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Benthic Profile of the Proposed Marine Protected Area no. 4 Island Garden City of Samal

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ABSTRACT

This study was conducted to determine the benthic profile of the proposed marine protected area no. 4, in Island Garden City of Samal. There are 44 coral genera identified and the area is commonly dominated by these coral genera, namely: *Acanthastrea*, *Acropora*, *Anacropora*, *Coscinarea*, *Cycloseris*, *Cyphastrea*, *Echinophyllia*, *Echinopora*, *Euphyllia*, *Favia*, *Faviidea*, *Favites*, *Goniastrea*, *Heliofungia*, *Merulina*, *Mycedium*, *Physogyra*, *Pocillopra*, *Porites*, *Symphyllia*, *Lobophytum*, *Sarcophyton*, *Heliopora*, *Sympodium*, and *Cespitularia*. The genus evenness is considered low due the patchy distribution of corals, while the genus richness of the coral reef is observed to be high based on the number of coral genera identified. The current environmental conditions such as physical and chemical factors are found to be fair and moderate, and suitable for the growth and reproduction of several corals. The abundance of small reef dwelling fishes indicates that the coral reefs are healthy and diverse. Larger pelagic and commercially important fishes such as groupers and snappers were also common based on the interview but rarely observed during the survey.The economic factors attest no detrimental effects to the coral reef and other marine organisms. In general, proposed marine protected area no. 4 is estimated to have 58 percent of live coral cover and 79 percent for its total coral cover.

Keyword/s: Coral reef, Coral diversity, Corals, Bethic, IGACOS, marine protected area

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INTRODUCTION

Coral reefs represent one of the most diverse and productive ecosystems in the world. They are found in shallow, clear water environments, and require tropical and subtropical warm water temperatures extending to about 30° north and south of the equator and forming only where surface waters are never cooler than 16° C [11]. They provide livelihoods for coastal communities through fishing, aquaculture and tourism [12].

The Island Garden City of Samal (IGACOS) is surrounded with beautiful marine water and expected to have an abundant coral reef ecosystem. The city fisheries office's partial descriptive assessment shows ancient, complex and biologically diverse marine ecosystems of great social, economic, and ecological

importance and they must be preserve, restored, and protected. But the lack of historical data and evaluation may threaten the coral reefs by these factors such as coastal development, over fishing, marine pollution, and over exploitation of marine resources.

The city government primary concerned and interests are now on the protection of their marine resources from the impact of development and unregulated fishing. In fact, these are now manifested by the City Fisheries and Aquatic Resources Office by their projects.

Materials and Methods

Data Gathering Instruments

The instruments that were used in this study are the following: refractometer, secchi disc, portable ph meter, underwater compass, digital and video camera, one meter plumb line, 50 meters transect tape, motorized boat, coral atlas, computer, and CPCe program.

Sampling Techniques

site preparation

The community or the Barangay involved was notified through a letter, which was addressed to their Barangay Captain. A meeting was arranged among Barangay officials and to the fisherfolks to formally introduce the researcher's objectives and plan of activities as well as to highlight the importance of their participation to the success of this study.

manta tow

The proposed marine protected area no. 4 was assessed using the manta tow technique to get a general idea of the various types and amounts of habitat types in the area and also, this method was used for the selection and delineation of sites and numbers of samples to be assessed and for comparison with local perceptions of the coastal area [14].

point intercept transect

This method was used to estimate the relative abundance of living and non-living things on the reef bottom that was observed within the defined area [14].

fish visual census

This method was used to observed and estimate the variety, numbers, and even sizes of common, easily identified reef fishes [14].

physical and chemical data

During the course of the survey, seawater temperature readings were taken from the survey boat using a bulb thermometer at the sea surface. The diver also took the temperature at the maximum survey depth.

Similarly, the salinity was recorded using a refractometer and water taken from both the surface and the maximum survey depth. Water turbidity was measured using a Secchi disc, and was used on the survey boat to measure vertically through the water column [4].

The survey divers qualitatively assess the strength and direction of the current in the survey site. Direction was recorded based on compass reading and the strength will also be assessed as being "none", "weak", "medium", or "strong" [12].

taxonomic classification

Using the Coral Point Count program, the underwater photographic images was overlaid by a matrix of randomly distributed points and the fauna/ flora genus or substrate type lying beneath each point was visually identified using the data code generated and stored by the program. Data from individual transects were combined to produce both inter-and intra-site comparison and the transect data sets were statistically analyzed to give quantitative population as well as their diversity. [8]

Statistical Treatment

The data was analyzed using the frequency, relative frequency, relative density, and relative dominance with the following equations:

1. $\text{Frequency} = \frac{\text{no. of coral genus A occurs} \times 100}{\text{Total number of transect}}$
2. $\text{Relative frequency} = \frac{\text{Frequency value of coral genus A} \times 100}{\text{Total frequency value of all coral genera}}$
3. $\text{Relative density} = \frac{\text{Number of coral genus A} \times 100}{\text{Total number of all coral genera}}$
4. $\text{Relative dominance} = \frac{\text{\% of coral genus A}}{\text{\% of total coral covers}}$
5. $\text{Importance Value} = \frac{\text{Rel. frequency} + \text{Rel. density} + \text{Rel. dominance}}{3}$

Coral point count program automatically analyzed the data sets generated from the under water photographs with basic statistics as well as Shannon-Weaver Index for diversity.

RESULTS AND DISCUSSION

Physical Factors

seawater temperature

There were a total of nine recordings of seawater surface and subsurface temperatures were made. Table 1 reveals the recordings of the temperature throughout the study, the surface temperatures of the different sampling stations have an average reading that ranges from 28^0C to 30^0C.Meanwhile, the subsurface temperature have a average reading that ranges from 26^0C to 29^0C. This implies that the sub-surface temperature of the study area is within the normal range,

which is suitable for the growth and reproduction of the selective coral species. Coral reefs grow best in waters with a temperature of between 21 and 29 degrees Celsius (70 and 85 degrees Fahrenheit [6].

Table 1. Temperatures of the three Sampling stations

Stations	Number of samples	Ave. Surface temp. ^{0}C (0 depth)	Number of samples	Ave. Sub-surface temp. ^{0}C (40 ft. depth)
Station 1	3	30	3	26
Station 2	3	28	3	27
Station 3	3	30	3	29

sea water turbidity

Table 2 reveals the turbidity of the three sampling stations. Nine readings of sea water vertical turbidity were accomplished and it was recorded that stations one and two have an average visibility of nine meters, while station two has vertical visibility of eight meters. These indicate that the seawater of the three sampling stations is clear and with no heavy load of sediments that decreases the sun light absorption. Decreased light penetration has been shown to increase corals susceptibility to the onset of disease and shift in coral communities in favor of those more suitably adapted to growth in lower light conditions can lead to significant alterations to the coral reef ecosystem of an area [3].

Table 2. Seawater turbidity of the three Sampling stations

Stations	Average Vertical Turbidity
Station 1	9 meters
Station 2	8 meters
Station 3	9 meters

seawater current and direction

Recordings of current strength were made throughout the course of the study and all three sampling stations were recorded to have medium current strength. Estimates of current direction were also made, and northwards to southwards flowing currents account for the greatest proportion of recordings in all three sampling stations. This entail that the seawater current strength is good for the dispersal of the coral larvae as well the distribution of their foods. While, the seawater current direction assures the dispersal of larvae are adjacent and along the reef area and replenish fish stocks and regenerate benthic communities. Accurate modeling of seawater movement or current pattern is essential for conservation since fish and coral larvae become entrained within the currents and rely upon this as their mechanisms of dispersal [1].

Table 3. Seawater current strength of the three sampling stations

Stations	Current Strength
Station 1	Medium
Station 2	Medium
Station 3	Medium

substrate quality

The coral reef profile is generally observed to be gentle in its slope, with a few isolated areas showing steep wall profile particularly in transect one of sampling station three. Table four reveals the substrate quality of the marine protected area. It was found that the substrate types of sampling stations one and two are generally composed of sand, rubble and dead corals. While sampling station three shows a high coverage of sand, rubble, dead old coral with algae and rock (steep wall). It manifest that the substrates quality of the coral reef particularly in stations one and two are favorable as a good foundation of the individual corals, in which indicated by greater coverage of mixed hard and soft corals in these area. Communities of unattached branching corals such as *Anacropora* and Fungiids which interspersed with soft coral communities were common on soft substrates. Meanwhile, the sandy, fine mud habitat with dead coral and algae substrate of station three is suggested to be associated with localized activities particularly fishing practices [5].

Table 4. Substrate type of the three sampling stations in

Stations	Substrate Type
Station 1	Sand, rubble and dead coral
Station 2	Sand, rubble, dead old coral
Station 3	Sand, fine mud, dead old coral w/algae, bed rock (steep wall)

seawater pH

Table 5 reveals both surface and subsurface seawater pH of the three sampling stations. It was recorded that the surface seawater of the study area has the average pH ranges from 7.3 to 8.0. While the subsurface seawater has the average pH that ranges from 7.5 to 7.7. Both surface and subsurface seawater were considered as basic and within normal range. These imply that the seawater has normal amount of calcium carbonate which is vital for the growth of hard corals. The level of seawater pH is associated with the amount of calcium carbonate present, normal seawater has a calcium level of about 380 to 450 ppt. which is equivalent to seawater alkalinity level of about 7.5 to 8.0, decreased of seawater pH level could lead to serious damage to marine creatures that need calcium carbonate to build their shells and skeletons [13].

Table 5. Average seawater pH of the three Sampling stations

Stations	Surface pH	Sub-surface pH
Station 1	7.7	7.5
Station 2	7.3	7.6
Station 3	8.0	7.7

seawater salinity

Subsurface seawater samples were also taken from each station for salinity. Table 6 shows the average salinities of the three sampling stations and it has been recorded that sub-surface seawater has a salinity value that ranges from 34.5ppt to 36.2 parts per 1000. These imply that the seawater salinity of the study area is characterized within normal range and it is suitable for the growth of the selective corals. In their ideal environments such as salinity which is between 34 and 37 parts per 1000, coral reefs will grow from 1 to 100 centimeters per year [10].

Table 6. Average seawater salinity of the three Sampling stations

Stations	Sub-surface ppt.
Station 1	34.5
Station 2	36.2
Station 3	35.0

Socio-economic Factors

economic activities

One private beach resort was observed on the area and exclusively used by the owner. Majority of the coastal population's occupations are fishermen, so fishing is commonly observed. Small sari-sari stores as their alternative livelihood. Agricultural farming was also observed, particularly in the upland area of the two Barangays.

coastal population

The proposed marine protected area no.4 is composed of two barangays: Aumbay and Tagbaobo and most of the population are confined in the upland area. There were only 120 residence observed residing near the coastal area which reduces the risk of over exploitation of the marine resource in the area.

fishing practices

Figure 1 reveals the types of fishing gears or method used by the local fishermen of Barangay Tagbaobo and Aumbay. Result showed that there were six types of fishing gears or method recorded. Hook and line (Taga) is very common with the 30.2 percent. Followed by spear (Pana) with 20 percent, fish trap (Bubu) with 16.9 percent, and scoop net (Sigpaw) with 14.6 percent, and fillnet (Pukot) with the percentage value of 10 percent. It was noted that most fishing methods

used were traditional which reduces the risks of overfishing and the reef dwelling fishes will have the chance to reproduce, and also shows no detrimental effect to the coral reef.

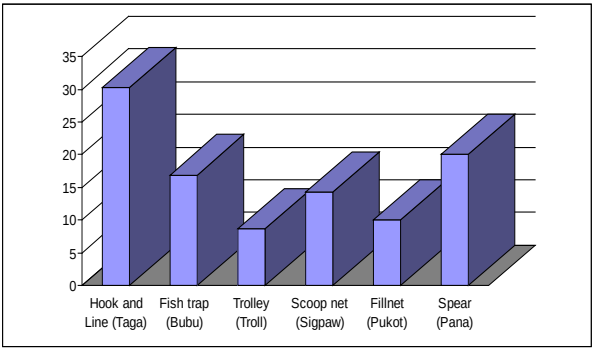

Fig. 1. Types of fishing practices of the local fishermen

developmental projects

Part of their coastal development projects are the establishment of the Barangay coastal zone. This zoning includes the specific fish landing zone, Barangay Beach Park zone and also the declaration of the area as the "no fishing zone or fish sanctuary".

Meanwhile, the city government is conducting a habitat assessment of their coastal jurisdictions. As well as conducting a information dissemination campaign as to the importance and protection of their marine resources. In order for coastal zone management to be effective, local communities must first be educated in the importance of protecting the marine environment and given the opportunities to understand the precious resource that lies just beyond their coastline [7].

Distribution and Abundance of living and non-living things per station

Figure 2 reveals the abundance and distribution of living and non-living things of the three sampling stations. Noticeably, station one which is inside the fish sanctuary of Marine Protected Area had the higher percent value of hard coral recorded which is 60 percent, followed by station two with 44.66 percent and station three with 14.67 percent. Meanwhile, soft coral are noticeably observed to be abundant and dominating in station three with 25.6 percent and followed by stations 2 and 1 with 25.6 percent and 16.16 percent, respectively. These indicate that the hard coral are most abundant in station 1 this can be link to the geographical description which is gentle slope and types of substrate observed in station 1. The higher abundance of hard bedrock substrates in areas with higher hard coral cover highlights the need for solid substrate upon which coral larvae can settle and grow [2].

On the other hand, station three has the highest percentage value of soft corals with the value of 25 percent. This is due to the sandy substrate of the area,

which the soft corals are best suited. Soft coral communities were common on soft substrates [5].

The dead coral with algae is high in stations 2 and 3 with the 23.33 percent and 19.20 percent, respectively.

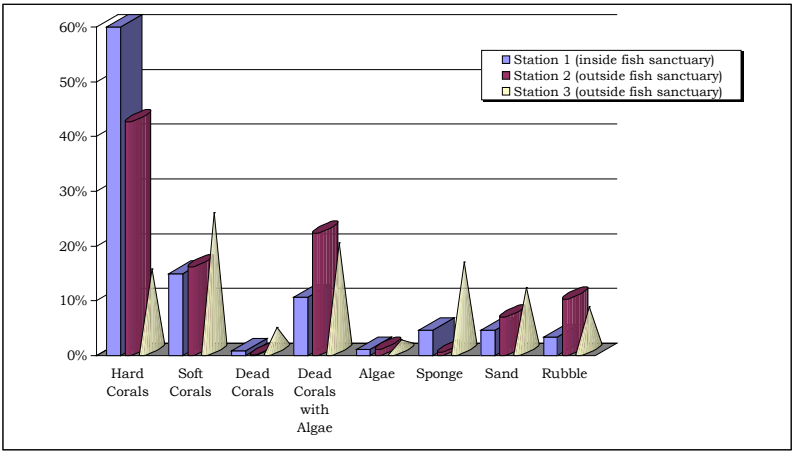

Fig. 2. Distribution of benthic life forms

Percent Live Coral Cover

In general, the proposed marine protected area no. 4 can be consider as "good" in terms of live coral cover and can be consider as "excellent" in terms of coral cover. Table 7 reveals the average coral cover of the proposed marine protected area no. 4, it has been recorded that live hard corals has the highest average value of 39.0 percent compared to soft corals with 19.0 percent and has a sub-total of 58 percent which can be noted as "good" in live coral coverage.

Furthermore, the entire coral reef of the proposed marine protected area number 4 is classified as excellent in coral cover, with the average value of 79.0 percent.

Table 7. Average coral cover of the Proposed Marine Protected Area no.4

live coral cover	Average
Hard Corals	39%
Soft Corals	19%
Subtotal	***58%***
Dead Corals	14%
Dead Coral w/ Algae	19%
Subtotal	***21%***
Coral Cover	**79%**

Classification of Corals

Using the Coral Point Count program for coral identification, it has been recorded that there were 18 coral families and 44 genera identified within the three sampling stations. station 1 have seven coral genera that are common and abundance in this area these are: *Sarcophuton* with the average of 21.33 percent which dominates the area, Followed by *Mycedium* with the average of 10.67 percent, *Porites* with 13.00 percent, *catalaphyllia* with 9.33 percent, *Acropora* with 8.22 percent, *Lobophyton* with 5.00 percent and *Dendrophyllia* with 9.33 percent. In station two there were also seven coral genera that are abundantly growing in the area, these are *Euphyllia* with the average of 14.33 percent, followed by *Acropora* 11.67 percent, *Porites* with 4.33 percent, *Astreopora* with 3.67 percent, *Sarcophyton* with 4.00 percent, and *Acanthastrea* and *Galaxea* with 3.33 percent.

Meanwhile, there are only six genera that were noted to be abundant in station three these are: *Euphyllia* with 17.00 percent, *Acropora* with 16.00 percent, *Anacropora* with 10.33 percent, *Echinophyllia* with 6.00 percent and *Porites* with 5.00 percent. Compared to the other sampling stations 1 and 2, the hard corals like *Acropora* and *Anacropora* in station three had greater value of density. This implies that these coral genera are suitable to the present benthic habitat of station three. Coral genera staghorn *Acropora* and Anacropora were common in many sandy areas [12].

Coral Diversity

In general, the proposed marine protected area no. 4 is considered as high in diversity with the average of 2.59. Among the three sampling stations, station 2 which is outside the fish sanctuary has a high coral diversity with a value of 2.97 and followed by station 1(inside fish sanctuary) with the value of 2.41 and station 3 with 2.35. The high diversity of the sampling stations is mainly due to its characteristics having a sandy substrate and some bedrock with medium strength of current and with a topographical description of a gentle slope which is suitable for the growth of several coral genera.

On the other hand, the data indicate that the coral richness of the three sampling stations is classified as high. This is attributed to the 44 coral genera identified in the area. Meanwhile, the sampling stations are categorized as low in coral evenness. This means that the individual genera are not evenly distributed in the area.

Coral Genus Dominance

It was recorded that *Euphyllia* is the most frequent genus of coral that usually occur in every quadrant of the transect tine with 18.29 percent followed by *Acropora* with the value of 15.44 percent, *Sarcophyton* with 11.84 percent, and *Porites* with 10.44 percent. The predominance of the genus *Euphyllia*, *Acropora*, *Sarcophyton*, and *Porites*, in the marine protected area are due to their genus adaption to their environment.

The genus *Euphyllia has* the high value with 0.183 percent followed by *Acropora* relative frequency value of 0.54 percent and sarcophyton with the value of 0.118 percent. The hard coral genus ranked highest in the relative density with

0.73 percent and 0.185 percent for soft coral genus. Two of these hard coral genera namely, *Euphyllia* and *Acropora* have the high relative density of 0.17 percent and 0.14 percent respectively.

The hard coral group of genus has relative dominance with 0.63 Percent and the soft coral group have the lowest relative dominance value of 0.16 Percent.

Again, the *Euphyllia* and *Acropora* dominated among the other coral genus in the coral reef with 0.151 percent and 0.128 percent, respectively.

The hard coral group has the high share of importance value (IVs) of 2.14 percent and 0.54 percent for the soft coral group of genus. Three of the hard coral groups have the importance values that range from 0.159 percent to 0.179 percent; these are *Euphyllia, Acropora and Mycedium*.

Meanwhile, among the five coral genera of soft corals, only the genus of *Sarcophyton* has high importance value with 0.33 percent.

Fish Distribution and Abundance

Table 8 reveals the average fish distribution and abundance in the study area. Among the observed group of fishes, station 1 is greatly dominated by these following fishes: Pata (Damsel fish) have the highest average value of 920.67, followed by Bilong-bilong (Fairy basslets fish) with the average of 100.00, Dalagang bukid (Fusiliers fish) with 49.67 and Labayan (Wrassess fish) with 46.67.

While station 2 has been noticed that the Sunghan (Surgeon Fish) have the highest average value with 460.00, and Pata (Damsel fish) with average value of 91.00, Maya-maya (Snapper fish) with the average of 54.00, Pisos-pisos (Butterly fish) with 20.33 and Labayan (Wrasses fish) with 18.00.Furthermore, amongst the identified fishes in station 3 maya-maya (snapper) has the highest average value of 367.67 percent, solid (fusiliers) with 26.67 percent and cardinal fish with 14.0. While Bilong-bilong (fairy basslets) and Lapu-lapu (grouper) has 7.67 percent and 6.67 percent, respectively. The high abundance of small, reef dwelling fish families such as the Damselfish, Wrasses were often observed throughout the coral reef, this could be an excellent indicator that the coral reef is highly divers and its health is in good condition. The increased spatial complexity of coral reef habitats provides a larger variety of niches to support greater diversities of fish at both species and family [9].

But the larger and commercially more important species such as the grouper and snappers were rarely observed during the study. It is suggested that this commercially import fish are naturally large and therefore more likely to swim away if disturbed by divers compared to smaller reef dwelling fish.

Table 8. Average fish distribution and abundance in marine protected area no. 4

	Station		**Station 2**		**Station 3**	
Fish Category	Density	Average	Density	Average	Density	Average
Adlo (angel fish)	8	2.67	11	3.67	6	2
Bilong (fairy basslets)	300	100	2	0.67	23	7.67
cardinal fish	21	7	1	0.33	42	14

Solid (fusiliers)	149	49.67	5	1.67	80	26.67
Labayan (wrasses)	140	46.67	54	18	3	1
Lapu-lapu (grouper)	4	1.33	1	0.33	20	6.67
Lipti (sweetlips)	6	2	3	1	3	1
Maya-maya (snappers)	3	1	162	54	1103	367.67
Molmol (parrotfish)	16	5.33	4	1.33	4	1.33
Pakol, Pugot (triggerfish)	1	0.33	1	0.33	1	0.33
Pata (damsel fish)	2762	920.67	273	91	17	5.67
Pisos-pisos (butterfly fish)	17	5.67	61	20.33	3	1
Sanggowanding(moorish idol)	4	1.33	1	0.33	4	1.33
Silay (coral breams)	1	0.33	40	13.33	100	33.33
Bagis (surgeonfish)	65	21.67	1380	460	15	5

Target fish family with high economic value

Figure 3 reveals the target fish family with high market value. It shows that Sunghan (surgeon fish) and Dalagang-bukid (fusiliers) were the common target fish observed in stations 1 and 2, respectively. Naturally larger fish such as Lapu-lapu (grouper), maya-maya (snapper) and Mol-mol (parrot fish) were less likely to observe in the area.

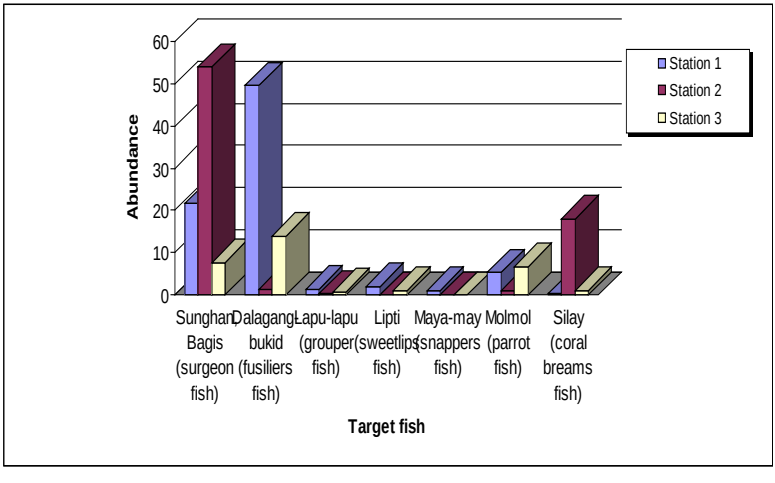

Fig. 3. Average abundance of ecologically and commercially import fish

CONCLUSIONS

The proposal of the area as one of the marine protected area and other coastal management done by the local and city government has significantly protected and preserved the coral reef within the area.

Environmental conditions such as the physical factors and chemical factors of the

coral reef which is considered as fair and moderate are generally suitable for the growth and reproduction of the 18 coral family and 44 coral genera several types of corals which are resulted to its present diversity. Although the topographical description of the coastal are is moderately slope, the steep wall in station 3 greatly affect the coral distribution.

The abundance of small reef dwelling fishes is significant to the diversity and also it portrays the healthy condition of the coral reef.

On the other hand, the socio-economic factors which were mentioned in this study reveal no alarming effects to the coral reef. The coastal development and coastal population are well regulated by the local government. Fishing practices or gears used by the fishermen are mostly tradional in accordance with the law.

RECOMMENDATIONS

1. A series of biodiversity studies on the natural marine resources and rehabilitation of the coral reef in the entire Island Garden City of Samal should be conducted.

2. A careful review on the municipal water boundary is needed since some of the fishermen are not from the localities that may cause some of the damages to the other coral reef in the area.

3. Although marine resources in the city are not yet totally deflated, a sustainable coastal and marine management are very important for the future generation.

4. A strict implementation of the environmental laws should be done to prevent further destruction and for the preservation of the marine resources.

5. Careful reviews of the land use plan of the city, especially on the coastal area are necessary. Effective coastal zoning and control of coastal population are vital. It's expected that in every development done in the area can have an adverse effect the marine resources.

6. Department of Environment and Natural Resources (DENR XI) and City Government of Samal should closely monitor the area to ensure the success of the management applied to the marine resources.

7. The city government of Samal should increase the levels of education offered on the importance of marine sanctuaries and the need to conserve marine resources.

8. Priorities areas which had high coral cover and biodiversity for marine protection to provide a source of coral larvae for future regeneration of coral cover within the Island.

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