity Index (H'), with respect to the maximum diversity (H'_{max}) of the sites surveyed, and evenness (J') with the given formulas:

$$H' = -\Sigma p_i \ln p_i \qquad H'_{max} = \ln(S) \qquad J' = \frac{H'}{H'_{max}}$$

Where: p_i is the proportion of individuals belonging to species *I and S* is the total number of species

Results and Discussion

A total of 117 species of macroinvertebrates were recored from nine selected marine sanctuaries and one non-sanctuary (Annex 4.6.1). Phylum Porifera was the most specious phylum with 32 species, followed by Mollusca and Chordata with 27 and 20 species, respectively. PMS had the most number of macroinvertebrate species recorded (*R*= 62) while CMS-L had the least (*R*= 26). The site with the highest mean density of macroivertebrates was NMS - AFR with a mean density of 298.66 ± 1.69 individuals/40m^2 followed by MMS and PMS with 138 ± 0.61 individuals/40m^2) and 132.33 ± 0.39 individuals/40m^2, respectively.

TUBOD MARINE SANCTUARY (TMS), SAN JUAN MUNICIPALITY

A total of 52 species of macroinvertebrates noted from TMS. Phylum Porifera was the most specious with 22 species followed by Chordata and Echinodermata with 12 and 7 species, respectively. This site had a macroinvertebrate mean density of 104.33 ±0.43 individuals/40m^2. The top three most abundant species of macroinvertebrates in Tubod Marine Sanctuary were the sponges *Sigmadocia* sp. (13.16 ± 2.3.39 individuals/40m^2) and *Nara nematifera* (10.83 ± 2.15 individuals/40m^2) and the ascidian *Atrolium robustum* (11.33 ±0.5.54 individuals/40m^2) (Fig. 4.6.1). The abundance of filter and suspension feeders in this area can be attributed to the strong currents prevailing in the area. These species prefer areas with strong currents so as to maximize feeding. Tubod Marine Sanctuary had the second highest diversity index (*H'*= 3.12) with respect to the maximum diversity (H_{max}= 4.76) of all sites surveyed. The third highest evenness (*J'*= 0.79) was also in this MPA. Further, seven commercially important macroinvertebrates were noted. Two of which were the species of giant clams *Tridacna squamosa* and *T. crocea,* considered vulnerable under the IUCN red list of threatened species (Teitelbaum and Friedman 2008). Several species of charismatic macroinvertebrates were also recorded from this site: the nudibranchs *Chromodoris magnifica* and *C. quadricolor*, the anemones *Entacmaea quadricolor* and *Heteractis crispa* and the Christmas tree worms, *Spirobranchus giganteus*.

Figure 4.6.1. The top three most abundant species of macroinvertebrates in Tubod Marine Sanctuary; the sponge (a) *Sigmadocia* sp., the purple sponge (b) *Nara nematifera* and the ascidian (c) *Atrolium robustum.*
Photo by: Danielle Mark Fukuda

MAITE MARINE SANCTUARY (MMS), SAN JUAN MUNICIPALITY

A total of 48 species of macroivertebrates was listed in MMS. Majority of the macroinvertebrates found in this site belonged to phylum Porifera with 19 species. This site had the second highest mean density (138 ±0.61 individuals/40m^2) compared to the rest of the seven sites. Like Like TMS, sponges and ascidians were also the most abundant. The ascidian *Didemnum molle* had the highest density (21.6 ± 0.12.027 individuals/40m^2), followed by the sponges *Sigmadocia* sp. and *Phyllospongia* sp. with mean densities of 11.67 individuals/40m^2 (SE ±4.05) and 8.5 individuals/40m^2 (SE ±2.57), respectively. MMS had the third highest diversity index (*H'*= 3.1) and second highest evenness (*J'*= 0.8) compared to surveyed sites. The sponge *Astrosclera* sp.2 was only noted from this site (Fig. 4.6.2). Nine species of commercially important macroinvertebrates and 12 charismatic species were also recorded from this site.

Figure 4.6.2. The sponge *Astrosclera* sp.2, was noted only from Maite Marine Sanctuary.
Photo by: Danielle Mark Fukuda

PALITON MARINE SANCTUARY (PMS), SAN JUAN MUNICIPALITY

A total of 62 species of macroinvertebrates were recorded from PMS, making it this site with the highest species. Phylum Porifera was also the most specious phylum with 24 species followed by Chordata with 13 species. Two phyla, Echinodermata and Mollusca, had both nine species. PMS had a macroinvertebrate mean density of 132.33 ± 0.39 individuals/40m^2), making it the site with the third highest mean density. The top 3 most abundant macroinvertebrates were all ascidians; *D. molle* had a mean density of 15.67 ±7.70 individuals/40m^2, followed by *D. moseleyi* and *Clavelina robusta* with 13.83 individuals/40m^2 ± 6.93 and 10.17 individuals/40m^2 ± 5.41, respectively. Ascidians are aggressive coral competitors; they compete with corals in terms of space and these organisms makes use of allelopathic chemicals which makes them more abundant in an area. Only one possible predator of ascidians was noted from this site - the nudibranch *Chromodoris magnifica* and its density was very low. Species recorded from this site were the sponges *Dactylospongia* sp. and *Myrmekioderma* sp., the mollusks *Cypraea tigris* and *Thuridilla gracilis* and the ascidian *Eudistoma reginum.* PMS had the highest diversity index (*H'*= 3.43), with respect to the maximum diversity of all the sites, and the highest evenness (*J'*= 0.83). This site also has the most number of commercially important macroinvertebrates. Thirteen species of macroinvertebrates that are actively being collected for aquarium trade, for consumption or for shell collection are found in PMS. Figure 4.6.3 shows some commercially important macroinvertebrates.

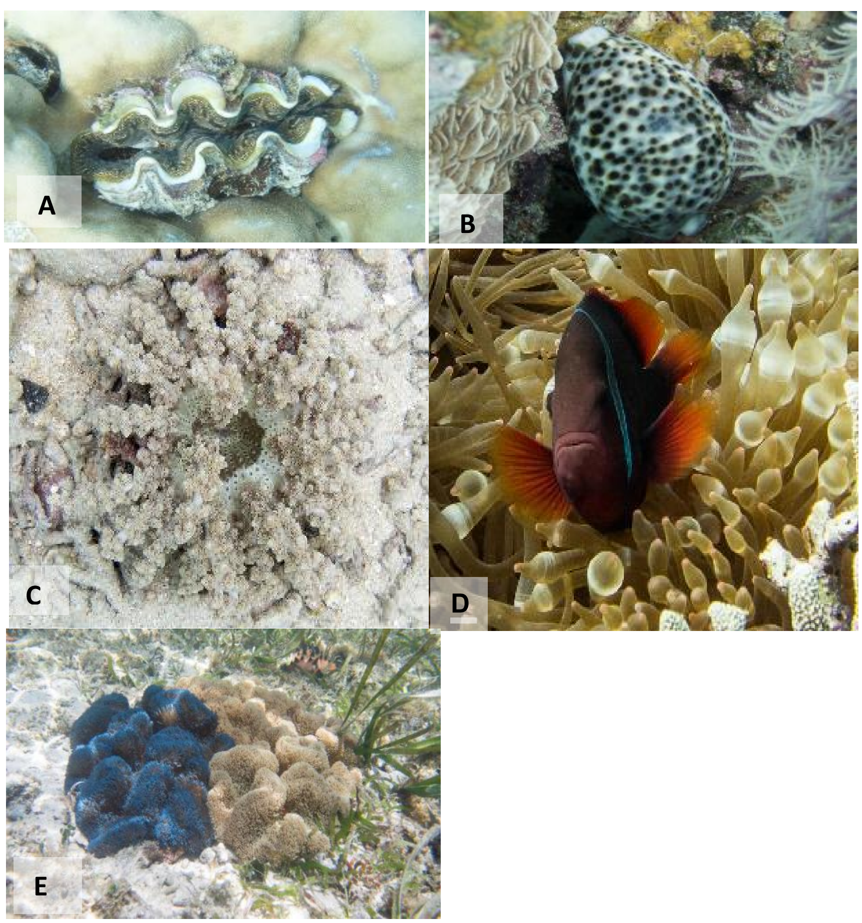

Figure 4.6.3. Macroinvertebrates with high commercial value found in Paliton Marine Sanctuary (PMS). (A) Giant clam, *Tridacna crocea,* (B) Tiger cowrie, *Cypraea tigris,* © Sea anemones, *Actinodendron* sp., (d) *Entacmaea quadricolor* and (e) *Stichodactyla gigantea* which are being collected for aquarium trade. Photos by: Danielle Mark Fukuda and Floramae Joyce Neri

CANGMUNAG MARINE SANCTUARY (CMS), SAN JUAN MUNICIPALITY

A total of 29 species of macroinvertebrates were noted from this site. Phylum Porifera and Chordata were most specious and with 9 species of macroinvertebrates recorded in each phylum, followed by Echinodermata with only 5 species. CMS had the second lowest macroinvertebrate mean density with only 64.83 ±0.79 individuals/40m^2. Suspension feeders were the most abundant organisms in this area dominated by *Sabellastarte* sp. (20 ±0.73 individuals/40m^2) followed by the ascidians *D. molle* (14 ± 3.88 individuals/40m^2) and *Polycarpa aurata* (6.5 ± 1.83individuals/40m^2). CMS had strong currents which could possibly explain the abundance of filter feeders. This site had a diversity index of 2.41 and an evenness of 0.72. The sponge *Haliclona* sp.2 and the ascidians *Clavelina moluccensis* and *Eudistoma* sp. were only noted from this site. The crab *Trapezia rufopunctata,* which was only found in two sites, are collected for aquarium trade and was also recorded here (Fig. 4.6.4). Only 4 species of commercially important macroinvertebrates were listed from this site.

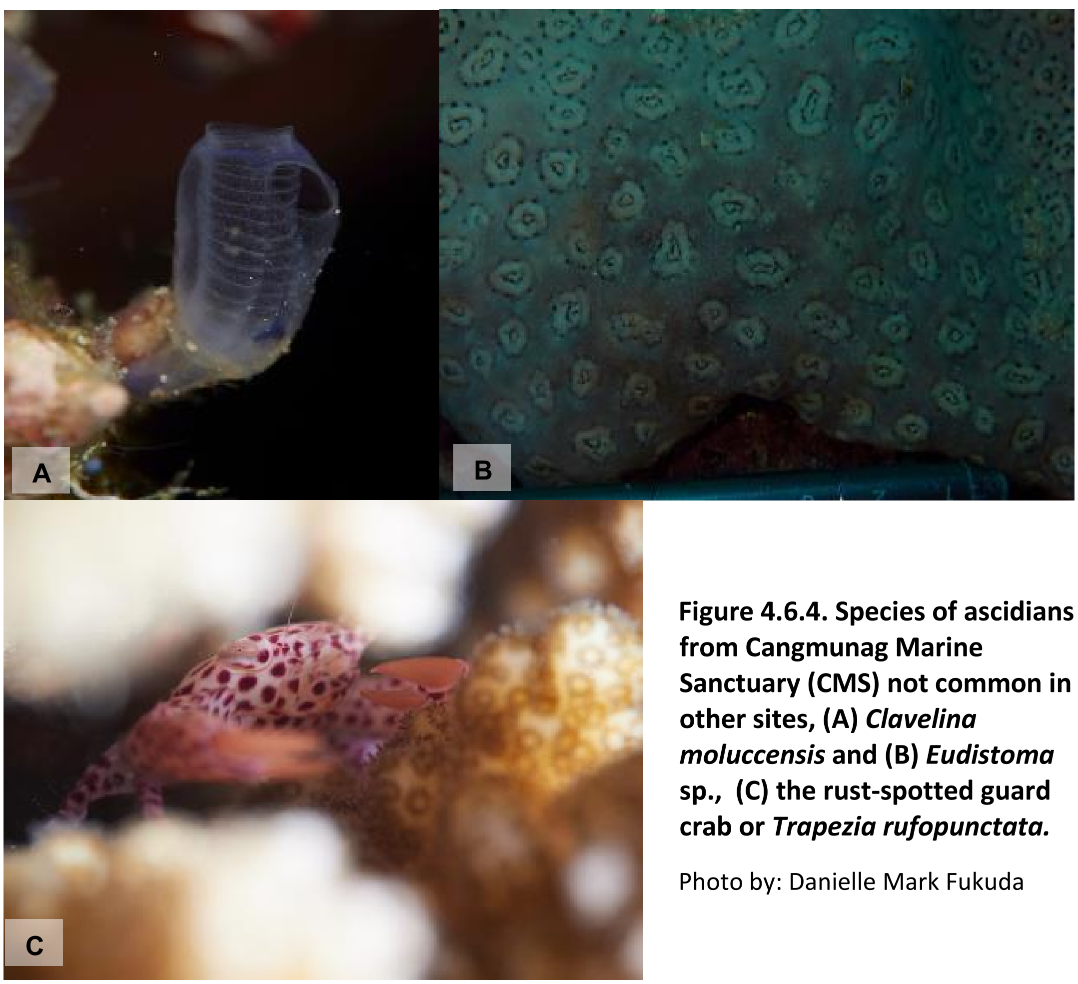

Figure 4.6.4. Species of ascidians from Cangmunag Marine Sanctuary (CMS) not common in other sites, (A) *Clavelina moluccensis* and (B) *Eudistoma* sp., (C) the rust-spotted guard crab or *Trapezia rufopunctata.*

Photo by: Danielle Mark Fukuda

CANGBAGSA MARINE SANCTUARY (CMS-L), LARENA MUNICIPALITY

Cangbagsa Marine Sanctuary had the lowest species richness (*R*= 26), macroinvertebrate mean density (35.16 ±0.0.68 individuals/40m^2), Shannon-Weiner diversity index (*H'*= 1.83) and evenness (*J'*= 0.56). Ten species of macroinvertebrates belonged to phylum Porifera, making it the most specious phylum in this site. The most abundant macroinvertebrates in this site were also filter or suspension feeders. The feather star *Comaster* sp. was the most abundant (17.61 ±3.59 individuals/40m^2), followed by another species of feather star *Comanthus* sp. (6.33 ±3.27 individuals/40m^2) and the feather duster worm *Sabellastarte* sp. (2.16 ±1.77 individuals/40m^2). The very low diversity of macroinvertebrates in this area can be explained by the dominance of only one species which was *Comaster* sp. Some comercially important species documented in this site were: the giant clam *T. squamosa,* which is one the most expensive species of giant clam (Junio et al., 1989) and also identified as an endangered species under RA 8850; the nudibranch *C. annae*, and three species of sea anemones namely, *E. quadricolor, H. aurora* and *S. gigantea.*

NONONC MARINE SANCTUARY - ADJACENT FISHED REEF (NMS-AFR), LARENA MUNICIPALITY

Fifty-eight species of macroinvertebrates were recorded from NMS and AFR, where 18 species were sponges making phylum Porifera the most specious phylum in this site. Phylum Mollusca and Chordata both has 11 species of macroinvertebrates belonging to those said phyla. This site has the highest mean macroinvertebrate density (298.66 individuals/40m^2 SE ± 1.68) of all the sites surveyed. The suspension-feeding macroinvertebrates *Sabellastarte* sp. (48 ± 1.22 individuals/40m^2), *Comaster* sp. (44.83 ± 6.89 individuals/40m^2) and *S. giganteus* (38 ± 2.90 individuals/40m^2) were the most abundant macroinvertebrates in the area. On the other hand, NMS and its AFR had a Shannon-Weiner diversity index of 2.55 and an evenness of 0.63. Like PMS, this site has the same number of commercially important macroinvertebrate species (*R*= 13) where majority of which were sea anemones and mollusks. Twelve charismatic species of macroinvertebrates were also noted.

NONOC MARINE SANCTUARY (NMS), LARENA MUNICIPALITY

Forty-four species of macroinvertebrates were noted inside NMS, which was lower compared to the species richness of NMS-AFR (*R*= 58). Phylum Porifera was still the most specious phylum in this site with 12 species, followed by phylum Chordata and Echinodermata with 9 and 8 species, respectively. The mean macroinvertebrate density in this site was 71.83 ± 0.60 individuals/40m^2. *Comanthus* sp. was the most abundant macroinvertebrate with a mean density of 21 ±7.07 individuals/40m^2), followed by *D. molle* (13.83 ± 4.04 individuals/40m^2) and *Comaster* sp. (11.16 ± 5.12 individuals/40m^2). Similar to NMS-AFR, the top 3 most abundant invertebrates were the suspension-feeding macroinvertebrates. NMS often has relatively strong currents which could explain the abundance of these organisms. Twelve species of commercially important macroinvertebrates were noted from this site and the most number of species of charismatic macroinvertebrates was also recorded here.

BINOONGAN MARINE SANCTUARY (BMS), ENRIQUE VILLANUEVA MUNICIPALITY

A total of 47 species of macroinvertebrates were noted from BMS. Phylum Porifera was also the most specious phylum, with 14 species, followed by phylum Mollusca and Echinodermata that both had 10 species. The mean density of macroinvertebrates was also lower in 2017 (143.5 ± 1.17) compared to 2015 (210.5 individuals/40m^2 ± 2.15). Suspension feeders were also the most abundant macroinvertebrates in this site. *Comaster* sp. dominated with a density of 44.16 ±13.21 individuals/40m^2), followed by *Comanthus* sp. and *D. molle* (23.83 ± 7.63 individuals/40m^2) and 23.16 ± 8.43 individuals/40m^2). Bino-ongan Marine Sanctuary has a Shannon-Weiner diversity index of 2.22 Only 9 species of commercially important macroinvertebrates were noted.

CATICUGAN MARINE SANCTUARY (CMS-Si), SIQUIJOR MUNICIPALITY

Thirty-six species of macroinvertebrates were recorded from CMS. Phylum Echinodermata was the most specious with 9 species, followed by Porifera with 8 and, Mollusca with 7. The mean macroinvertebrate density 51.5 ± 0.47 individuals/40m^2) in 2017. *D. molle* (12 individuals/40m^2 ± 6.56), *Comaster* sp. (12 ±2.54 individuals/40m^2) and *Comanthus* sp. (4.16 individuals/40m^2 SE ±2.38) were the top 3 most abundant macroinvertebrates species in Caticugan. The Shannon-Weiner diversity index of this site is *H'* of 2.49 while the eveness is 0.69. Nine species of commercially important macroinvertebrates and 10 species of charismatic macroinvertebrates were also recorded from this site.

Charismatic Species of Macroinvetrebrates

Charismatic species are organisms that have a popular appeal and are usually used to focus attention on conservation campaigns. These organisms are important in assessing biodiversity loss and extinction risk in the ocean since these organisms are the ones frequently studied by scientists (Ducarme et al., 2012). Marine megafauna are often the focus of scientific and conservation research with an average of 60 conservation-relevant papers written about these organisms (McClenachan et al., 2011). Invertebrates on the other hand, receive the least attention with an average of 0.1 conservation-relevant papers per species. A total of 29 species of charismatic invertebrates belonging to 5 different phyla were noted during the surveys. Majority of these charismatic invertebrates are also commercially important ones which are collected either for aquarium trade or for shell collections. A checklist for the commercially important macroinvertebrates noted during the surveys is provided in Annex 2.

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Annex 1. Macroinvertebrates species list from 9 sites surveyed in Siquijor Island, Philippines. (TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS= Paliton Marine Sanctuary; BMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary adjacent fished reef; NMS= Nonoc Marine Sanctuary Inside; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; x= present).

Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Porifera	*Acanthodoryx*	*fibrosa*	X	X	X		X	X	X		
	Aplysilla	sp.	X	X	X	X		X			
	Astrosclera	sp.	X		X			X	X	X	
	Astrosclera	sp. 2		X							
	Callyspongia	sp.	X	X	X	X		X			
	Carteriospongia	*contorta*	X	X							
	Chelnoaplysilla	sp.		X	X			X		X	
	Cinachyrella	sp.	X	X	X						
	Clathria	*mimma*		X	X	X					
	Clathria	sp.	X	X	X	X		X	X	X	X
	Clathria	sp. 2			X						
	Clathrina	*sp.*	X								
	Cribrochalina	sp.	X	X	X			X			
	Dactylospongia	sp.			X						

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Porifera	*Haliclona*	*koremella*	X								
	Haliclona	sp.				X	X		X		
	Haliclona	sp. 2					X				
	Ianthella	sp.	X	X	X						
	Leucetta	*chagosensis*	X	X	X			X	X	X	
	Liosina	*granularis*	X	X	X	X	X	X	X	X	X
Porifera	*Myrmekioderma*	sp.			X						
	Nara	*nematifera*	X	X	X			X			
	Pericharax	sp.	X	X	X		X	X	X	X	X
	Phyllospongia	*foliascens*	X	X	X	X	X	X			X
	Placortis	sp.	X	X	X	X	X	X	X		
	Pseudoceratina	sp.	X	X	X	X	X		X		X
	Sigmadocia	sp	X		X	X		X	X	X	
	Spechiospongia	*vagabunda*	X		X	X		X	X	X	

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
	Stylissa	*massa*	X								
	Stylissa	sp.				X		X			
Porifera	*Stylotella*	*aurantium*	X			X		X			X
	Theonella	sp		X	X	X	X	X		X	X
	Xestospongia	sp			X				X	X	X
Cnidaria	*Actinodendron*	sp.			X	X			X		
	Entacmaea	*quadricolor*	X	X	X	X	X	X		X	X
	Heteractis	*crispa*	X	X		X	X	X	X		X
	Heteractis	*magnifica*		X		X					X
	Hetractis	*aurora*						X	X	X	
	Stichodactyla	gigantea			X			X	X	X	
Annelida	*Bispira*	sp.						X			
	Sabellastarte	sp.	X	X	X	X	X	X	X	X	X
	Spirobranchus	*giganteus*	X	X	X			X	X		X

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Arthropoda	*Alpheus*	sp.				X					
	Alpheus	*bellus*									X
Arthropoda	*Ancyclomenes*	*venustus*		X				X			
	Dardanus	sp.	X	X	X	X	X	X		X	
	Stenopus	*hispidus*							X		
	Stichodactyla	*gigantea*									
	Thor	*amboinensis*						X	X		
	Trapezia	*rufopunctata*			X		X		X		
Mollusca	*Arca*	sp.				X	X				X
	Atrina	sp.		X	X	X		X			
	Chicoreus	sp.	X					X			
	Chromodoris	*magnifica*	X		X			X			
	Chromodoris	*annae*		X		X				X	
	Chromodoris	*strigata*									X

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
	Chromodoris	*quadricolor*	X								
	Conus	*capitaneus*				X					
	Conus	*leopardus*						X			
	Cypraea	*tigris*			X						
	Hyotis	*hyotisa*				X		X			
	Lambis	*scorpius*				X					
	Lambis	*chiagra*									X
	Lopha	*cristagali*				X					
Mollusca	*Pedum*	*spondyloideum*		X	X	X	X	X		X	X
	Phyllidiella	*pustulosa*							X		
	Phyllidiopsis	*annae*							X		
	Phyllodesmium	*briareum*			X			X			
	Pteria	sp.				X		X			
	Septifer	*bilocarius*							X		

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
	Serpulorbis	*grandis*	X	X	X	X	X	X	X	X	X
	Thuridilla	*gracilis*			X						
Mollusca	*Tridacna*	*crocea*	X	X	X		X	X			X
	Tridacna	*squamosa*	X	X					X	X	
	Tridacna	*maxima*							X		
Mollusca	*Trochus*	sp.			X	X					
	Turbo	sp.						X			X
	Acanthaster	*planci*						X	X		
	Comanthus	sp.	X	X	X	X	X	X	X	X	X
	Comaster	sp.	X	X	X	X	X	X	X	X	X
	Culcita	*novaeuguineae*				X					
	Diadema	*setosum*	X	X	X			X			
Echinodermata	*Echinaster*	*luzonicus*								X	X

Annex 1. Macroinvertebrates species list from 9 sites surveyed in Siquijor Island, Philippines. (TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS= Paliton Marine Sanctuary; BMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary adjacent fished reef; NMS= Nonoc Marine Sanctuary Inside; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; x= present).

Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Echinodermata	*Echinometra*	*matheii*			X	X	X				X
	Echinothrix	*diadema*			X			X			
	Echinothrix	*calamaris*						X			X
	Himerometra	*robustipinna*	X								
	Linckia	*laevigata*	X	X	X	X	X	X	X		X
	Mespilia	*globulus*			X				X		X
	Nardoa	*tuberculata*	X								
	Ophiothrix	sp.	X	X		X		X	X		
	Ophiothrix	*janularis*			X	X	X				
	Oxycomanthus	sp.		X		X			X		
	Oxycomathus	*benneti*								X	X
	Pearsonothuria	*graeffei*			X	X					X
	Synaptula	sp.				X			X		
	Synaptula	*maculata*									

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Chordata	*Aplidiopsis*	sp.	X	X	X			X			
	Ascidia	sp.	X								
	Atrolium	*robustum*	X	X	X	X	X	X	X		
	Bortylus	sp.			X				X		X
	Clavelina	*robusta*	X	X					X		
	Clavelina	*moluccensis*					X				
	Clavelina	*robusta*			X	X	X	X			
	Clavelina	sp.	X		X						
	Diadema	*setosum*									
	Didemnum	*gutatum*	X	X	X	X	X	X			
	Didemnum	*molle*	X	X	X	X	X	X	X	X	X
	Didemnum	*moseleyi*	X	X	X	X		X			
	Didemnum	sp.						X			
	Eudistoma	*reginum*			X						

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Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Chordata	*Eudistoma*	sp.					X				
	Herdmania	*mommus*	X	X	X	X	X	X	X		
	Leptoclenides	*reticulatus*	X	X	X			X			
	Polycarpa	*aurata*	X	X	X		X	X	X	X	X
	Rhophalaea	sp. 1	X	X	X		X	X	X	X	X
	Rhophalaea	sp. 2							X		X
	Sigillina	*signifera*							X	X	X

Annex 2. Checklist of charismatic macroinvertebrates from the 9 SPR survey sites in Siquijor Island, Philippines. **(TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS= Paliton Marine Sanctuary; BMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary Adjacent fished reef; NMS= Nonoc Marine Sanctuary Inside; CMS = Cangbagsa Marine Sanctuary; CMS= Caticugan Marine Sanctuary; x= present)**

Phylum	Genus	Species	Common Name	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Cnidaria	*Actinodendron*	sp.	Hellfire Anemone			X	X			X		
	Entacmaea	*quadricolor*	Bubble-tip Anemone	X	X	X	X	X	X		X	X
	Heteractis	*crispa*	Blue-tip Anemone	X	X		X	X	X	X		X
	Heteractis	*magnifica*	Magnificent Sea Anemone		X		X					X
	Hetractis	*aurora*	Beaded Sea Anemone						X	X	X	
	Stichodactyla	gigantea	Carpet Anemone			X			X	X	X	
Annelida	*Spirobranchus*	*giganteus*	Christmas Tree	X	X	X			X	X		X

			Worm									
Arthropoda	*Alpheus*	sp.	Snapping Shrimp/Goby Shrimp				X					
	Alpheus	*bellus*	Snapping Shrimp/Goby Shrimp									X
	Ancyclomenes	*venustus*	Graceful Anemone Shrimp		X				X			
	Stenopus	*hispidus*	Banded Coral Shrimp							X		
	Thor	*amboinensis*	Squat Shrimp						X	X		
	Trapezia	*rufopunctata*	Rust-Spotted Guard Crab			X		X		X		
Mollusca	*Chromodoris*	*magnifica*	Magnificent Chromodoris	X		X			X			
	Chromodoris	*annae*	Anna's		X		X				X	

		Chromodoris									
Chromodoris	*strigata*	Streaked Chromodoris									X
Chromodoris	*quadricolor*	-	X								
Cyprea	*tigris*	Tiger Cowrie			X						
Phyllidiella	*pustulosa*	Pimpled Phyllidiella							X		
Phyllidiopsis	*annae*	Anne's Phyllidiopsis							X		
Phyllodesmium	*briareum*	Yellow-Tipped Phylodesmium			X			X			
Thuridilla	*gracilis*	Orange-Edged Sapsucking Slug			X						
Tridacna	*crocea*	Burrowing Giant Clam	X	X	X		X	X			X

	Tridacna	*squamosa*	Fluted Giant Clam	X	X					X	X	
	Tridacna	*maxima*	Maxima Clam							X		
Echinodermata	*Comanthus*	sp.	Many-Armed Feather Star	X	X	X	X	X	X	X	X	X
	Comaster	sp.	Legless Feather Star	X	X	X	X	X	X	X	X	X
	Himerometra	*robustipinna*	Robust Feather Star	X								
	Oxycomanthus	*benneti*	Bennet's Feather Star		X		X			X	X	X

Annex 3. Mean macroinvertebrate density per site. **(TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS = Paliton Marine Sanctuary; BIMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary Adjacent fished reef; NMS= Nonoc Marine Sanctuary; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; BMS =Binoongan Marin Sanctuary; *= density <1; X= found outside of the transect)**

Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
Porifera	*Acanthodoryx*	*fibrosa*	*	1.33	*		X	*	*		
	Aplysilla	sp.	3.67	3.67	3	*		*			
	Astrosclera	*sp.*	*		*			2.5	*	*	
	Astrosclera	sp. 2		1							
	Callyspongia	sp.	*	1.83	1.67	*		*			
	Carteriospongia	*contorta*	*	*							
	Chelnoaplysilla	sp.		*	*			*		*	
	Cinachyrella	sp.	*	*	*						

Annex 3. Mean macroinvertebrate density per site. **(TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS = Paliton Marine Sanctuary; BIMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary Adjacent fished reef; NMS= Nonoc Marine Sanctuary; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; BMS =Binoongan Marin Sanctuary; *= density <1; X= found outside of the transect)**

Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
	Clathria	*mimma*		*	*	*					
	Clathria	*sp.*	*	*	1.33	*		X	*	*	1.33
	Clathria	sp. 2			1.67						
	Clathrina	*sp.*	*								
	Cribrochalina	sp.	*	2	1.67			*			
	Dactylospongia	sp.			*						
	Haliclona	*koremella*	1.67								
	Haliclona	sp.				2.333333	*		*		

Annex 3. Mean macroinvertebrate density per site. **(TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS = Paliton Marine Sanctuary; BIMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary Adjacent fished reef; NMS= Nonoc Marine Sanctuary; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; BMS =Binoongan Marin Sanctuary; *= density <1; X= found outside of the transect)**

Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
	Haliclona	sp. 2					2.17				
	Ianthella	sp.	*	*	*						
	Leucetta	*chagosensis*	*	*	1.5			*	*	*	
	Liosina	*granularis*	*	*	*	1.833333	*	*	*	X	*
	Myrmekioderma	sp.			2.33						
	Nara	*nematifera*	10.83	3	3.5			1.17			
	Pericharax	sp.	*	*	*		1.83	2	*	*	X
	Phyllospongia	*foliascens*	2.5	8.5	2.17	*	*	*			X

Annex 3. Mean macroinvertebrate density per site. **(TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS = Paliton Marine Sanctuary; BIMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary Adjacent fished reef; NMS= Nonoc Marine Sanctuary; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; BMS =Binoongan Marin Sanctuary; *= density <1; X= found outside of the transect)**

Phylum	**Genus**	**Species**	**TMS**	**MMS**	**PMS**	**BMS**	**CMS**	**NMS-AFR**	**NMS**	**CMS-L**	**CMS-Si**
	Placortis	*sp.*	1.5	3.83	2.67	1.67	*	1	*		
	Pseudoceratina	sp.	*	11.17	1.33	*	*		1.33		*
	Sigmadocia	sp	13.17		2.33	20		7.17	*	X	
	Spechiospongia	*vagabunda*	*		*	*		*	*	*	
	Stylissa	*massa*	1								
	Stylissa	sp.				X		*			
	Stylotella	*aurantium*	*			*		*			*
	Theonella	sp		*	*	*	*	1		*	*

Annex 3. Mean macroinvertebrate density per site. (TMS= Tubod Marine Sanctuary; MMS= Maite Marine Sanctuary; PMS = Paliton Marine Sanctuary; BIMS= Binoongan Marine Sanctuary; CMS= Cangmunag Marine Sanctuary; NMS-AFR= Nonoc Marine Sanctuary Adjacent fished reef; NMS= Nonoc Marine Sanctuary; CMS-L= Cangbagsa Marine Sanctuary; CMS-Si= Caticugan Marine Sanctuary; BMS =Binoongan Marin Sanctuary; *= density <1; X= found outside of the transect)

Phylum	Genus	Species	TMS	MMS	PMS	BMS	CMS	NMS-AFR	NMS	CMS-L	CMS-Si
	Xestospongia	sp			*				*	*	*

Annex 3, continued.

Phylum	Genus	Species	TUB	MAI	PAL	BIN	CAN	NON-O	NON-I	CNB	CAT
Cnidaria	*Entacmaea*	*Quadricolor*	*	*	*	*	*	*		X	*
	Heteractis	*crispa*	*	*		*	1.33	1.83	*		*
	Heteractis	*magnifica*		X		*					*
	Hetractis	*aurora*						*	*	*	
	Stichodactyla	gigantea			*			X	*	*	
Annelida	*Bispira*	sp.						8			
	Sabellastarte	*sp.*	1	4	*	1.33	20	48	1.67	2.17	1.17
	Spirobranchus	*giganteus*	1	5	1.67			38	*		5.33
Arthropoda	*Alpheus*	sp.				*					

	Alpheus	*bellus*									*
	Ancyclomenes	*venustus*		*				X			
	Dardanus	*sp.*	*	1	1.67	*	*	2.33		*	
	Stenopus	*hispidus*							*		
	Stichodactyla	*gigantea*									
	Thor	*amboinensis*						X	*		
	Trapezia	*rufopunctata*			*		*		X		
Mollusca	*Arca*	sp.				*	*				*
	Atrina	sp.		3.67	*	*		*			
	Chicoreus	*sp.*	*					*			
	Chromodoris	*magnifica*	*		*			*			

Chromodoris	*annae*		*		*				*	
Chromodoris	*strigata*									*
Chromodoris	*quadricolor*	*								
Conus	*capitaneus*				*					
Conus	*leopardus*						X			
Cyprea	*tigris*			*						
Hyotis	*hyotisa*				*		*			
Lambis	*scorpius*				X					
Lambis	*chiagra*									*
Lopha	*cristagali*				*					
Pedum	*spondyloideum*		1.17	2	1.33	1.17	3		*	*

	Phyllidiella	*pustulosa*							*		
	Phyllidiopsis	*annae*							*		
	Phyllodesmium	*briareum*			3.17			6			
	Pteria	sp.				1.33		*			
	Septifer	*bilocarius*							X		

Phylum	**Genus**	**Species**	**TUB**	**MAI**	**PAL**	**BIN**	**CAN**	**NON-O**	**NON-I**	**CNB**	**CAT**
	Serpulorbis	*grandis*	*	*	2	6.67	1	*	*	*	*
Mollusca	*Thuridilla*	*gracilis*			*						
	Tridacna	*crocea*	*	X	*		*	X			*

	Tridacna	*squamosa*	1.17	*					X	*	
	Tridacna	*maxima*							X		
	Trochus	sp.			*	X					
	Turbo	sp.						X			X
Echinodermata	*Acanthaster*	*planci*						*	*		
	Comanthus	sp.	5.5	7.5	4.67	23.83	*	7.67	21	6.33	4.17
	Comaster	*sp.*	3.67	6.33	5.67	44.17	*	44.83	11.17	17.67	12
	Culcita	*novaeuguineae*				*					
Echinodermata	Diadema	setosum	*	*	3.67			*			
	Echinaster	*luzonicus*								X	*
	Echinometra	*matheii*			*	X	*				*

	Echinothrix	*diadema*			*			*			
	Echinothrix	*calamaris*						*			X
	Himerometra	*robustipinna*	*								
	Linckia	*laevigata*	*	1.5	1.5	3	*	*	*		1.83
	Mespilia	*globulus*			*				*		*
	Nardoa	*tuberculata*	*								
	Ophiothrix	sp.	5	4.83		1.83		1.33	X		
Echinodermata	*Ophiothrix*	*janularis*			4.17	*	1.17				
	Oxycomanthus	sp.		1.17		*			4.83		
	Oxycomathus	*benneti*								1.83	*
	Pearsonothuria	*graeffei*			*	2.17					X

	Synaptula	sp.				X			*		
	Synaptula	*maculata*									
	Aplidiopsis	sp.	*	*	*			*			
	Ascidia	sp.	*								
Chordata	*Atrolium*	*robustum*	11.33	5.17	10	1.83	*	3.83	4		
	Bortylus	sp.			*				*		1.17
	Clavelina	*robusta*	8.33	7					X		
	Clavelina	*mollucensis*					*				
	Clavelina	*robusta*			10.17	X	3.67	7.5			
	Clavelina	sp.	6.5		1.67						
Chordata	*Diadema*	*setosum*									

	Didemnum	*gutatum*	*	*	*	X	*	*			
	Didemnum	*molle*	4	21.67	15.67	23.17	14	64.83	X	X	12
	Didemnum	*moseleyi*	5.83	4.83	13.83	X		25.50			
	Didemnum	sp.						1			
	Eudistoma	*reginum*			*						
	Eudistoma	sp.					1.33				
	Herdmania	*mommus*	*	*	1.33	*	*	*	*		
Chordata	*Leptoclenides*	*reticulatus*	*	*	*			1.67			
	Polycarpa	*aurata*	*	1.83	3.17		6.5	1.17	*	*	1.5
	Rhophalaea	sp. 1	4.17	16.5	7.33		2.33	6	3.83	1.17	2
	Rhophalaea	sp. 2							*		X
	Sigillina	*signifera*							2.33	1	2.5

ANNEX 4: Photos of Macroinvertebrates

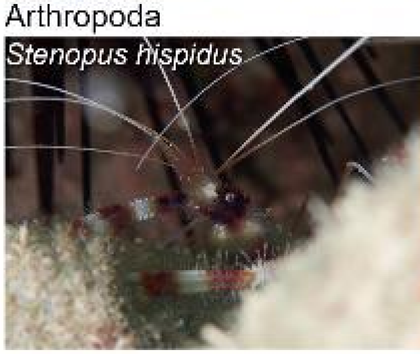
Porifera

ANNEX 5: Photos of Macroinvertebrates

Cnidaria

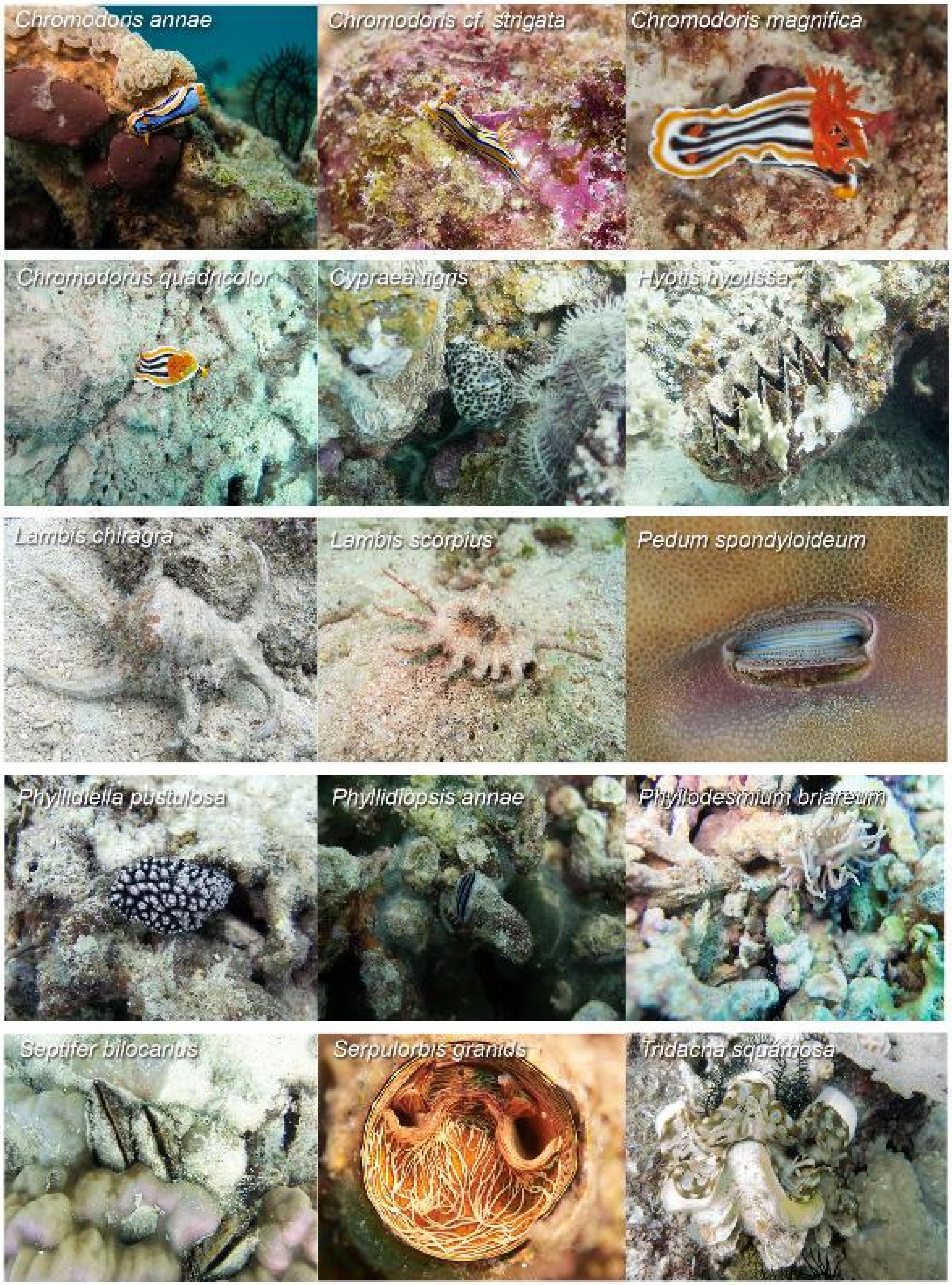
Annelida

Arthropoda



ANNEX 6: Photos of Macroinvertebrates

Mollusca



ANNEX 7: Photos of Macroinvertebrates

Echinodermata

ANNEX 8: Photos of Macroinvertebrates

Chorda

5.0 Expedition Photos: Winning photos

"Braveheart"
Best represents SPR 2017
Ae Sabonsolin

"Charlie and Star"
Animal and People
Mark Copley

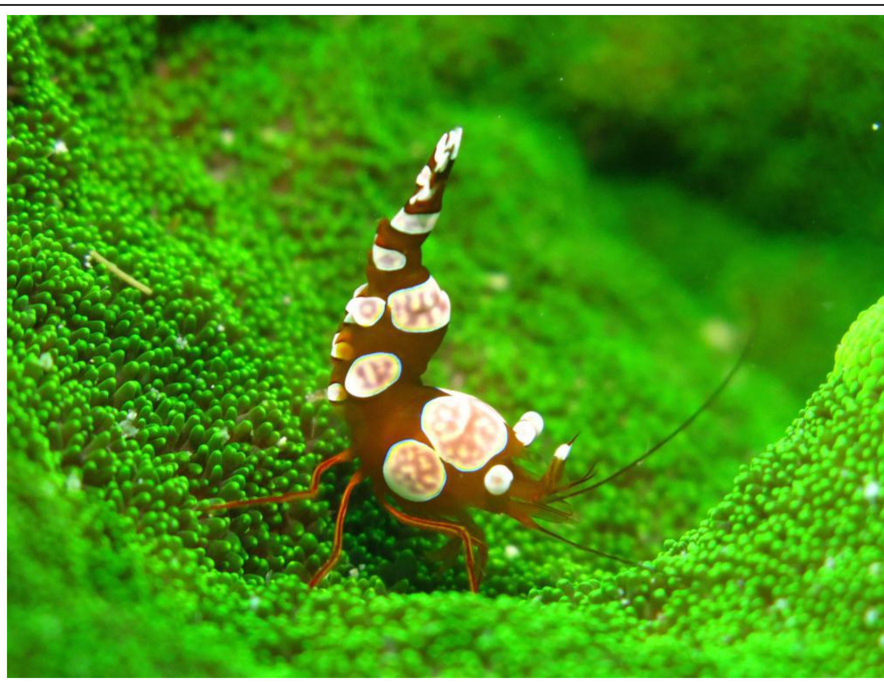
5.0 Expedition Photos: Winning photos, continued.

"Glass Shrimp"
Best in Macro
Ae Sabonsolin

"Pajamafishr"
Best fish
Michelle Baird

5.0 Expedition Photos: Winning photos, continued.

"Team work "
People
Laurent Boillon



"Toes in the Air"
Ae Sabonsolin

5.1 Expedition Photos: Coral planting in Olang Marine Sanctuary, Maria

(Photos by Laurent Boillion)

5.2 Expedition Photos: MPA Monitoring

(Photos by Laurent Boillion)

5.3 Expedition Photos: Day 1 “Getting to know you” SPR Volunteers with Siquijor Province, LGUs and AFP

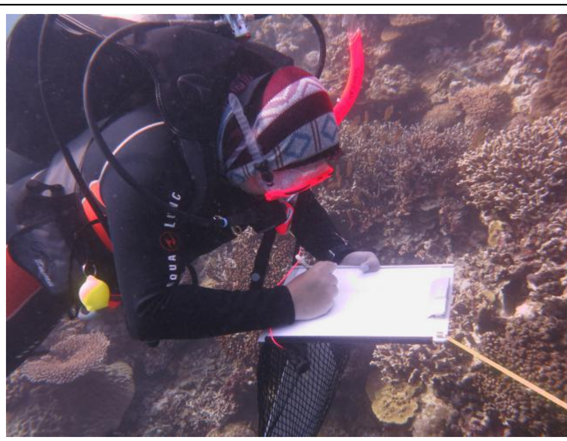
(Photos by: AP Maypa)

5.4 Expedition Photo: Day 3 - Work and Fun

(Photos by: AP Maypa)








5.5 Expedition Photo: Days 4-6


Ae Sabonsolin

SPR 2017 REPORT

CCEF
Sustainable coasts, involved communities.