Biophysical Profile of Lutao Reef in 2007

Renato C. Diocton, Raul B. Celmar, Danilo A. Mabonga, Ricardo T. Severo, Jr., Aaron D. Garcia, Dante G. Taon, & Fernando R. de Guzman
Samar State University, College of Fisheries and Marine Sciences,
Catbalogan City, Philippines
rdiocton2004@yahoo.com

Abstract: Coral reefs are one of the most productive marine ecosystems that helps replenish fish stocks in the sea. Samar, Philippines relies so much on marine products as the main source of food and livelihood, thus care of its reef is very important. There are several reefs in the bays and seas of Samar with Lutao Reef as the largest for the City of Catbalogan. The barrier reef is estimated to be 1.6 km long and 0.25 km width covering an area of about 37.64 hectares. Despite being a protected habitat since 1996, the reef shows a certain level of degradation attributed to some destructive fishing, gleaning of important marine resource, and practices such as improper waste disposals causing damage to the corals in the reef. Non-biodegradable waste clings on to the coral reef were observed. Only about ¾ is covered with about 13 genres of live corals mostly of Acropora genre. About 10% of the reef corals are dead, some exhibits coral bleaching. A total of 43 species of fish were identified with nine dominant species namely; *Pomacentrus trillineatus, Pomacentrus richardsoni, Plotosus lineatus, Cheilodipterus novemstriatus, Abudefduf vaigienses, Protocaesio tile, Neoglyphidodon melas, Abudefduf sexfasciatus,* and *Cheilodipterus quinquelineatus* with numbers varying monthly. There are signs of slow phase of recovery which can be enhanced with strong intervention from the authorities and the people.

Keywords: Reef fishes, coral bleaching, marine protected area, Maqueda Bay, Samar Sea

1. Introduction

As an archipelago having about 18,000km of shoreline and 7,100 islands, the Philippines is considered a maritime nation and is dependent to a certain level to the healthy coastal environment (DENR, et al., 2001). Over the last 20 years, more than 75% of Philippine coral reefs have been degraded from human activities (Chou et al. 1994; Gomez et al., 1994). Significant to irreversible loss of the ocean and coastal life support systems are expected due to unsustainable use of natural resources, pollution and habitat destruction (www.oneocean.org -1, nd.).

Healthy coral reefs are one of the most productive marine ecosystem capable of producing about 35 MT of coral reef fishes per hectare per year (Alcala,1987). Coral reefs are very diverse, complex ecosystems which occur in shallow tropical waters. Reefs often contain a very dense and diverse assemblage of species, many of which are filtering the water for food, feeding on reef plants, or seeking common prey. Coral reefs are fragile and susceptible to harm from many sources that have differing effects (USCRTF, 1999). Aside from coral reefs protecting coastlines from damaging effects of wave action and tropical storms, it serves as very conducive habitat and shelter for many marine organisms and as a source of nitrogen as well as other essential nutrients for marine food chains (Queensland Museum, nd.).

The Fishing industry depends on the coral reef because many fish spawn there and juvenile fish stay there until they leave to the open sea (Queensland Museum, nd.). The use of aquatic resources has been a challenge to man throughout his existence on earth (Royce, 1972). In 1989, the world catch of marine life peaked to about 89 million tons and

declined since then (Weber 1993; McGinn, 1998). In the Philippines, the decline even started as early as 1950 with catch per unit effort for small pelagic municipal fisheries with a catch of 3 CPUE to less than 0.25 CPUE in the year 2000 (www.oneocean.org -2, nd.) The Philippine fishery production has declined by about 5.9% between 2015 and 2016 with municipal fisheries declining almost the same percentage at 5.06% (PSA, 2016). On the other hand, aquaculture has increased (ibid) due to increased demand and low supply of fish in the wild.

Maqueda Bay and other bays in Samar Philippines are considered to be a major fishing grounds in the Eastern Visayas Region. Like the trend worldwide, these bays are also suffering from all types of overfishing such as growth overfishing, recruitment overfishing, economic overfishing, ecological overfishing and Malthusian overfishing including damaged to benthic habitats caused by trawling, exploiting mud-living bivalves, and use of explosives and poisons (Caldecott, 1996). There was a sigh of relief when the Philippine Local Government Code was passed in 1991 because local authorities were able to implement control of the municipal waters. Destructive fishing like trawlers was restricted to fish within 7 km of shore, excluding outsiders from municipal fishing grounds, banning destructive fishing methods, and establishing sanctuaries for key ecosystems (ibid). The overall impression during the period was very optimistic and considered it as a turning point for Maqueda Bay as the efforts in managing it has gained growing public support (ibid). However, this sentiment during the period were short-lived as people returned to the old ways. According to Samar Sea Fisheries Management Plan of 2016, the fish catch has dropped by about 56.25% in the last 30 years (FAO, 2016). Various studies have shown that 50 commercially important fish species that existed in the Samar Sea in the 1980s were down to 10 a decade after (ibid).

Unsustainable fishing is the most pervasive of all local threats to coral reefs (Burke et al., 2011). Fishermen in the area complained that some uses dynamite, trawl and Danish (*pahulbot*) fishing methods despite of laws/ordinances banning their usage (Cabrales et al., 2015).

2. Objectives

The paper presents the assessment of the biophysical structure of Lutao Reef and the nearby vicinity of the south-eastern part of Samar Sea in 2007 to serve as benchmark information for future studies in Lutao Reef and vicinity.

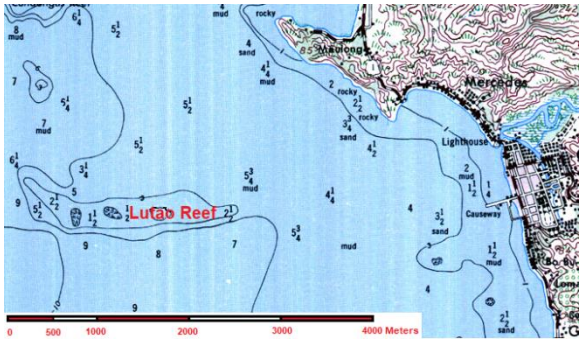
3. Methodology

3.1 Research Design:

The study described the condition of Lutao Reef and its immediate vicinity. Several underwater survey techniques were used, and observations were presented quantitatively regarding frequency counts and proportions presented in tables and graphs. Qualitative descriptions were also presented.

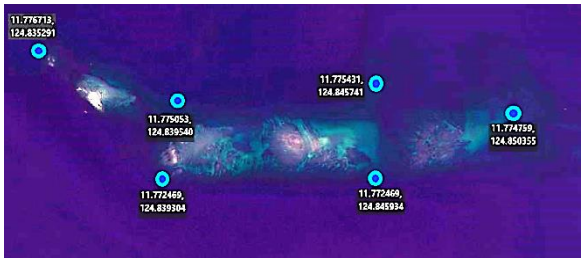
3.2 Research Environment:

Lutao Reef is a barrier reef covering about 37.64 hectares about two (2) nautical miles off Punta de Jesus, SSU Mercedes Campus in Catbalogan City. The reef was declared a marine sanctuary, reserve and as a field laboratory for then Samar Regional School of Fisheries now the SSU Mercedes Campus through a local (Catbalogan, Samar) ordinance number 96-043 series of 1996. The reef system is about 1.6 km width, and the widest part (center portion) is about 0.25 km. Portions of the reef are exposed during low tide.



Source: NAMRIA

Figure 1. Bathymetry map in the vicinity of Lutao Reef



Source: Google Map

Figure 2. Arial shot of Lutao Reef (Photo enhanced/reef submerged in water).

3.3 *Data gathering and tools:*

The survey used a motorized boat, various diving equipment such as SCUBA gears and snorkels, and GPS for recording position. Fishing activities using gill net, hook and line, and fish traps were undertaken to determine catch per unit effort. The determination of water's physicochemical parameters used regular measuring tools such as a thermometer, refractometer and the Secchi disk for water transparency. Secondary information were gathered from the National Mapping and Resource Information Authority (NAMRIA) and satellite images from Google Maps and Bing Maps were also used in the study.

3.3.1 Manta tow survey

Manta tow involves towing a snorkel diver behind a small boat along the upper reef slope to make a direct observation on the distribution of corals on a broad scale. The method used in the assessment of corals was suggested by English et al. (1990). The method is particularly useful for assessing broad changes in the distribution and abundance of coral cover, especially on live corals. The boat was allowed to run at a speed of 3-knots and recording was done every 10 minutes. Obtained percentage estimates of coral cover were converted into a five-point scale as suggested by Uychiaco et al. (2001).

3.3.2 Line Intercept Transect (LIT)

The LIT was performed from a representative spot in an unbroken coral line assemblages. The method is used to assess the sessile benthic organism community of the coral reefs. The community is characterized using the life form categories which provide a morphological description of the reef community. The categories were recorded on data sheets by divers who swim along lines which are placed roughly parallel to the reef crest at a depth of five (5) meters and 10 meters at each site. For the monthly monitoring, the location of each site is recorded and marked on the reef.

There were five permanent transect lines along the reef zone as shown in figure 3. The growth rates of corals were observed for nine months from January to September 2007.

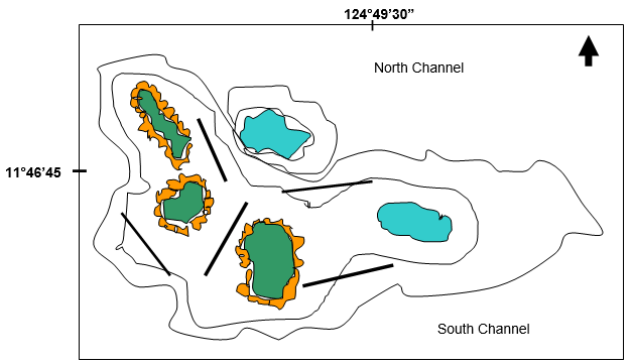


Figure 3. Location of the Permanent Transect and Quadrants

Figure 4. Installing of transect lines

3.3.3 Fish Visual Census

The fish population was estimated using visual census inside a 100 meters transect performed during coral assessment through a LIT methodology. Fish census uses two techniques. The first detects differences in assemblages of reef fishes at different sites using abundance categories. This provides baseline data for zoning, management, and monitoring of coral reef. The second involves counting the individual fish and estimates their total length to determine that standing stock and population size structure of specific species.

3.3 *Data Analysis and presentation:*

Data collected were presented in frequency counts and percentages. Marine species were grouped as to their respective families. The biomass per species per site was expressed in grams per 500 m^2. Biomass estimate was calculated using the formula from Kulbichi et al. (1993).

$Y = aXbN$ (1)

where Y = biomass in grams
X = standard length in cm.
` a and b = constant per specie
N = counts

Catch per unit effort (CPUE) and Yield estimates

$Y_i = C_i D_i N_i$ (2)

$Y_t = \sum_{i=1}^{n} Y_i$ (3)

where:
Y_i = annual yield of particular gear
C_i = catch per day of gear
D_i = average days of gear operation/year
N_i = estimated number of a unit operated in particular gear in the area.

4. Results and Discussion

The Lutao Reef is the largest of several reefs in Catbalogan City waters. Other reefs are the Old Mahayag-Iguid Reef, Cabugawan Reef, Marisan Reef and Buluan Reef. The forgoing are the observations made for Lutao Reef from January to September 2007.

Figure 5 shows a typical barrier reef. Coral growth along the back reef flat is better than the fore reef slope. Some gentler sloped portion of the reef has better coral growth. Coral pinnacles are common in the area.

The reef flat is like fringing reefs that are shallow and nearly flat. Sand and coral rubbles patches are interspersed with seagrass or seaweed beds of sargassum, soft corals, and patches of dense, hard coral cover. Waves and currents have piled up sand forming into sand cays, bar or keys. The richest coral growth is usually at the outer reef crest.

Exposed fore-reef areas often have a series of finger-like projection alternating with the sand channel. There was formation of spur-and grove or buttresses in the area. The wind, waves, or both are involved, because spur and

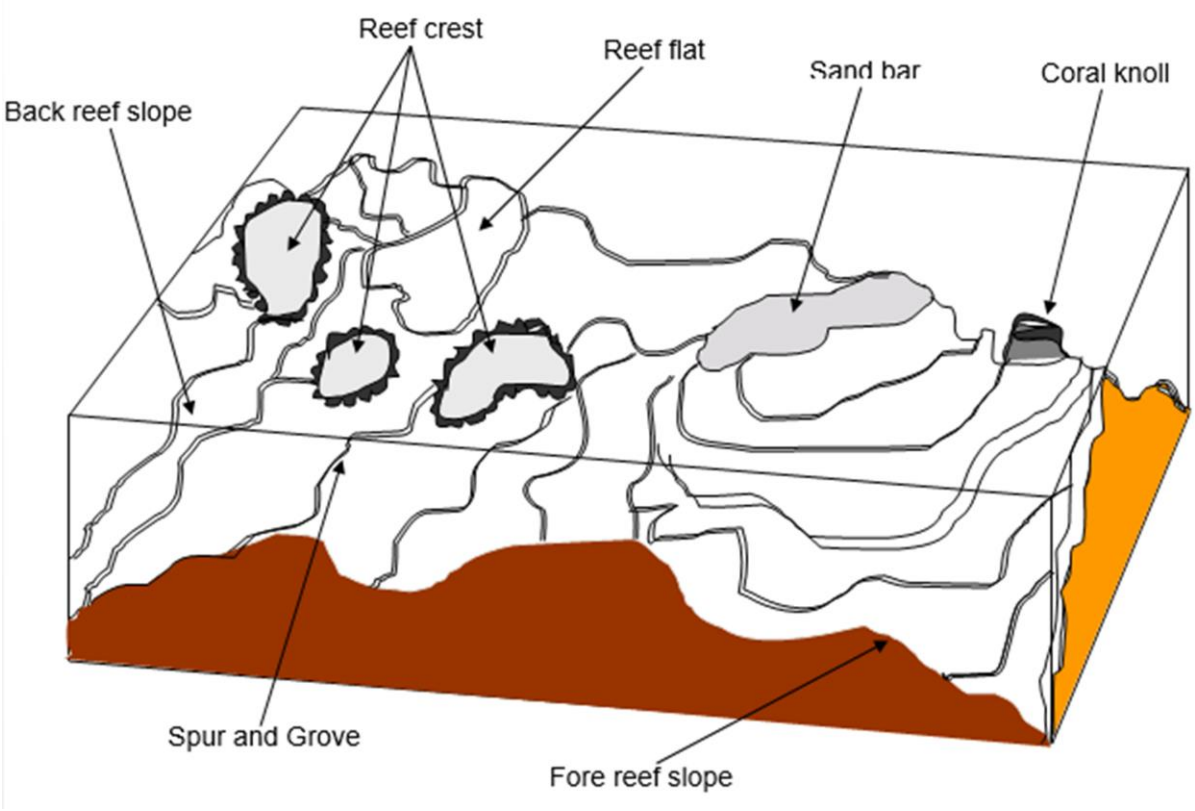


Figure 5. Geophysical Structure of Lutao Reef (southeast view)

grooves formations are developed only when on the reef that exposed to consisting strong winds.

Fore reef slopes vary from relatively gentle to nearly vertical. The steepness is dependent on the wave action. The abundance and variety of corals along the fore reef slopes decreases with depth, and the growth form depends on the location. The coral formation at the crest is mostly stout and compact, and many are massive because it's more exposed to the pounding of the waves. Under the crest is very diverse coral formation. Whether they form branches, columns, or whorls, the corals in this zone often grow vertically upward. This kind of coral growth may be an adaptation to competition. Corals that grow upward like skyscrapers rather than outward need less space to attach. They also likely to be shaded, and if spread out to the top, can shade out other corals. The deeper on the reef slope corals tend to grow in a flat sheet, which probably helps then collect more light.

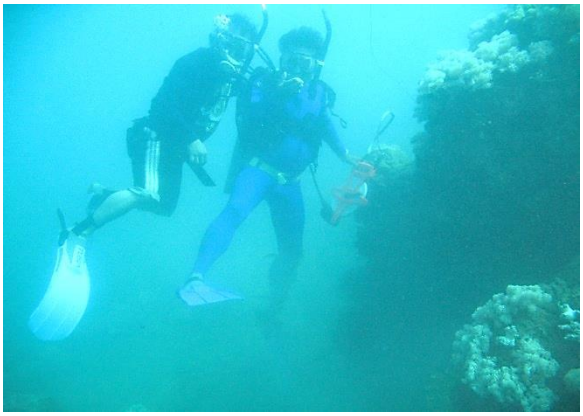


Figure 6. Divers exploring the Fore Reef Zone

4.1 Physico-Chemical Variables

The mean sea water temperature at the fore reef (station 1) was 27.6°C (bottom) and 27.9°C (surface) and at the back reef zone (station 2) recorded at

28.3°C (bottom) and 28.7°C (surface). The mean salinity reading was 33.45 ppt at station 1 and 34.6 ppt at station 2. The highest recorded salinity was in March 2007 which reaches about 36.5 ppt this was due to mild El Niño. Among other factors, high temperature may cause coral bleaching especially those found in the shallow portions (Buchheim, 2013) of Lutao Reef. On the other hand, mean Secchi disk reading on water transparency was 15.4 meters and 12.3 meters for station 1 and two respectively.

4.2 Morphological Characterization of the Corals

A total of six transect line has been established and were monitored monthly using the same method to acquire the time observation of the morphological structure of the reef life forms.

Figure 7. A massive boulder encrusted with secondary growth soft corals

The marine protected area is a barrier reef located in the vicinity of Catbalogan City waters. Despite the existence of local ordinance since 1996, it appears that the reef has not received the kind of protection to enhance the growth of corals. Many physical contaminants were observed during the dive such as the plastic wrappers of food stuff even sanitary napkins. This goes to show that adjacent barangay throw their solid wastes into the sea. Mostly of the garbage found in the reef was a non-biodegradable item such as plastic bags that clings into the reef increasing force applied to the corals from an enhanced pressure which may break them. In the study of Orale (2009), a total of 7.2 tons of wastes are thrown (directly and indirectly) into the sea daily. More than half of these wastes are plastics including plastic bags (ibid). One particular threat to coral reefs are microplastics which when eaten by corals may pose adverse effects to them (Hall et al., 2015), but not enough studies have been conducted to this effect. Larger marine debris can crush and damage corals; some get entangled to corals (NOAA-1, nd.) increasing the impact of strong waves on them.

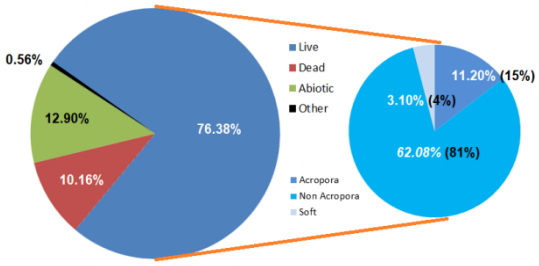


Figure 8. Percent Cover of the Major Benthic Life Forms

Around 76.38% are covered with live corals between the stations observed. These live corals consist of hard coral corals for Acropora 11.20 (15%) and Non-Acropora 62.08 (81%) and soft corals 3.10 (4%). The rest of the stations consists of about 10.16% dead corals recorded, other fauna 0.56% and abiotic of about 12.90%.

Table 1. Estimated Coral Cover of Lutao Reef in Percent

Category	Reef Location			Sand
	Fore	Back	Flat	Bar
Live Coral	65	75	45	1
Dead Coral	5	10	30	1
Soft Coral	15	5	10	0
Sand	2	5	5	95
Rubble	13	5	10	3
Total	100	100	100	100

Table. 2. Growth rates of corals from 2 x 2 permanent quadrat

Genera	# of samples	Initial size (mm)	Mean increment after nine-month	
			Diameter (cm)	Area (cm^2)
Acropora	2	147 x 229; 125 x 234	0.055-1.95	0.215
Coeloseris	1	256 x 347	0.065	0.033
Cyphastrea	1	73 x119	1.05	0.87
Diploastrea	2	278 x 296; 266 x 3.63	0.30-0.40	0.115
Favites	1	56 x 81	0.20	0.03
Galaxea	1	123 x 169	0.02	0.03
Lobophyllia	1	134 x 147	1.35	1.43
Platygyra	2	131 x 142	0.67-0.50	0.05
Porites	2	72 x 75; 80 x 81	0.28-0.35	0.145
Turbinaria	1	124 x 141	0.65	0.33

The highest live cover was located on the back reef. Most likely because it has a steep drop off that give a very conducive growth to corals. The location is exposed to wave action and current coming from Samar Sea. This situation favors the growth of coral which extends side ward of the back reef (Alpino et.al.1998)

Data on the growth of corals belonging to 13 genera were identified. The growth range of Acropora is within the growth range of genus in eastern Cebu (Alcala,1987). This is because Lutao is subjected to wave energy since it is located in a channel leading to the adjacent bay which receives particulate maters of terrestrial origin. Patchiness of coral rubbles was observed suggesting that dynamite fishing was performed inside the reef.

Figure 9. Lace Coral

The decrease in the percentage cover of hard corals is somewhat associated with the increase of other lifeforms such as the soft corals. Rubbles of corals were observed which could be attributed to spear fishing still performed in the area and other destructive fishing practices such as dynamite fishing and trawling are still performed in the area (Cabrales et al., 2015) that can potentially cause of coral breakage. Fishermen activities in the reef like collection of other invertebrates such sea cucumber and mollusc have adverse effects in the reef. Such activity should be regulated to assure the sustainability of the coral reef productivity (Vista et al.,1996). Fishermen tend to disturb the reef in the collection process leading to breakage of fragile coral reefs. One delicate and fragile type of coral is lace corals with one of its species can be found in Lutao Reef.

Table 2 shows the increment of the selected genus of coral inside the quadrant with its initial dimensions. *Acropora*, *Lobophylla* and *Cyphastrea* got the highest increment in the nine (9) months of observation.

It appears that the morphological character of the coral in Lutao Reef is influence by many factors such human activity, wave action and disturbance by physicochemical activity. Distribution of coral is mainly affected by currents and

deposition of the larvae in the reef zone. It can be gleaned in the dendrogram that the sand bar has the biggest value of dissimilarity because the substrate is stable, unlike rock and boulders that larvae can easily settle. Moreover, the location of the sand bar was exposed to terrestrial contaminant or sedimentation by origin that may hamper the settling of coral (Melana et al.,2000)

Figure 10. A dendrogram of the lifeform composition

There is no distinctive lifeform composition, and shallow transect gives low percentage coral cover because of exposure to human induced breakages due to gleaning, anchor breakage, storm surges, monsoonal wave action and even careless spearfishing activity.

4.3 Coral Reef Assemblages

There were around 43 species found in the reef. Indicator species like groupers and butterflyfishes was present in the site but were low in number and biomass. The low number of Grouper maybe due to its high commercial value, on the other hand Butterfly Fish species is also low in number even if the fish has low commercial value.

4.3.1 Fore Reef Zone

Identified reef fishes were both resident and transient but relatively in small sizes. The presence of butterfly (an indicator species) suggests that health of the reef was still in good condition, except of course with the presence of debris from waste that smother the coral reef area. Predator species like *Serranidae* also indicate that reef was still in balance condition. A total of 541 individual fish were estimated during the dive with a biomass of 1,622.99 grams along the transect line at five meters depth contour (see Table 3 and Figure 12). Dominant species are the Stripe catfish and followed by Protocaesio having 200 and 120 counts respectively. Other than predator species butterfly and protocaesio fishes makes the area so colorful. The reef provides a better place for fishes to stop over for feeding especially predation among larger species such as groupers (Armada,1996).

4.3.2 Back Reef Zone

This two crest are connected during low tide where rock boulder was bare that served as land bridges. This looks like a fringing reef type of the island extending eastward with gradually sloping terrain up to 9 fathoms deep. In the slope is inhabited by various species of coral-dwelling and resident fishes.

Figure 11. (T) Blue starfish (B) Juvenile Giant Clam (endangered species)

Table 3. Identified Coral Reef Fishes in Lutao Reef (February 2007)

	Reef Fishes	Fore Reef		Back Reef		Sand bar		Total	
Local (English) Name	Scientific name	f	BM	f	BM	f	BM	f	BM
I-ito (Stripe Catfish)	*Plotosus lineatus*	200	394.4	-	-	300	171.7	500	566.1
Sinaw-an (Protocaesio)	*Protocaesio tile*	120	149.4	126	167.4	-	-	246	316.8
Palata (Sergeant major-1)	*Abudefduf vaigienses*	12	352.5	5	52.2	100	94.6	117	499.3
Mo-ong (Cardinal fish -1)	*Cheilodipterus quinquelineatus*	35	118.0	35	123.2	-	-	70	241.1
Sinaw-an (Redbelly Fusilier)	*Caesio cunning*	-	-	-	-	45	336.2	45	336.2
Lubayan (Wrasse -1)	*Halichoeres scapularis*	21	26.1	21	112.1	2	11.0	44	149.3
Mol-mol (Parrot fish-2)	*Scarus ghobban*	25	13.7	15	23.7	-	-	40	37.4
Siri (Butterfly whiptail)	*Pentapodus setosus*	20	111.8	2	36.8	9	41.2	31	189.8
Palata (Damselfish -1)	*Pomacentrus grammorhyncus*	10	72.9	19	178.4	-	-	29	251.3
Ti-aw (Goatfish)	*Upeneus tragula*	12	121.9	15	98.3	-	-	27	220.2
Mol-mol (Parrot fish -1)	*Diproctacanthus xanthurus*	15	8.2	10	21.2	-	-	25	29.4
Borobolpen (Razorfish)	*Aeoliscus strigatus*	20	6.0	4	9.0	-	-	24	15.0
Danggit (Siganus)	*Sganus gutatus*	20	30.0	3	56.5	-	-	23	86.6
Mo-ong (cardinal fish -2)	*Apogon angustatus*	-	-	-	-	19	30.8	19	30.8
Alibang-bang (Butterfly fish-2)	*Chaetodon oxtofasciatus*	3	14.8	5	16.4	4	15.2	12	46.4
Botete (Puffer fish-1)	*Chelonodon fluviatilis*	2	3.3	1	3.2	9	14.7	12	21.2
Pakol (Triggerfish)	*Acreichthys tomentosus*	5	2.8	2	12.8	1	2.6	8	18.1
Tingag (Grouper-2)	*Epinephelus fasciatus*	5	58.5	1	18.7	2	11.0	8	88.2
Palata (Damselfish-2)	*Abudefduf vaigienses*	-	-	-	-	7	4.5	7	4.5
Bantay kibot (Sea anemone fish)	*Amphiprion melanopus*	1	5.9	1	5.1	4	42.1	6	53.2
Alibang-bang (Butterfly fish-1)	*Chaetodon ocillecaudus*	5	25.7	-	-	-	-	5	25.7
Palata (Sergeant major-2)	*Abudefduf sexfasciatus*	-	-	5	52.2	-	-	5	52.2
Botete (Puffer fish-2)	*Canthigaster solandri*	4	6.5	-	-	-	-	4	6.5
Tingag (Grouper-1)	*Cephalopholis hoenack*	4	78.4	-	-	-	-	4	78.4
Tingag (Grouper-3)	*Ephinephelus malabaricus*	2	22.0	2	41.5	-	-	4	63.5
Lubayan (Wrasse -2)	*Halichoeres chloropterus*	-	-	-	-	1	6.5	1	6.5
	Total	541	1622.7	272	1028.8	503	782.0	1316	3433.5
	Total Number of Species	21		18		13		26	

Legend: f = frequency BM = biomass (grams)

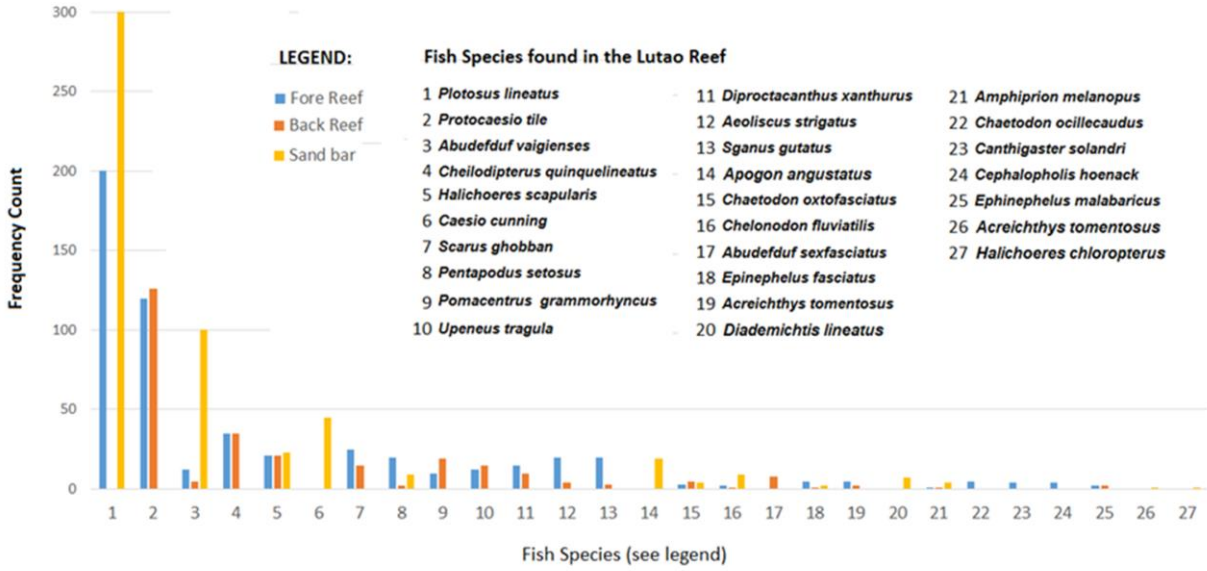


Figure 12. Frequency distribution of Fishes in Lutao Reef

The back reef zone has the smaller number of reef fishes observed during the census. About 18 species were found here, and about 272 fishes were counted with a total biomass of 1,051.9 grams. Dominant in number is *Protocaesio tile* while regarding size, the 19 pieces of Damselfish specifically the *Pomacentrus grammorhyncus* species dominates the area in terms of biomass. This observation is not too different compared to the survey conducted in 2006.

On the other hand, coral was dominated by the massive, encrusting and tabular form which constitutes around 30% of the live coral forms. While branching, staghorn coral and erect folliose show around 20% of the total population. Flora which was present in the area was *Sargassum sp, Padina sp, Caulerpa sp*. and other genera which were about 5% of the seaweed community. Other invertebrates that were present were the top shell, sea urchin, sea cucumber and various starfishes.

This area is potential for giant clam, transplantation and seed bank. Aside from giant clam it can be a good site for culture abalone since natural such as *Laurentia* can be found on the slope. A location is a strategic place for fish migration coming from offshore to near shore reef zone., the crest area can be a good stopover for transient fishes. There was a narrow strip of *Sargassum sp*. line in the shallow portion of the reef front.

Figure 13. Some coral bleaching in the reef

Shown in figure 10 is a coral suffering from coral bleaching. When corals are stressed by changes in conditions such as temperature, light or nutrients, they expel symbiotic algae living their tissues, causing them to turn completely white (NOAA-2, nd.). Among others, the high sea temperature is considered as a major factor of bleaching.

4.3.3 Inner Reef Zone

This area is exposed to northeast monsoon, but a dense live coral cover can be seen in inner reef slope. The area experienced an infestation of the crown of thorn (*Acanthaster planci*) that bleach and kill some branching coral. During the survey, it was noted some of the coral has already recovered from the damage inflicted by the infestation. Various species of reef fishes was recorded however some valued fishes were absent during the dive. The area has a good exchange of seawater that favors the growth of hard and soft corals.

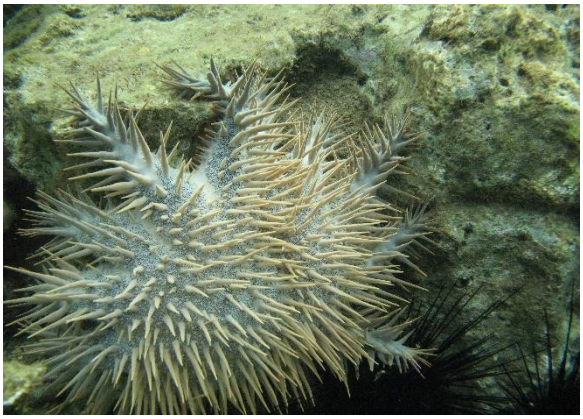


Figure 14. Crown of thorns (locally known as “dap-ag”)

4.3.4 The Sand Bar

The San Bar is a long sand dune with a gradual slope on the eastern part while dropping off on the western side up to 6m. The coordinate of the site was Lat. 11°49'00"N and Long. 124°46'00". The

transparency of the water was fair at only 1.5 m to 10 m visibility. The transparency of the water was severely affected by siltation with 0.5 m visibility. The branching coral that was present in the previous dive is now in rubbles, damaged by dynamite fishing including siltation. Sedimentation rate was high because of the suspended solids that could not be flushed out inside the bar.

A total of 503 of fish was estimated along the transect line with an estimated biomass of 782 grams. There were few genera recorded, but the number of its group was observed to be high and was dominated by Stripe cat fish (*Plotosus lineatus*) with 500 counts and biomass of 566.1g followed by *Protocaesio tile* totalling to 246 with biomass of 316.8g and the 117 pieces of Seargent *major (Abudefduf vaigienses)* with biomass of 499.3g. This representative group of resident species reveals that high valued reef fishes have been exhaustively exploited by night time spear fishing.

There were also butterfly fishes in the Sand Bar area. Biologists consider this species as the good indicator of reef health (Hourigan et al., 1988). The shallow transect of this reef zone had lower percentage of hard coral cover than the deep transect, although submissive corals occurred more frequently in the shallow transects.

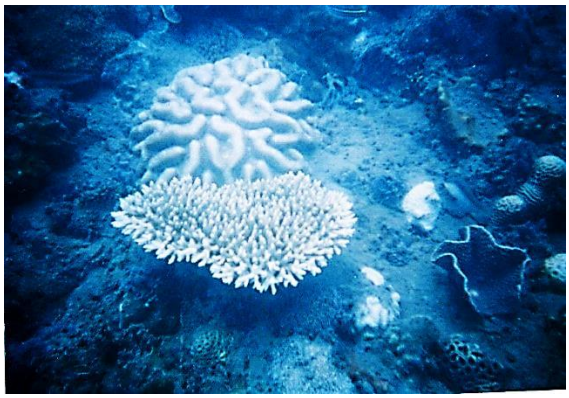


Figure 15. Brain and tabulate corals found in the sand bar area

Patchiness of coral formation sand bar edge can be attributed to the unstable base of the coral once larvae settle, sometimes coral colony up sided with the action of current coral recruits can easily be destroyed by current.

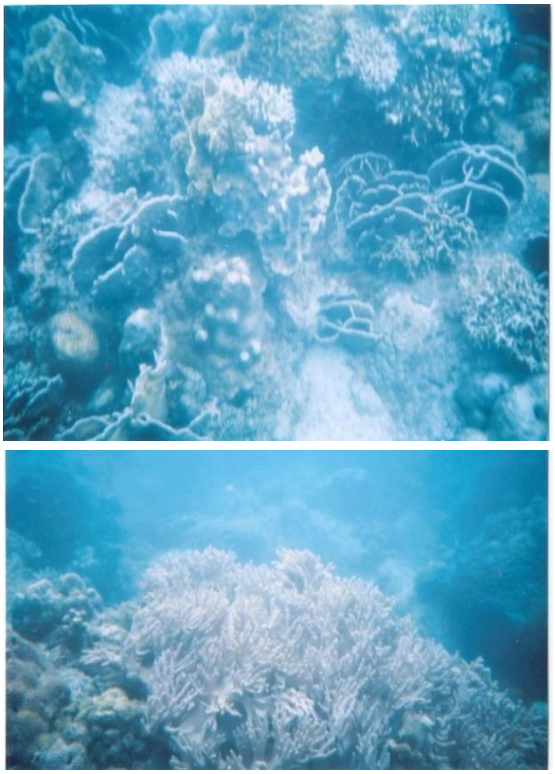


Figure 16. Diverse soft and hard coral in Lutao Reef

The fore reef has the most number of fish followed by the sandbar, and the least was in the back reef. Regarding biomass, the fore reef, back reef, and the sand bar have about 1.62, 1.05 and 0.91 kg respectively. The frequency distribution is shown in figure 12.

4.3.5 Reef Crest

The reef crest of the marine sanctuary is bare during low tide exposing its boulder and big rocks formation. Some branching corals have shown regeneration on the reef slope and the same with foliose erect. Juvenile fish assemblages have been observed near the crest. It was also

observed that the reef had recovered especially inside the protected areas. However, destruction levels of corals outside the buffer zone are very evident due to gleaning of comb oyster *("kuya")* hammer oyster *("aba-aba")* and others. This observation is true in the crest because it is shallow making it conducive for gleaning activities especially during low tide. Fishermen say they are collecting various edible molluscs including sea urchin in the gonad. Sometime they flip boulders to collect abalone damaging the fragile nature of reefs. Interview of fishermen/gleaners reveals they have low appreciation on how to care for the reefs.

Figure 17 shows the recent status of reef crest. It is dominated by soft coral and *Sargassum*. While standing dead coral were also noted that indicates the gleaning activity despite being a sanctuary. In general, the reef has recovered about 5% of live corals, especially on reef slope. Bigger fishes have been sighted in deeper waters adjacent to the reef during the 2007 survey.

Figure 17. Foliose erect corals found abundant in reef crest about 1-meter depth

The shallow portion of the reef is dominated by *Sargassum, Halemida, Turbinaria*, and *Dicyota* a brown algae which are a good habitat for sea horses. There were no sea horses observed during the census. Juvenile mushroom coral was also present on this part of the reef.

The murkiness of the water column was brought out of the siltation and a second growth sargassum near to massive corals. In the deeper portion of the reef corals are sparsely distributed while in the near shore they are closely assembled. There were dead corals in the sites including some rubbles was noted in the southern part of the reef zone.

Fish assemblages were noted to be less compared with the 2006 census. Such decrease in biomass can be attributed to fishing activity by local fisherfolk. Despite fishing pressure inflected to the reef still, numerous species of reef resident fishes still exist, but notably, a small number were present during the survey.

Another important reef zone is the flat reef zone. The entire rock formation was with high soft and hard coral cover. Hard corals were present in foliose, branching, tabulate, encrusting, massive and submassive form. Aside from these, their were also biotic elements such as the sedimentary rock, sand or coral rubbles. There is indicator of good recruitment of corals in the inner reef flat where several genres of corals were noted. On the other hand, the area also exhibits obvious signs of gleaning of hammer shell (aba-aba) in the area. This mollusc is a popular in Catbalogan City; its extraction requires force that disturbs and damages the reef significantly.

Figure 18. Encrusted Sargassum bed in reef flat

Some of the seaweed debris comes from the farm adjacent to the marine protected area because of the inclement weather that has happened during the census. This natural cycle frequently occurs especially in shallow portions of the reef. The year 2007 was considered an El Niño year where damage to a shallow portion of the reef due to a higher temperature is expected.

Another danger to the reef is the presence of crab meat processing plant nearby that may cause bleaching brought about by chlorine used to disinfect and the sewage that untreated before draining into the coast. There is great possibility that even narrow mangrove strips can be affected by effluents from the processing plant. Also, the silt-rich water coming from the rivers in the mainland especially during rainy seasons poses a danger to coral reefs.

Interviews conducted with local fishers reveals that they have too little information about the marine protected zones of Catbalogan. Many are not aware of the specific boundaries of these protected sites as no markers were not available.

4.4 Four-Month Fish Census

Of the 43 species identified in the reef, only four (4) species was present in the entire four-month census, namely; the Razorfish *(Aeoliscus strigatus)*, Siganus *(Siganus gutatus)*, Stripe Catfish *(Plotosus lineatus)*, and a specie of a Grouper *(Cephalopholis hoenack)*. The rest of the fishes may be too few, small (juvenile or small sized species) to get noticed, have been exploited (harvested/fished) or has migrated to another location. The recruitment, mortality, and migration are very different between species. Jones (1990) says that variation in the composition of coral reef fish assemblages as well as their abundance is a result of recruitment patterns. He further expressed that in experimental reefs, adult members increased as a function of recruitment. In a study of Caribbean reef fish have shown that 67% of species for which recruitment limitation has been demonstrated, changes in benthic mortality are likely to have a stronger influence on observed limitation of adult population sizes than are proportionately equivalent to changes in recruitment rate (Shulman & Ogden, 1987). It is likely that the abundance of a particular fish species in a reef is the effects of numerous variables such as competition, predation, and available habitat (Massoud, 2002).

The top five species in the Lutao Reef in terms of abundance are Protocaesio *(Protocaesio tile)*, Seargent major *(Abudefduf vaigienses) and three* Damsel fish species namely *Pomacentrus trillineatus, Neoglyphidodon melas, and Pomacentrus richardsoni* . Most abundant are *Pomacentrus trillineatus* and *Pomacentrus richardsoni* which peaked in September 2007.

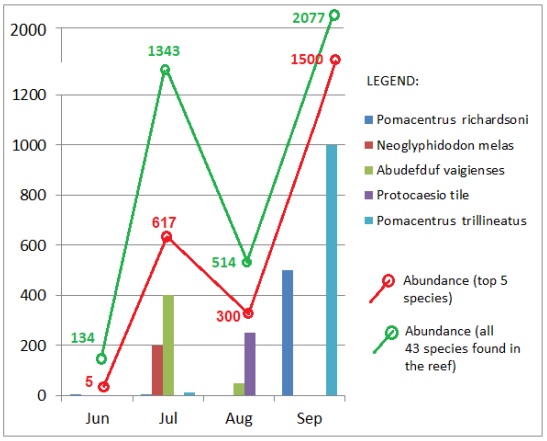


Figure 19. Population Dynamics of Reef Fishes (top five most abundant and overall)

Table 4 shows the fishes identified during the fish visual census in Lutao Reef from June to September 2007. In June, around 19 species of fishes with a total count of 134 and a biomass of about

Table 4. Reef Fish Census (June-September 2007)

Reef Fishes			Jun-07		Jul-07		Aug-07		Sep-07	
Local Name	English name	Scientific name	f	BM	f	BM	f	BMI	f	BM
Alibangbang	Butterfly fish	*Chaetodon oxtofasciatus*	7	24.97	5	44.84	5	41.48	-	-
Alibangbang	Butterfly fish	*Chaetodon ocillecaudus*	-	-	1	8.96	2	8.86	1	8.16
Bantay kibot	Sea anemone fish	*Amphiprion melanopus*	-	-	-	-	2	14.94	-	-
Borobolpen	Razorkfish	*Aeoliscus strigatus*	10	43.2	20	26.99	8	10.98	7	25.23
Botete	Puffer fish	*Canthigaster solandri*	-	-	2	10.83	1	4.51	1	4.23
Botete	Puffer fish	*Chelonodon fluviatilis*	-	-	-	-	2	12.25	-	-
Botete	Puffer fish	*Stephanolepis tomentusos*	-	-	1	4.43	-	-	-	-
Danggit	Siganus	*Siganus gutatus*	21	56.23	25	122.4	11	132.05	40	382.23
Hamurok	Mojarra	*Gerres oyena*	-	-	-	-	-	-	15	36.6
I-ito	Stripe Catfish	*Plotosus lineatus*	20	14.55	70	188	100	193.43	300	122.89
Lubayan	Wrasse	*Stethojulus strigiventer*	-	-	1	8.47			15	56.31
Lubayan	Wrasse	*Halichoeres melanurus*	1	2.6	12	110.82	-	-	-	-
Lubayan	Wrasse	*Halichoeres scapularis*	2	2.33	5	36.36	5	36.49	-	-
Lubayan	Wrasse	*Coris variegate*	12	23.98	-	-	-	-	-	-
Lubayan	Wrasse	*Pseudocheilnus octotaenia*	2	2.35	-	-	-	-	9	44.58
Lubayan	Wrasse	*Halichoeres chloropterus*	-	-	4	28.83	-	-		
Lubayan	Wrasse	*Halichoeres hoeveni*	-	-	1	9.2	-	-	-	-
Lubayan	Wrasse	*Halichoeres margaritaceous*	-	-	1	9.01	-	-	-	-
Mol-mol	Parrot fish	*Diproctacanthus xanthurus*	-	-	-	-	15	6.2	-	-
Mol-mol	Parrotfish	*Scarus ghobban*	-	-	2	121.35	5	12.68	-	-
Mo-ong	Cardinal fish	*Cheilodipterus novemstriatus*	2	3.5	300	92.52	-	-	150	126.32
Mo-ong	Cardinal fish	*Cheilodipterus quinquelineatus*	2	6.3	100	108.43	25	117.59	-	-
Mo-ong	Cardinal fish	*Apogon angustatus*	3	3.52	-	-	-	-	-	-
Pakol	Triggerfish	*Acreichthys tomentosus*	-	-	1	31.2	2	8.67	5	45.63
Palata	Damsel fish	*Pomacentrus trillineatus*			12	18.02	-	-	1000	255.34
Palata	Damsel fish	*Pomacentrus richardsoni*	5	16.23	5	22.54	-	-	500	171.9
Palata	Sergeant major	*Abudefduf vaigienses*	-	-	400	575.04	50	123.25	-	-
Palata	Damsel fish	*Neoglyphidodon melas*	-	-	200	144.18	-	-	-	-
Palata	Damsel fish	*Abudefduf sexfasciatus*	-	-	150	144.88	-	-	-	-
Palata	Damselfish	*Pomacentrus grammorhyncus*	2	3.57	-	-	8	70.49	-	-
Parog	Goby	*Acentrogobius puntang*	9	41.66	-	-	-	-	-	-
Parog	Stripe blenny	*Meiacanthus grammistes*	2	2.3	-	-	-	-	-	24.02
Parog	Urchin cling fishes	*Diamdemichthyis lineatus*	2	18.02	1	6.36	-	-	-	-
Salay salay	Moorish idol	*Zanctus cornutus*	-	-	2	10.07	-	-	-	-
Sinaw-an	Protocaesio	*Protocaesio tile*	-	-	-	-	250	394.38	-	-
Sinaw-an	Protocaesio	*Protocaesio tile*	25	69.78	10	154.05	-	-	-	-
Siri	Butterfly whiptail	*Pentapodus setosus*	-	-	1	8.25	2	11.87	3	46.12
Ti-aw	Goatfish	*Upeneus tragula*	-	-	-	-	12	12.39	5	56.41
Tingag	Grouper	*Cephalopholis hoenack*	5	28.16	5	19.4	4	65.37	2	15.35
Tingag	Grouper	*Epinephelus fasciatus*	2	6.52	6	66.56	-	-	5	24.23
Tostos	Sand perch	*Parapercis cylindrical*	-	-	-	-	-	-	8	26.5
Tostos	Sand perch	*Parapercis cylindrica*	-	-	-	-	5	16.43	-	-
Tostos	Sand perch	*Parapercis mimaseana*	-	-	-	-	-	-	5	56.58
		Total	134	369.77	1343	2131.99	514	1294.31	2077	1528,63
		Number of species	19		28		20		19	

369.77 grams, relatively lower from the 2006 survey. In July 2007, the number of species increased to 28, the highest in the four month observation period. A total of 1,343 pieces of fishes were estimated with a biomass of 2131.99 grams. The number of fishes went down in August to 514 pieces and later bounce back to 2077 with Damsel fish particularly the *Pomacentrus trillineatus* species dominating.

A total of 2,077 individual fishes were counted during the survey which amounted to a biomass of approximately 1.53 kg. This consist 19 species belonging to 14 genera and 12 families. Such composition of fish was quite fair considering of the damages in the reef observed specially due to blast fishing. Fishing using gill net can also damage to branching in the area since it is easily entangled when drifted to corals. Some of *Euchuema cottonii* were also found in the vicinity which is distributed in the reef zone. In general, the reef zone is still intact but need to be monitored frequently.

Figure 20. Dense juvenile *Ceasionidae* dominates in the reef

The reef is very close to the city center, and monitoring should not be an issue. The condition of the reef during the survey indicates that reef protection was not strictly implemented. Other practices such as waste disposal and the silt-rich storm water from the main land also affected the reef. Lutao Reef can recover on its own but requires support from the authorities to prevent further damage and improve the growth rate of corals.

5. Conclusion and Recommendation

The following conclusions were derived based on the survey made in 2007.

The 37.64 hectares of reef currently houses about 43 species of fishes. A little more than ¾ of the area is covered with live corals dominated by non-Acropora type. Around a tenth is dead corals, some exhibits coral bleaching, others are rubbles believed due to dynamite fishing and harvesting of corals.

There are around 43 species of fish during the census with numbers fluctuating. Most abundant fishes belong to the family of Damselfish.

The reef is growing but in the slow phase. It is stressed with marine debris and silt-rich runoff waters during heavy perception. There are indicators that destructive fishing activities are present within the reef because of gleaning of hammer shell and comb oyster, fishing activity and collection of valuable marine species like abalone, sea urchin, and others.

Enforcement of ordinance making Lutao Reef a marine protective area is weak, no demarcation of the protected zone is installed, and local fisher folks are not too aware of the restrictions and locations of the protected zones.

6. Bibliography

Alcala, A.C. 1987. Effects of marine reserves on coral fish abundance and yields of the Philippine Coral Reefs. Ambio 17 (3).

Alcala, A.C. 1995. Possible effects of water pollution on corals reefs of Negros Island, Philippines. Proc. 4th Reg. Seminar. Biology and Agriculture Research. NRCP Bull. No. 63

Alpino, J. P, J. P. Salazar, J. P. Meniano, and E H. Cebu. 1998. Rapid Resource Assessment on the Coastal Areas of Lao-ang, Northern Samar (Unpublished).

Armada, N. B. 1996. Capture Fisheries of San Pedro Bay, the Philippines In: Resource and Ecological Assessment of San Pedro Bay – Volume 5.

Buchheim, J. (2013). Coral Reef Bleaching. Odyssey Expeditions. Tropical Marine Biology Voyages. http://www.marinebiology.org/coralbleaching.htm Accessed July 3, 2017

Burke, L., Reytar, K., Spalding, M., and Perry, A. (2011). Reefs at Risk Revisited. Washington, D.C., World Resources Institute (WRI), The Nature Conservancy, WorldFish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network

Cabrales, PS., Racuyal, JT. and Mañoza AG. (2015). Crabbing into an Uncertain Future: The Blue Swimming Crab Fisher in Coastal Town of Eastern Philippines. Countryside Development Research Journal, 3(1).

Caldecott, JO. (1996). Designing Conservation Projects. Cambridge University Press

Chou, LM., Wilcinson, E, Gomez E., and Sudara, S. (1994). Status of Coral Reefs in the ASEAN Region, In C. Wilkinson (ed.) Living Coastal Resources of Southeast Asia: Status and Management. Report of the Consultative Forum, Bankok, Thailand, May 1994. Australian Institute of Marine Science, Townsville.

DENR, DA-BFAR, DILG. (2001). Philippine Coastal Management Guidebook No. 1: Coastal Management Orientation and Overview. Coastal Resource Management Project of the Department of Environment and Natural Resources, Cebu City, Philippines.

English, S., S. Wilkinson and V. Baker (Eds) 1994. *Survey Manual for Tropical Marine Resources*. ASEAN-Australia Marine Science Project: Living Coastal Resources. Australian Institute of Marine Sciences, Townsville, Australia

Food and Agriculture Organization of the United Nations, FAO. (2016). FAO, BFAR address biodiversity loss in Samar Sea. http://www.fao.org/philippines/news/detail/en/c/435529/ Accessed October 3, 2017

Gomez, ED., Aliño, PM., Yap, HT., Licuanan, WY. 1994. A review of the status of Philippine Reef. Marine Pollution Bulletin 29(1-3)

Hall, NM., Berry, KLE., Rintoul, L., Hoogenboom, MO. (2015). Microplastics ingestion by sclerractinian corals. Marine Biology, 162(3).

Hourigan TF., Timothy CT., Reese ES. (1988) Coral Reef Fishes as Indicators of Environmental Stress in Coral Reefs. In: Soule D.F., Kleppel G.S. (eds) Marine Organisms as Indicators. Springer, New York, NY

Jones, GP (1990). The importance of recruitment to the dynamics of a coral reef fish population. Ecology 71.

Massoud, Fish Recruitment to Reefs. Tropical Ecosystems: Coral Reefs, Rainforests and A Potpourri of Weather, Earth Science and Other Good Things. Miami University. http://jrscience.wcp.muohio.edu/FieldCourses00/PapersMarineEcologyArticles/FinalPaper.FishRecruitmen.html Accessed November 2, 2017.

McGinn, AP. 1998. Rocking the boat: Conserving fisheries and protecting jobs. Worldwatch Paper 142. Worldwatch Institute, Washington, D.C.

Melana, D. M., J. Atchue III, C. E. Yao, R. Edwards, E. E. Melana, and H. I. Gonzales, 2000. *Mangrove Management Handbook.* Department of Environment and Natural Resources, Manila, Philippines through the Coastal Resources Management Project, Cebu City, Philippines.

National Oceanic and Atmospheric Administration, NOAA-1. (nd.). How Marine Debris Impact Corals? https://marinedebris.noaa.gov/impacts/how-does-marine-debris-impact-corals Accessed November 2, 2017

National Oceanic and Atmospheric Administration, NOAA-2. (n.d.). What is Coral Bleaching? https://oceanservice.noaa.gov/facts/coral_bleach.html Accessed October 3, 2017.

Oneocean.org-1. Managing Philippine Coasts and Seas: Understanding the Challenge. http://oneocean.org/flash/the_philippine_seas.html Accessed June 12, 2017.

Oneocean.org -2 (nd.) The Philippine Fisheries Situation. http://oneocean.org/fish/the_philippine_fisheries_situation.html Accessed June 12, 2017.

Orale, RL. (2009). Towards solving coastal debris problems in Catbalogan, Samar and Maqueda Bay, Philippines. Asian Journal on Energy and Environment, 10(02).

Philippine Statistics Authority, PSA. (2016). Fisheries Situationer, April – June 2016.

Queensland Museum, (nd.). Importance of Coral Reefs. http://www.qm.qld.gov.au/microsites/biodiscovery/05human-impact/importance-of-coral-reefs.html Accessed July 3, 2017.

Royce, W. F. 1972. Introduction to the Fishery Sciences. Academic Press, Inc., New York; pp. 343.

Shulman, MJ., Ogden, JC. (1987). What controls tropical reef fish populations: recruitment of benthic mortality? An example in the Caribbean reef fish *Haemulon flavolineatum*. Marine Ecology – Progress Series, 39

US Coral Reef Task Force, USCRTF, (1999). Coral Reef Protected Areas: A Guide for Management. https://www.coralreef.gov/ecosystem/strate.html Accessed July 17, 2017

Uychiaoco, A. J, S. J. Green, M. T. Dela Cruz, P. A. Gaite, H. O. Arceo, P. M. Aliño, and A. T. White, 2001. *Coral Reef Monitoring for Management*. University of the Philippines Marine Science Institute, United Nations Development Programme Global Environment Facility-Small Grants Program, Guiuan Development Foundation, Inc., Voluntary Service Overseas, University of the Philippines Center for Integrative and Development Studies, Coastal Resources Management Project, and Fisheries Resource Management Project. 110 p.

Vista, R., G. Arellano, P. Novio, S. Giray, E. Caballero, E. de Asis, and N. Narca (Eds), 1996. *An Estuaryo*. Provincial Agrarian Reform Coalition for Rural Development and Foundation for Philippine Environment

Weber, P. 1993. Abandoned seas: Reversing the decline of the oceans. Worldwatch Paper 116. Worldwatch Institute, Washington, D.C.

White, A. T. 1990. Coral Reefs: Valuable Resources of Asean Region. ASEAN/US CBRMP Education Series No. 1