ZAMBOANGUITA MPAs
June 2018 - August 2019

An evaluation of the Marine Protected Areas (MPAs) in Zamboanguita from June 2018 to August 2019. Assessing the health and climate change resilience of the ecosystems observed and providing management recommendations.
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GLOSSARY

**Biomass** - The total mass of organisms in a given area or volume, calculated via species-specific equations using observed body length.

**Coral Bleaching** - When corals are stressed by changes in environmental conditions, such as temperature, light, or nutrients they expel the symbiotic algae living in their tissues, causing them to turn completely white. The coral is still alive but is only receiving a small portion of the energy it needs to survive.

**Corallivore** - An organism that eats coral.

**Eutrophication** - when a body of water becomes overly enriched with minerals and nutrients, frequently due to runoff from the land, which induce excessive growth of algae. This process may result in oxygen depletion of the water body and death of animal life.

**Growth Form** - The shape in which a coral lays down its calcium carbonate skeleton.

**Marine Protected Area (MPA)** - A designated portion of the ocean where resource use is managed and/or restricted e.g. no fishing, no boats or no tourism.

**Resilience** - The ability of an organism to survive stress.

**Substrate** - The immobile, organic and inorganic substances covering the sea floor.

**Trophic Level** - The trophic level of an organism is the position it occupies in a food web. A food web is a succession of organisms that eat other organisms and may, in turn, be eaten themselves. Organisms with the same trophic level will have a similar diet and ecological role.
EXECUTIVE SUMMARY

- Following the regional trend, the average hard coral percentage cover of Zamboanguita’s MPAs is declining (graph 4). The main trigger of which appeared to be a coral bleaching event in September 2017 that made the municipality’s predominantly low resilience corals more vulnerable to algae overgrowth, disease and site-specific pressures, such as pollution at Maluay Malatapay MPA or the pier renovation adjacent to Lutoban Gac-ang MPA.

- The majority of coral bleaching events are triggered by increases in temperature caused by global climate change and greatly threaten the future existence of coral reefs. This highlights the importance of developing Integrated Coastal Management Plans (ICMP) following a Local Climate Change Action Plan (LCCAP) that aim to reduce carbon emissions and lessen the additional stressors to coral reef resilience e.g. coastal development, pollution and eutrophication.

- The ICMP for Zamboanguita’s MPAs should contain site-specific management plans to mitigate the local pressures faced by the different MPAs throughout the municipality.

- Use a holistic, “ridge to reef” management approach that considers the detrimental impacts of both coastal and upland development on the health of MPAs (e.g. everything from coastal construction to the dumping of waste into rivers).

- Average coral bleaching rates were higher in non-MPAs compared to MPAs, highlighting the importance of MPAs to increase reef resilience (graph 5).

- Despite declining coral cover, the average fish biomass in Zamboanguita’s MPAs is increasing (graph 10). This is mainly due to the observation of large schools of fish, which only visit specific sites (notably Basak Can-Unsang MPA) at certain times of the year. In order to continue to encourage the return of these migratory fish, it is extremely important to protect the deep reefs just inside MPA boundaries where they prefer to live.

- To increase fish biomass across all trophic levels, manage Zamboanguita’s MPAs as a network of MPAs between which large fish can migrate, reproduce and disperse larvae.

- MPAs should protect vitally important seagrass and mangrove ecosystems, as well as coral reefs, to protect all life stages of fish communities (e.g. juveniles in seagrass and mangroves).

- Despite a gradually increasing trend, Lutoban Gac-ang MPA had the lowest average commercial fish biomass of the region (graph 32), likely due to a high prevalence of fishing within MPA boundaries. This could be improved by increasing communications between community groups and the LGU and aligning various stakeholders’ MPA goals.

- Maluay Malatapay MPA had a gradually increasing and highly diverse fish biomass but the majority of fish remained small. Suitable fishing restrictions could help increase average fish size and associated reproductive output (e.g. by implementing individual fish size bans, gear restrictions or fishing seasons).
MCP’s ECOLOGICAL MONITORING METHODOLOGY

Stratified random sampling was practiced to ensure that there was no bias and that the data accurately represented the ecological status of the reef. 30 meter transect lines were randomly laid along continuous coral reef within defined depth ranges at all selected sites.

3 depth ranges were chosen due to observed differences in species diversity and population density between depths: shallow (3-7meters), medium (9-13meters) and deep (15-19meters).

Seasonal collection of the data was conducted to investigate the potential influences of local climate and winds. These seasons include:

- December, January and February
- March, April and May
- June, July and August
- September, October and November

At least 12 replicates were conducted per site, per season and for each ecological indicator group (invertebrates, substrate and fish) to accurately represent the ecosystems of interest. These replicates were used to create 1 representative average of the ecosystem per location and season.

> Substrate Methodology: point intercept method
- Substrate is recorded by identifying which substance is underneath each 25cm point along a 30 meter transect line.
- Analysis is focused on the substrate cover, growth form diversity, resilience profile and health of the ecosystem.

> Fish & Invertebrate Methodologies: belt transect method
- Fish and invertebrate surveys are performed by identifying, counting and sizing target fish and invertebrate species within the water column of 30 meter by 5 meter belt transects covering a total reef floor area of 150m².
- The list of fish and invertebrates recorded focusses on those species, which (through market surveys and local consultation) were identified as being commercially important.
- The ecologically important fish and invertebrate species were chosen using the IUCN standards, defining those species and functional groups, that play a role in reef resilience.
- When conducting fish surveys, surveyors leave the transect for 15 minutes before beginning each 10 minute survey to avoid disturbing the fish.

Zamboanguita monitoring sites include: Basak Can-unsang MPA, Lutoban Gac-ang MPA and Maluay Malatapay MPA¹, Población Dalakit MPA, Poblacion Guinsuan and Lutoban Cab-cab.

Additional monitoring sites in the region include: Salag MPA, Kookoos Nest, Antulang, Andulay MPA, Turtle Heaven, Masaplod Norte MPA, Poblacion Dauin MPA.

¹Maluay Malatapay was declared an MPA after Mar-May 2018 so is only included in the MPA trend from June 2018-present.
Figure 1. Underwater photographs of MCP divers conducting biophysical monitoring.
1. ZAMBOANGUITA MPAs - AVERAGE TRENDS

1) Substrate cover and resilience of MPAs

a. Overall substrate composition

With an average hard coral cover of **25%** from June 2018 to August 2019, the reefs of Zamboanguita's MPAs have less hard coral cover than the regional MPA average (30%) and the non-MPA average (28%) (graph 1 & 2). This is likely caused by the marine ecology of the municipality’s MPAs as they are all positioned close to river mouths that can provide an influx of silt and nutrients, which smother corals and allow algae to grow.

**Graph 1.** Average substrate composition of the reef across the region’s MPAs (left) and non-MPAs (right) from June 2018 to August 2019.

**Graph 2.** Average substrate composition of the reef across Zamboanguita’s MPAs from June 2018 to August 2019.
b. Hard coral cover and its growth form composition

The hard corals of Zamboanguita’s MPAs are dominated by an average of 64% low resilience growth forms such as branches & bushes (Branching, Digitate, Corymbose, Table) or plates & layers (foliose, laminar) (figure 2 and graph 3). They account for an average of 18% of the total reef composition. These types of hard corals are fast growing and provide natural shelter for many organisms on the reef. Juvenile species use branching corals as nursery grounds, while bigger, predatory fish like to rest under table corals. Due to their thin skeleton they are easily broken and vulnerable to storms and damage. These low resilience growth forms are likely to have a higher survival rate inside MPAs versus non-MPAs because they are protected from the daily impacts of boats and fishing activities. This also explains a high prevalence of medium resilience corals in the region’s non-MPAs (42%) because these are more resistant than the low resilience corals to damage (graph 3).
Low resilience corals spend most of their energy building and expanding their colony quickly, which means they are easily stressed by external pressures such as changes in temperature or water chemistry and are susceptible to disease and climate change. To keep the natural balance of the reef and leave space for slower growing corals, the biggest category of low resilience corals (branching) are natural prey for many types of coral predators (corallivores). This means the reefs of Zamboanguita's MPAs are vulnerable to various threats.

The hard corals of Zamboanguita’s MPAs are composed on average of 28% medium resilience growth forms (8% of total reef composition) and a minority of high resilience growth forms including massive and solitary (accounting for only 8% of reef composition) (graph 3). The latter are key to ecosystem recovery and development as they can survive more damage than the other categories.

Following the regional trend, the hard coral cover of Zamboanguita's MPAs declined from 34% in September 2017 to 24% in November 2018 (graph 4). This dramatic loss was likely due to the abnormally high water temperatures (~32°C) observed in summer 2017 caused by global climate change. MPAs in the region showed less of a decline in hard coral cover than non protected areas, suggesting that the minimisation of local pressures (such as fishing and boating activities) increased the reef’s resilience against more global stressors (e.g. climate change) (graph 4). Since 2019, hard coral cover appears to have stopped declining across Zamboanguita’s MPAs and regional MPAs (graph 4).

Graph 3. Average composition of hard coral growth forms classified by resilience across regional MPAs, regional non-MPAs and Zamboanguita’s MPAs from June 2018 to August 2019.
c. Reef health and resilience

Graph 5, depicting the health of observed hard corals, shows that non-MPAs in the region had a higher percentage of coral bleaching (4.7%) than MPAs (3%). This suggests that corals at protected sites are more resilient to bleaching than those at non-protected sites. The hard coral health of Zamboanguita’s MPAs fluctuates seasonally but maintained a healthier average than the regional MPA and non-MPA averages (graph 6), also suggesting a certain resilience to bleaching, disease, predation and infestation.

Graph 5. Average hard coral health % composition across regional MPAs, regional non-MPAs and Zamboanguita’s MPAs from June 2018 to August 2019.

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The high water temperatures of summer 2017 triggered a bleaching event affecting an average of 7% to 8% of hard corals at all survey sites in September 2017 (graph 7). This bleaching reduced again in colder months across all survey sites but showed a larger reduction at protected sites (back to 2%) as opposed to non protected sites (back to 4%) (graph 7). This indicates that MPAs were able to recover more quickly than non-MPAs. A second bleaching event occurred in June 2018 but Zamboanguita’s MPAs (3% bleaching) did not bleach as much as non protected sites (7% bleaching) (graph 7). Average bleaching at all survey sites is now less than 2% (graph 7).

The bleaching event of summer 2017, weakened the recovering hard corals of Zamboanguita’s MPAs leaving them vulnerable to disease. The average rate of disease increased from 0% in September 2017 to 3% in March 2018 (graph 8). Throughout the seasons, as average coral bleaching decreases, average disease increases (graph 8).
Zamboanguita’s MPAs showed an average decrease in hard coral cover from 34% in September 2017 to 24% in November 2018 and an increase in algae cover from 19% to 23% over the same time period (graph 9). After this partial coral to algae phase-shift, average rubble increased from 5% in June 2018 to 18% in August 2019 and silt decreased from 12% to 2% (graph 9).

A loss in hard coral cover and an inverted trend of increasing algal cover is occurring across the region. This phenomenon could be related to the general stress of a globally warming climate but more locally could be caused by coastal activities affecting water quality: algae thrive on carbon, oxygen, phosphorous and nitrogen. The latter two are found in high amounts in nutrient run off from agriculture and sewage, which cause algal blooms. It could also be a classic indicator of overfishing (a removal of top predators, which allows smaller predators to increase in population and eat the herbivores that would normally graze the algae from the reef).
This shift in ecosystem is currently happening faster in the MPAs of Zamboanguita than the rest of the region (graph 4). Understanding the cause requires analysis per MPA as it varies greatly per site. For example, the recently protected area Maluay Malatapay MPA is the most affected by this trend and is likely explained by a cumulation of large pressures affecting the reef e.g. high volumes of boating activity, trash and pollution, in addition to the more general pressures of overfishing and climate change.

If algae continues to increase, it will compete with corals for space, smother them and accelerate loss in coral cover. An algae dominated ecosystem should be avoided through proper marine resource management because algae are significantly less biodiverse organisms than corals and support less diversity in fish and invertebrate life. A phase shift from hard corals to algae will mean lower climate change resilience for the ecosystem and its dependent local communities because significantly less commercial value will be generated by the algal community. In order to avoid this phase shift, it is essential to ensure that herbivorous fish and top predators are well protected and thriving inside MPAs. As juveniles, herbivorous fish often use mangroves and seagrass beds as nursery grounds, before moving on to graze algae from the shallow reefs still rich in seagrass. Once they are large enough they then graze the deeper part of the reef. It is therefore extremely important to protect mangrove forests and seagrass beds in the shallow habitats within MPAs and ensure they are well known and respected.

2) Commercial productivity - Fish Biomass

From June 2018 to August 2019, regional MPAs produced an average of 20.1kg of commercial fish biomass per 150m² of coral reef, whereas regional non-MPAs only produced an average of 8.7kg (graph 10). Following the regional MPA trend, Zamboanguita’s MPAs produced an average of 20kg (graph 10), which is significantly higher than the regional non-MPA trend. Average fish biomass within Zamboanguita’s MPAs is currently increasing (graph 10). Peaks in commercial fish biomass within Zamboanguita’s MPAs occurred in September-November 2018 and June-August 2019 when they reached an all time high of 31.9kg. These peaks were caused by large schools of fish, which only visit specific sites (notably Basak Can-Unsang MPA) at certain times of the year,
likely for breeding purposes. The region’s non MPAs did not exhibit as much seasonal variation, likely because fishing is a fairly constant pressure and removes any seasonal, large schools of fish. Fishing seasons during calmer weather periods could also be contributing to seasonal declines in commercial fish biomass.

The type of fish present in MPAs, their populations and sizes are affected by many criteria and fluctuate seasonally. These variations are caused by ecological criteria (e.g. fish behaviour, breeding seasons, food availability, water temperatures, currents, etc.) but are also influenced by external factors such as surrounding fishing pressure, climate change or other anthropogenic threats. Despite the protection offered by MPAs, fish stocks inside the area will always be affected by nearby environmental conditions and pressures. The size and type of MPA and whether it protects suitable environments for all stages of the fish life cycle (such as mangroves and seagrass beds for juvenile fish nursery grounds) will influence movements in and out of the MPAs and the impact fishing pressure has on the MPA.

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**Zamboanguita’s MPAs are very different from each other in terms of reef ecology** (and therefore type of fish present) but also in their pressures and allocated resources. Graph 11 shows the high variation in fish biomass observed across Lutoban Gac-ang MPA (average 5.7kg fish biomass from June 2018 to August 2019), Maluay Malatapay MPA (12.1kg) and Basak Can-unsang MPA (41kg). **It is clear that Basak Can-unsang MPA is the main cause of the high biomass of Zamboanguita’s MPAs** seen in graph 10.

In order to fully understand the effectiveness of Zamboanguita’s MPAs, each site must be analysed individually. The high average fish biomass observed at Basak Can-unsang MPA does not necessarily mean that the rest of Zamboanguita's MPAs are struggling to produce fish. Site specific analysis suggests that the other MPAs just lack the larger, sexually mature fish or species that tend to school in large numbers. By understanding what is happening ecologically within each MPA, and
combining this with information about each MPAs threats and strengths, more specific management strategies can be developed to achieve the desired local fisheries goals of each MPA.

3) Management Recommendations

- Develop a Coastal Resource Management Plan for Zamboanguita’s MPAs that contains **site-specific management plans** to mitigate the local pressures faced by the different MPAs throughout the municipality.
- Ensure these site-specific management plans also consider the different **community goals** of each MPA (e.g. which types of fish would fishers like to see overspilling into the MPA’s surrounding waters and how do they catch them?).
- Maintain regular, **open communications with all barangay councils and fisherfolk associations** to address MPA-specific challenges.
- Use a holistic, **“ridge to reef” management approach** that considers the detrimental impacts of both coastal and upland development on the health of MPAs (e.g. everything from coastal construction to the dumping of waste into rivers).
- Ensure that **MPAs protect vitally important seagrass and mangrove ecosystems**, as well as coral reefs to protect ecosystem connectivity.
- Consider forming **inter-LGU (Local Government Unit) management alliances** with neighbouring municipalities to improve the management of MPAs in the region and strengthen the connectivity (e.g. via larval dispersal) between them by sharing MPA management successes and challenges.
- Ensure annual budgets prioritise funds for effective, continual **MPA demarcation**, effective **training, resources and wages for bantay dagat**, and community **Information Education Campaigns (IECs)**.
4) Photos

**Photo 1.** Gorgonian soft corals inside Basak Canunsang MPA.

**Photo 2.** Snappers swimming inside Basak Canunsang MPA.

**Photo 3.** Soft and hard corals inside Basak Canunsang MPA.

**Photo 4.** Snappers, sweetlips and small reef fish swimming above tyres outside Dalakit MPA.

**Photo 5.** Small reef fish swimming above a table coral outside of Lutoban Gac-ang MPA.

**Photo 6.** A school of fusiliers swimming over soft corals outside of Lutoban Gac-ang MPA.
2. BASAK CAN-UNSAN G MPA

1) MPA Description

Size: Basak Can-unsang South (8 hectares)
      Basak Can-unsang North (5 hectares)

MPA type: Combination of coral reef, wide sand patches and seagrass beds.
          Prone to mild-strong current, generally travelling North to South.
          Large river mouth, south of the MPA (Guinsuan river).
          River prone to flooding its banks and eroding the lowland banks.

Coral reef type: Patchy reef with 2 dense areas on southern part of the MPA.
                Dense medium / deep reef from 9 to 17 meters deep, 70 meters wide:
                • Mainly composed of hard corals, sponges and cnidarians.
                Dense shallow reef from 1 to 4 meters deep:
                • Mainly composed of soft corals, hard corals and seagrass.

Demarcation (from divers observations):
          Always recorded over the last year and bantay dagat generally on sight.

MCP monitoring: Reefs of Basak Can-unsang South for substrate, fish and invertebrates.

2) Substrate Composition and Resilience of the MPA

a) Substrate Composition

Graph 12. Average substrate composition of the total reef (left) and reef per depth range (right) at Basak Can-unsang MPA from June 2018 to August 2019.
Basak Can-unsang MPA has the lowest hard coral cover (22% average) of Zamboanguita’s MPAs (25% average) and the entire region (30% average). This is because Basak’s reefs are surrounded by seagrass and have naturally frequent patches of sand. Even the densest part of the coral reef (which is where monitoring is focussed) includes more sand than at other survey sites (22% average sand in Basak vs 13% average sand in Zamboanguita’s MPAs and 11% in average in regional MPAs).

This low coral cover is likely to be associated with the reef’s close proximity to a large river mouth. The river's frequent input of freshwater and sediment affects the survival rate of corals. Corals are sensitive marine animals that need clear water conditions and relatively stable environments. They host symbiotic algae called zooxanthellae, which photosynthesise to produce energy and provide the coral with most of its energy. Efficient photosynthesis requires clear water with a lack of sediment. Reefs near rivers are likely to grow and respond to changes much more slowly than areas with clearer water. The mild-strong currents at Basak help to minimise this threat by washing away some of the river’s input south of the MPA.

Algae percentage cover is higher in the shallows than at other depths, likely because there is more sunlight for growth (graph 12). This additional growth in the shallows allows the algae to compete with hard corals for light and space.

b) Hard Coral Cover, Reef Health and Resilience

Graph 13. Average hard coral cover across the region’s MPAs (pink), the region’s non-MPAs (black) and Basak Can-unsang MPA (green) from September 2017 to August 2019. Highlighted averages are from June 2018 to August 2019. Error bars represent standard error from the mean average.

Basak has been the most affected by the regional trend of decreasing average hard coral cover since 2017, with a drop from 32% in September 2017 to 19% in November 2018 (graph 13). This is likely linked to the region’s bleaching events in September 2017 and June 2018 (graph 7). In June 2018, Basak’s corals showed higher percentages of bleaching than the rest of the region’s reefs (graph 14). These bleaching events were always temporary but caused long term reductions in hard coral cover, particularly those corals of low resilience growth forms, which are more vulnerable to environmental changes (graph 15). Basak’s hard corals are composed on
average of 68% low resilience growth forms, 27% medium resilience and 5% of high resilience growth forms, so a reduction in low resilience growth forms affects the majority of the reef.

Graph 14. Average bleached hard coral % cover across Basak Can-unsang MPA (green), regional MPAs (pink) and regional non-MPAs (black) from September 2017 to August 2019.

Graph 15. Average hard coral cover of low resilience corals (purple), medium resilience corals (yellow) and high resilience corals (red) at Basak Can-unsang MPA from September 2017 to August 2019.
The June 2018 bleaching event also weakened the corals, making them more susceptible to disease, infestation and predation in September 2018 (graph 16). All of these pressures combined could be why the average percentage cover of rubble has been increasing over the last year (June 2018 to August 2019) (graph 17). Algae cover also increased to 41% in March 2018, higher than the maximum hard coral cover for the entire survey period (graph 17). This can sometimes be caused by an increase in small carnivorous fish (big reef fish) populations, which increase the predation of herbivorous (algae grazing) fish but the increases shown in graph 20 would not explain such a dramatic increase in algae. There could be an external influence causing an increase in algae cover, such as an influx of nutrients to the water. Algae growth reduced again to an average of 15% in June-August 2019 (graph 17).

Graph 16. Average hard coral cover classified as “pressured” including bleached (red), diseased (yellow), recently killed (black), infested (pink) and predated (purple) across Basak Can-unsang MPA from September 2017 to August 2019.

Graph 17. Average substrate percentage cover of hard coral (pink dotted), algae (green), rubble (purple) and silt (black) across Basak Can-unsang MPA from September 2017 to August 2019.
3) MPA Commercial Productivity

a) Fish Biomass

Commercial fish biomass at Basak MPA increased by +720% from June 2018 to August 2019, producing an average of 41kg per 150m² of coral reef (graph 18). This made it the entire region’s and Zamboanguita’s most effective MPA in terms of fish biomass productivity. This is most likely due to the successful management efforts of this MPA over recent years, including its effective demarcation, efficient enforcement strategy and strong community engagement. Strong currents at Basak also bring plankton-rich water to the reef, which attracts filter feeders and schooling fish that contribute to a very well connected food web.

b. Fish Composition

The composition of the average fish biomass at Basak MPA from June 2018 to August 2019 can be divided into four main groups, depending upon their diet (silvery fish/top predators, plankton feeders, big reef fish and small preyed fish) (graph 19). From June 2018 to August 2019, Basak MPA followed the expected trend of a healthy ecosystem by containing a high biomass of top predators (average 13.2kg / 32%) (graph 19).

Fish stocks inside the MPA fluctuate seasonally with reductions in biomass of all fish groups (graph 20) in December 2017-February 2018 and June-August 2018 (graph 18 and 20) most likely due to the seasonal migrations of schooling fish. Peaks in biomass in September-November 2018 and June-August 2019 were caused by high abundances of all fish groups (graph 20).
From June to August 2019, Basak MPA hosted a high average biomass of commercial fish of medium to high maturity level including, barracudas (rumpi) representing 31% of total fish biomass but only 2% of their numbers (indicating a very large size), fusilliers (solid) representing 22% biomass and 46% numbers, snappers (lalagan) representing 14% biomass and 12% numbers and a constant production of unicornfish (bagis) and breams (bika bika) (graph 21 and 22).
Graph 21. Average composition of commercial fish biomass per 150m² of coral reef at Basak Can-unsang MPA from June 2018 to August 2019.

Graph 22. Average composition of commercial fish numbers per 150m² of coral reef at Basak Can-unsang MPA from June 2018 to August 2019.
The medium (9-13m) and deep (15-19m) reefs of Basak South MPA exhibited much higher productions of fish biomass than the shallow (3-7m) reefs (graph 23). These deeper reefs are important habitats for schooling fish, such as barracudas (rumpi), fusiliers (solid) and snappers (lalagan), which showed peaks in their populations in September 2018 with more than 30kgs of fish biomass coming from great and blackfin barracudas alone and the recording of schools of more than 200 fish. The occasional observation of juveniles of the same species in large schools during other seasons is a good sign of the rejuvenation of their stocks.

Graph 23. Seasonal distribution of average commercial fish biomass per 150m² of coral reef across Basak Can-unsang MPA at 3-7m (green), 9-13m (yellow) and 15-19m (blue) from September 2017 to August 2019. Highlighted averages are from June 2018 to August 2019.

4) Management Recommendations

• The reefs of Basak South MPA are naturally narrow, so could be easily overfished if appropriate demarcation of the MPA's boundaries and buffer zone are not maintained all year round. It is recommended that if marker buoys, ropes and their sinkers are ever lost, that they are replaced as soon as possible.

• It is recommended that coastal resource use, such as land development or agriculture, is considered within an MPA-specific management plan for Basak because it’s proximity to a river makes its reef (which is dominated by low resilience corals) more vulnerable to external threats like sedimentation and nutrient influx that could be created upstream.

• Continue the current successful enforcement strategy and strong community engagement in MPA management from the Local Government Unit (LGU).

• Research could be conducted into larval dispersal and the migrations of schooling fish to better understand the connectivity of the area and its influence on neighbouring MPAs.
5) Photos

**Photo 7.** Hard and soft corals inside Basak Can-unsang MPA.

**Photo 8.** Fish swimming above a gorgonian soft coral inside Basak Can-unsang MPA.

**Photo 9.** A feather star and ascidians being forced sideways by the strong current inside Basak Can-unsang MPA.

**Photo 10.** A school of fusiliers swimming above a school of snappers inside Basak Can-unsang MPA.

**Photo 11.** A school of great barracuda swimming inside Basak Can-unsang MPA.
4. LUTOBAN GAC-ANG MPA

1) MPA Description

Size: Lutoban Gac-ang (24 hectares)

MPA type: Combination of coral reef and wide patches of seagrass beds
Protected from strong current, generally oriented North to South
Lutoban river mouth, North of the MPA (affecting the sanctuary)

Coral reef type: Dense reef with a very large shallow plateau to 5 meters depth
• Mainly composed of hard corals, seagrass, algae and sponges
Steep medium / deep depth from 9 to 16 meters
• Mainly composed of hard and soft corals and sponges

Demarcation (from divers observations):
Incomplete, with frequent fishing in the MPA and constant fishing in the buffer zone.

MCP monitoring: Due to misunderstandings over the last year between MCP, the community and the LGU of the MPA's boundaries, MCP has been focussing its monitoring efforts in the most Northern part of Lutoban's coral reef. This is the most accessible section of the reef without a boat and was believed to be inside the MPA. It has, however, now come to light that this is not inside the MPA. Due to incomplete demarcation of the MPA and community misunderstandings that have led to a high volume of fishing within the MPA, however, this data can still be used as an indicator for the status of Lutoban MPA until we have a complete data set within the MPA.

2) Substrate Composition and Resilience of the MPA

a) Substrate Composition

Lutoban MPA had a higher average hard coral cover (31%) (graph 24) than Zamboanguita's MPA average (25%) and the entire region (30%) suggesting that it should be able to support a productive ecosystem of commercially important fish and invertebrate species. Lutoban is characterised by a dense coral reef, a large proportion of which is in the shallows (3-7m) where observed coral cover was highest (40%) (graph 24). Average algal cover was the same as the regional trend (21%) and highest at medium depths (26% at 9-13m) (graph 24).
b) Hard Coral Cover, Reef Health and Resilience

From September 2017 to May 2018 coral cover declined from 35% to 28% (graph 25). This coral loss was likely because of the region’s particularly warm summer in 2017 and the corresponding bleaching event in September 2017 (graph 26). Hard coral cover recovered again to 34% in December 2018 (graph 25 and 26). Despite these losses, Lutoban has actually been less affected by bleaching than the rest of the region (average 2% bleaching in Lutoban compared to 3% for the regional MPA average) (graph 26).
These losses in hard coral cover occurred mainly on the shallow reef (3-7m) where it declined from 52% in September 2017 to 37% in May 2018 (graph 27) and caused the largest declines in medium resilience corals, which declined from 11% in September 2017 to 5% in February 2018 (graph 28). Hard coral percentage cover appears to be recovering across all depths and resiliences (graph 27 and 28).

Graph 26. Average bleached hard coral cover across Lutoban (green), regional MPAs (pink) and regional non-MPAs (black) from September 2017 to August 2019.

Graph 27. Average hard coral cover across Lutoban (pink) at 3-7m (green), 9-13m (yellow) and 15-19m (blue) depths from September 2017 to August 2019.
Lutoban displayed fewer instances of unhealthy corals (bleached, predated, diseased, recently killed or infested) than regional MPAs and non-MPAs (graph 29). Corals experienced high levels of bleaching in September 2017 and in December 2018, after the pier was renovated in October 2018, increasing sedimentation in the water (graph 30). During the cooler months, corals were mainly affected by low levels of disease (graph 30).

**Graph 28.** Average hard coral cover of low resilience corals (purple), medium resilience corals (yellow) and high resilience corals (red) at Lutoban from September 2017 to August 2019.

**Graph 29.** Average hard coral cover classified as “unhealthy” (including bleached, predated, diseased, recently killed and infested) across regional MPAs (pink), regional non-MPAs (black) and Lutoban (green) from September 2017 to August 2019. Error bars represent standard error from the mean average.
During the renovation of Lutoban pier in October 2018, percentage cover of rubble increased from 4% in June 2018 to 12% in November 2018 (graph 31). After the renovation, algal growth increased from 19% in June 2018 to 28% in May 2019 (graph 31). Silt also increased from 6% in September 2018 to 20% in May 2019 (graph 30). Increases in algae cover over the survey period always occurred at the same time as decreases in hard coral cover indicating an inverse relationship between the two substrates and a tendency to phase-shift (graph 31). Coastal construction, like the renovation of the pier at Lutoban Cab-cab, typically cause these increases in silt and algae because large parts of the coastline are disturbed. As a result, hard coral cover decreases because the silt and algae smother and overgrow corals, depriving them of the light they need to survive. Such construction can, therefore, be very detrimental to the reef. To investigate these impacts further, the non-MPA site, Lutoban Cab-cab, was also monitored (see section 5).
3) MPA Commercial Productivity

a) Fish Biomass

From June 2018 to August 2019, **Lutoban had the lowest average commercial fish biomass of the region** per 150m² of reef (graph 32). Average fish biomass was 5.7kg at Lutoban vs 20.1kg in regional MPAs, 8.7kg in regional non-MPAs and 20kg in the Zamboanguita’s MPAs (graph 32). Lutoban’s seasonal variation in fish biomass follows the trend of regional non-MPAs rather than MPAs suggesting that it is not effectively protected and that illegal fishing occurs inside the MPA (graph 32). Regular observations and discussions with governments and communities confirm this theory and is attributed most commonly to a lack of demarcation. Lutoban’s average fish biomass increased from 1.4kg in December 2017 to 7.5kg in December 2018 but started to decline again to 5.7kg in June 2019 (graph 32), potentially linked to declines in hard coral cover and increases in silt and algae cover after the renovation of the pier (graph 31).

Analysis per depth range highlights a fishery relying primarily on the medium reef (graph 33). From June 2018 to August 2019, average commercial fish biomass was 3.7kg per 150m² in the shallow reef (3-7m), 7.3kg in the medium reef (9-13m) and 6.1kg in the deep reef (14-19m) (graph 33). **Commercial fish at the medium reef increased** from 4.8kg per 150m² in September 2018 to 8.8kg in June 2019. **Production at the deep reef decreased** from 9.5kg per 150m² in September 2018 to 4.5kg in June 2019. This indicates the necessity to secure the boundaries of the MPA as the deeper reefs appear to be subject to fishing pressure.
Silvery fish such as tuna are important fishery targets and represented 11% of Lutoban’s average fish biomass from June 2018 to August 2019 (graph 34) but were only observed in significant numbers on the medium reef (9-13m) from December 2018 - February 2019 (graph 35). These types of fish are normally observed mainly on the deeper reef (15-19m), indicating the potential for Lutoban to support an increased commercial fish biomass if fishing is adequately restricted at the deeper reef boundaries of the MPA.

Graph 33. Seasonal distribution of average commercial fish biomass per 150m² of coral reef across Lutoban at 3-7m (green), 9-13m (yellow) and 15-19m (blue) from September 2017 to August 2019. Highlighted averages are from June 2018 to August 2019.

Graph 34. The composition of average commercial fish biomass in kg per 150m² of coral reef at Lutoban from June 2018 to August 2019, with fish divided into groups depending on their diet.
Average composition of the fish observed, illustrates a high diversity of fish families and the occasional sighting of schools of tuna (graph 36), which contributed to 9% of total observed fish biomass. Although important to biomass, tunas only represented 4% of fish numbers, indicating that they were large individuals with high reproductive output (graph 37). If effectively managed, the deep reef shows potential to support larger populations of these silvery fish.
4) Management Recommendations

- **Strengthen relationships and communications** between the LGU and the local community (especially the barangay council, local fishers and gleaners).
- Conduct **IECs for the local community** alongside MCP to:
  - Raise awareness about the importance of MPAs and the negative impacts of illegal fishing within MPAs.
  - Confirm the location of the MPA and its boundaries to avoid confusion.
  - Regularly update the community on the status of the MPA e.g. fish populations.
  - Align the LGU’s goals with the community’s fishery goals.
- Ensure **proper demarcation of the MPA** is maintained, particularly to protect the potentially highly productive deeper reefs of Lutoban.
- Motivate the bantay dagat (through training, IECs and wages) to **enforce the regulations of the MPA**, particularly patrolling its extremities.
- **Restrict further renovation of the pier** at Lutoban Cab Cab and consider its impact on neighbouring reefs as a warning that further coastal development may alter the diversity of neighbouring reefs, contributing to overall declines in hard coral cover and fish biomass.
5) Photos

**Photo 12.** A sea star in the seagrass outside of Lutoban Gac-ang MPA.

**Photo 13.** A peacock mantis shrimp in the seagrass outside of Lutoban Gac-ang MPA.

**Photo 14.** A school of fusiliers swimming above soft corals outside Lutoban Gac-ang MPA.
5. LUTOBAN CAB CAB (NON-MPA)

1) Hard Coral Cover, Algae Cover and Resilience

After the renovation of the pier in October 2018, decreases in hard coral cover and increases in algae and silt were observed at the Lutoban Cab Cab monitoring site, directly adjacent to the pier. Silt increased from 4% in September 2018 to 13% in March 2019 but the year’s data suggests that this could be a normal, seasonal fluctuation (graph 38). *Algae increased from 14% in June 2018 to 22% in December 2018* (graph 38) and *filamentous algae increased from 1% in June 2018 to 7% in December 2018* (graph 39). Algae, (particularly filamentous) typically blooms in response to declining water quality, which suggests a decrease in water quality after the renovation of the pier.

![Graph 38. Average substrate percentage cover of hard coral (pink dotted), algae (green), rubble (purple) and silt (black) across Lutoban Cab Cab from September 2017 to August 2019.](image)

![Graph 39. Average substrate percentage cover of filamentous algae (green), macro algae (purple) and turf algae (black) across Lutoban Cab Cab from September 2017 to August 2019.](image)
The hard corals of Lutoban Cab-cab were on average composed of 42% low resilience growth forms, 49% medium resilience and 9% high resilience growth forms from June 2018 to August 2019. Percentage cover of all hard coral growth forms decreased following the regional trend (graph 38 and graph 4) but after the renovation of the pier in October 2018, low resilience corals notably decreased from 26% in December 2018 to 7% in March 2019 (graph 40). Low resilience corals are easily destroyed by the increases in silt and algae commonly associated with coastal construction. Medium resilience corals initially decreased after the renovation from 18% in September 2018 to 12% in December 2018 but increased again to 38% in March 2019 (graph 40).

This recovery was observed mainly at shallow depths (3-7m), while medium (9-13m) and deep (15-19) reefs still showed high presence of algae (figure 3). This suggests that the shallow reef could be strong enough to recover from the pressures of the pier renovation but would also experience a long term loss in low resilience coral growth forms that provide important habitats for small reef fish. Such recovery will also only be possible if all external pressures are removed (e.g. sedimentation, physical damage from ships or pollution) and if herbivorous fish populations are high enough to remove the algae.

Figure 3. Underwater photographs of the substrate at the Lutoban Cab Cab monitoring site next to the pier. Left: Dominated by medium resilience corals. Middle: Medium resilience corals interspersed with filamentous algae. Right: Dominated by filamentous algae.
2) Management Recommendations

- Restrict further renovation of the pier at Lutoban Cab Cab and consider its impact on neighbouring reefs as a warning that further coastal development may alter the resilience and diversity of neighbouring reefs, contributing to overall declines in hard coral cover and fish biomass.

3) Photos

**Photo 15.** Filamentous and macro algae overgrowing hard corals in March 2019 at 9m depth.

**Photo 16.** Filamentous algae overgrowing hard corals in March 2019 at 7m depth.

**Photo 17.** Filamentous and macro algae overgrowing hard corals in March 2019 at 9m depth.

**Photo 18.** Filamentous overgrowing hard corals in March 2019 at 9m depth.
6. MALUAY MALATAPAY MPA

1) MPA Description

Size: Maluay Malatapay (2 hectares)

Established: 2018

MPA type: A combination of coral reef and wide patches of seagrass beds. Protected from strong currents. High pressures from coastal activities, including a large, weekly cattle market and intense, daily boat traffic from tourism trips to Apo Island, both of which cause anchoring issues, common oil leaks and other pollution (solid and liquid). River mouth, north of the market area causing sediment and nutrient output which will travel south with currents.

Coral reef type: Dense coral reef with a very large shallow plateau at 5 meters depth. • Mainly composed of hard corals, seagrass, algae and sponges. Steep reef slope at the medium to deep depths (from 9-16 meters deep). • Mainly composed of hard corals, rubble and sponges.

Demarcation (from divers observations): Recent establishment and demarcation of the MPA has forced the high boat traffic to relocate their parking to the sandy area just south of the MPA, minimising the more direct boat damage e.g. anchoring.

MCP monitoring: Monitoring is conducted on the reefs of the MPA for substrate, fish and invertebrates.

2) Substrate Composition and Resilience of the MPA

a) Substrate Composition

Maluay Malatapay MPA had a high average percentage cover of algae (31%) (graph 41) compared to regional MPAs (21%) (graph 1) and a notably higher percentage cover of algae (35%) (graph 41) on its deep reef (15-19m) compared to Basak (14%) (graph 12) and Lutoban Gac-Ang (18%) (graph 23). Malatapay also had a lower average percentage cover of hard coral (21%) (graph 41) compared to regional MPAs (30%) (graph 1).

A high percentage cover of algae is usually linked to low water quality and high amounts of nutrients, which could be a result of high levels of pollution from Malatapay’s regular boat traffic and the weekly cattle markets. This poses a risk to the health of the reef because algae competes with hard corals for space and light by smothering and overgrowing them.
b) Hard Coral Cover, Reef Health and Resilience

Average percentage hard coral cover at Malatapay followed the regional trend of decline but drastically decreased from 36% in September 2017 to 18% in June 2018 (graph 42). This large decline was likely linked to the region’s bleaching event in September 2017 caused by a particularly hot summer (graph 7), which made Malatapay’s hard corals even more vulnerable to the high boating pressures of the area. Fortunately, the reef appears to be slowly recovering from this loss of hard coral cover, bringing its average hard coral cover from June 2018 to August 2019 up to 21% (graph 42).

Graph 41. Average substrate composition of the total reef (left) and reef per depth range (right) at Maluay Malatapay MPA from June 2018 to August 2019.

Graph 42. Average hard coral cover across the region’s MPAs (pink), the region’s non-MPAs (black) and Maluay Malatapay (green) from September 2017 to August 2019. Highlighted averages are from June 2018 to August 2019. Error bars represent standard error from the mean average.
From June 2018 to August 2019, an average of 92% of the hard corals observed at Malatapay MPA were classified as healthy and 3% were bleached. In September 2017, a large bleaching event caused 8% of corals to bleach and allowed disease to increase to 5% in March 2018 (graph 43). Prevalence of unhealthy corals (bleached, predated, diseased, recently killed or infested) diminished to 0% in June 2018 (graph 44), at the same time that average hard coral cover decreased to 18% (graph 42). This suggests that all of the unhealthy corals on the reef were under too much pressure to survive the September 2017 bleaching event. A second bleaching event occurred in December 2018 when bleaching reached 6% (graph 43). Colder waters at this time suggests that this bleaching event was not caused by temperature and was more likely caused by poor water quality caused by coastal activities, decreasing the corals vital access to light.

Graph 43. Average hard coral cover classified as “pressured” including bleached (red), diseased (yellow), recently killed (black), infested (pink) and predated (purple) across Maluay Malatapay MPA from September 2017 to August 2019.

Graph 44. Average hard coral cover classified as “unhealthy” (including bleached, predated, diseased, recently killed and infested) across regional MPAs (pink), regional non-MPAs (black) and Maluay Malatapay MPA (green) from September 2017 to August 2019. Error bars represent standard error from the mean average.
As hard coral cover decreased, algae cover increased from 19% in September 2017 to 36% in December 2018 (graph 45). Turf algae initially increased from 10% in September 2017 to 18% in March 2018, followed by increases in macro algae from 8% in March 2018 to 21% in September 2018 (graph 46). The 2 types of algae then continued to compete for space on the reefs, one increasing in percentage cover as the other decreased, and vice versa, until they both started to decline in June 2019 (graph 46). Increases in algae are an indicator of poor water quality with high amounts of nutrients, in this case likely caused by Malatapay’s high boating pressures polluting the area. They can also be an indicator of a decrease in herbivorous fish but graph 51 shows that populations of small preyed fish (mainly herbivores) actually increased from September 2017 to August 2018.

From June 2018 to August 2019, Malatapay's hard corals were composed on average of 12% high, 25% medium and 63% low resilience growth forms. Graph 47 shows that the decrease in hard coral cover observed in June 2018 (graph 42) affected all levels of resilience. Average hard coral cover of low resilience corals decreased from 17% in September 2017 to 11% in June 2018, while medium
resilience corals decreased from 14% in September 2017 to 5% in June 2018, and high resilience corals decreased from 4% in September 2017 to 2% in June 2018 (graph 47). All resilience levels appear to be slowly increasing again but such a decrease in medium resilience corals could greatly reduce the overall resilience of Malatapay’s reefs (graph 47).

Graph 47. Average hard coral cover of low resilience corals (purple), medium resilience corals (yellow) and high resilience corals (red) at Maluay Malatapay MPA from September 2017 to August 2019.

3) MPA Commercial Productivity

a) Fish Biomass

Graph 48. Seasonal distribution of average commercial fish biomass per 150m² of coral reef across the region’s MPAs and non-MPAs and Maluay Malatapay MPA from September 2017 to August 2019. Highlighted averages are from June 2018 to August 2019. Error bars represent standard error from the mean average.
Malatapay MPA had an average 12.1kg of fish biomass per 150m$^2$ of reef from September 2017 to August 2019, which is much lower than the regional MPA average of 20.1kg but higher than the non-MPA average of 8.7kg (graph 48). It should be noted, however, that Malatapay was only declared an MPA in March-May 2018. Malatapay’s seasonal fluctuations followed the trend of regional MPAs, increasing from 5.4kg in March 2018 to 16.5kg in September 2018 and then decreasing again to 8.6kg in March 2019 (graph 48). The first peak in September 2018 was only observed at the medium depth (9-13m) where biomass increased to 36.8kg (graph 49). A second peak in biomass of 33.3kg was observed in December 2018 only at the deep reef (15-19m) (graph 47). From June 2018 to August 2019, an average of 4.5kg of fish was observed on the shallow reef (3-7m), 14.8kg on the medium reef (9-13m) and 17.1kg on the deep reef (15-19m) (graph 49). This shows a great potential for the medium and deep reefs of Malatapay to support high commercial fish biomass.

![Seasonal distribution of average commercial fish biomass per 150m$^2$ of coral reef across Maluay Malatapay MPA at 3-7m (green), 9-13m (yellow) and 15-19m (blue) from September 2017 to August 2019.](graph 49.

From June 2018 to August 2019, the majority of fish biomass (5.8kg / 48%) was composed of plankton feeders (graph 50). This high plankton feeder biomass was caused mainly by a peak to 8.8kg during the cooler months of December 2018-February 2019 (graph 51). The second largest category was big reef fish, which accounted for 4.6kg or 38% of total fish biomass from June 2018 to August 2019 (graph 50). Big reef fish peaked to 7.3kg in September 2018 and then declined again in June 2019 (graph 51).
From June 2018 to August 2019, fusiliers (solid) accounted for 24% of the total commercial fish biomass and unicornfish (bagis) accounted for 22% (graph 52). Both of these families of fish are plankton feeders. Over the same period, snappers (lalagan) accounted for 20% of total biomass, which explains the peak in big reef fish biomass. Percentages of average fish abundance (graph 53) were very similar to those for biomass, indicating that individual fish were not large. This shows that Malatapay MPA is effective at producing high numbers of small fish but ineffective at allowing them to grow to mature sizes. High populations of small fish and a high diversity of fish families (graph 53) suggest a high larval recruitment and juvenile fish production in Malatapay MPA. MPA effectiveness could be improved if fish were able to grow and achieve maximum sizes.
Graph 52. Average composition of commercial fish biomass per 150m² of coral reef at Maluay Malatapay MPA from June 2018 to August 2019.

Graph 53. Average composition of commercial fish abundance per 150m² of coral reef at Maluay Malatapay MPA from June 2018 to August 2019.
4) Management Recommendations

- Continue to implement and improve MPA management and enforcement activities.
- **Investigate the cause of local water quality declines** by assessing whether the suspected pollution is mainly derived from the river, boat traffic or the coastal market and tourism activities.
- Create an **Integrated Coastal Resource Management Plan** which addresses the current harmful impacts of the local boating, tourism and market activities at Malatapay (e.g. enforce strict no dumping of solid or liquid waste from boats and ban single-use plastics at the market).
  - Also account for the potential impacts of further coastal and upland development.
- **Align LGU MPA goals with community MPA goals and agree upon suitable fishing restrictions which could help increase average fish size and therefore reproductive output** and protect the reef against pollution (e.g. by protecting ecologically important species like herbivores, implementing individual fish size bans, gear restrictions or fishing seasons).
5) Photos

Photo 19. Medium and low resilience hard corals inside Maluay Malatapay MPA.

Photo 20. Low resilience hard corals and soft corals inside Maluay Malatapay MPA.

Photo 21. Close up of the individual polyps of a branching hard coral inside Maluay Malatapay MPA.

Photo 22. Clownfish sheltering in an anemone inside Maluay Malatapay MPA.

Photo 23. Coconut octopus on the sand outside Maluay Malatapay MPA.

Photo 24. Swimming crab eating a scallop on the sand outside Maluay Malatapay MPA.
7. POBLACIÓN DALAKIT MPA

1. MPA type

Size: Población Dalakit (2 hectares)

MPA type: Combination of shallow coral reef, seagrass beds and sand.
An artificial reef composed of tyres in the sand outside of the MPA.
Close to a river mouth (just south of Kav’s Beach Resort).

Coral reef type: Only a dense shallow reef from 2 to 4 meters deep.
- Mainly composed of hard corals, seagrass, algae and sponges.

Demarcation (from divers observations): Usually complete.

MCP monitoring: Began in March 2019 after requests from the LGU. Reef is only present in the shallows (0-7m) so monitoring is only conducted at the shallow monitoring range of 3-7m.

2. Substrate lifeforms and resilience of the MPA

a) Substrate Composition, Resilience and Health

Graph 54. Average composition of the total reef substrate (left) and of hard coral resilience (right) at Población Dalakit MPA from March to August 2019.

The shallow reef at Dalakit MPA had a high average hard coral cover (48%) (compared to the regional MPA average of 30%), comprised mainly of low (65%) and medium resilience corals (34%) (graph 54). Its near complete absence of high resilience corals makes it more vulnerable to external pressures. Despite this, it was relatively healthy (94% on average) but did have a high rate of predation (4%) compared to the regional MPA average of 1% (graph 55). The observed coral predation is not of environmental concern at the moment because it was caused by small, slow-
moving corallivores (drupella and coraliophilla snails) and not by the more effective corallivore, the crown of thorns sea star, which can cause significant coral loss at high populations.

Graph 55. Average hard coral health % composition at Población Dalakit MPA from March to August 2019.

2) Commercial Productivity

a) Fish Biomass

Considering that it only has a shallow reef, Dalakit MPA had an impressively high average fish biomass of 12.4kg per 150m² of reef from March to August 2019. This is the highest commercial fish productivity on a shallow reef out of all of Zamboanguita’s MPAs, which had an average of 8.1kg of fish per 150m² at shallow depths. It should be noted, however, that the data sample size for Dalakit MPA is much smaller than that of other MPAs in Zamboanguita, simply because surveying of Dalakit only began in March 2018, compared to June 2017 for the rest of Zamboanguita. Data collection should be continued to further validate these findings.

Graph 56. The composition of average commercial fish biomass in kg per 150m² of coral reef at Población Dalakit MPA from March to August 2019, with fish divided into groups depending on their diet.
Average commercial fish biomass was mainly comprised of big reef fish (7.3kg, 59%) and small preyed fish (4.8kg, 38%) (graph 56). The big reef fish biomass was mainly caused by goatfish (12% of total fish biomass), barracuda (11%), sweetlips (9%), snappers (8%) and groupers (6%) (graph 57). Of the small preyed fish, surgeonfish accounted for 31% of total fish biomass (graph 57). Top predators and plankton feeders contributed very little to total biomass (graph 56), likely because these types of fish prefer medium and deep reefs with stronger currents.

3) Management Recommendations

- Continue to implement and improve MPA management and enforcement activities.
- Continue regular monitoring to obtain a complete annual set of data.
- Divers observed lots of fish aggregating around the artificial reef made of tyres, outside the MPA. Fish could be using the artificial reef instead of their natural habitat. Research could be conducted to investigate fish populations on the artificial reef vs the shallow reef and seagrass inside the MPA and the potential impacts that could have on fish biomass sustainability.
  * It should be noted that artificial reefs made of tyres will degrade over time, releasing chemicals into the surrounding water. Materials should be limited to properly installed, pH balanced concrete or rebar and regularly monitored to ensure stability. Please refer to the separate document, “factors and principles to consider when establishing artificial reefs” available on the MCP website: [www.marineconservationphilippines.org/articles/](http://www.marineconservationphilippines.org/articles/).
4) Photos

Photo 25. Snappers, sweetlips and small reef fish swimming above tyres outside Dalakit MPA.

Photo 26. Snappers, sweetlips and small reef fish swimming above tyres outside Dalakit MPA.

Photo 27. A magnum sea cucumber in the shallow reef of Dalakit MPA.

Photo 28. A broad club cuttlefish in the sand outside Dalakit MPA.

Photo 29. A cushion star in the shallow reef of Dalakit MPA.

Photo 30. A juvenile lionfish in the shallow reef of Dalakit MPA.