ISSN 2455-4863 (Online) **www.ijisset.org** *Volume: 5 Issue: 7 | 2019*

"Fish and Plankton Resources of Cabugao Bayin Catanduanes Island, Philippines"

Ryan Paul C. Brillante[1], Jimmy T. Masagca[2]

[1]*Faculty Member, Natural Science Department, College of Arts and Sciences*

[2]*Faculty Member, Natural Science Department, College of Arts and Sciences and Research Director, Catanduanes State University, Catanduanes, Philippines*

ABSTRACT: *This paper aimed at determining the fish and plankton resources of Cabugao Bay in Catanduanes Island, Luzon, Philippines during November-December 2017 and January 2018 by evaluating (a) fish species, (b) phytoplankton species, and (c) blue green algae in water samples. Descriptive method of research was used through fieldwork survey. Six sampling sites were considered. Results showed that blue green algae readings in water sample and phytoplankton species are evident in Cabugao Bay. Three similar species of phytoplankton were found in all the six study sites established in the bay. Fish species determined recorded a total of 31 families and 52 genera. Studies in the future may tackle the correlation of physico-chemical parameters between blue green algae and phytoplankton species considering diurnal or tidal fluctuations in Cabugao Bay. Correlation studies on zooplankton and phytoplankton species may likewise be carried out to determine non-point pollution attributed to oil, gasoline, and the presence of microplastics.*

Keywords: *coastal waters, blue green algae, phytoplankton species, fish species*

1. INTRODUCTION

The Philippine archipelago has more than 1,700 reef fish species and an estimated nine percent of global coral reef area (approximately 25,060 km^2) [1]. With this scenario, the country is home to numerous aquatic and marine resources. However, the marine resources of the Philippines are also experiencing the highest level of anthropogenic and climatic threats [2]. The anthropogenic threats include fishing overcapacity; overfishing and destructive fishing practices; increased domestic, agricultural, and industrial runoff from a burgeoning population; poor land use; and increased sedimentation from forest deforestation and unregulated mining activities [3], [4], [5]. Environmental problems, including water quality decline and pollution, have exacerbated the reduction in fisheries productivity [6]. Hence, determining the fish and plankton population in Cabugao Bay will allow understanding of the impacts of cumulative stressors and enable decision-making that will incorporate trade-offs in ecosystem goods and services. This will also allow a holistic approach to ecosystem-based management (EBM) that will account for from bottom-up (e.g. eutrophication, primary producers or plankton analysis) to top-down (e.g. data from fish landings) [7].

Catanduanes is a small island in the Pacific which is one of the 7,100 islands comprising the Philippine archipelago. It lies between 13.5^0 and 14.1^{0}N Latitude and extends from 124.0^0 to 124.5^{0}E Longitude. Being along the Pacific side of the Philippines, it is surrounded by coastal waters joining the vast Pacific. As such, its waters are home to a large number of aquatic life. This study was carried out in one of the island's small body of water known as Cabugao Bay. It is a small body of water which serves as the island's vital source of fishes. It is also perceived to be a productive ecosystem wherein the coastal municipalities of Virac and Bato, to some extent, depend for protein from fish; and fishing is the source of livelihood of a great number of the population living in the coastal area. The bay also serves for the propagation and growth of fish and other aquatic resources which are intended for commercial and sustenance of fishing. People use it as well for recreation or similar activities as there are a number of beach resorts along the area. Hence, the beaches along the coast of Cabugao Bay cater for fisheries activities, entertainment, tourism, and other human activities.

The study determined the biological features of Cabugao Bay in terms of fish population, phytoplankton population, and blue green algae in water samples.

2. METHODOLOGY

The map of Cabugao Bay (Figure 1) shows the location of the six sampling sites. Study sites 1 (Batalay) and 2 (Guinobatan) are far from the shore while study sites 3 (San Vicente-IbongSapa), 4 (Francia-rawis-Santa Cruz) and 5 (Salvacion-San Pablo) are close to the shore. Study sites 2 (Guinobatan) and 6 (Palnab-Pajo-Antipolo) are influenced at the entrance of rivers. These study sites cover the coastal area of Cabugao Bay stretching to the municipalities of Bato and Virac.

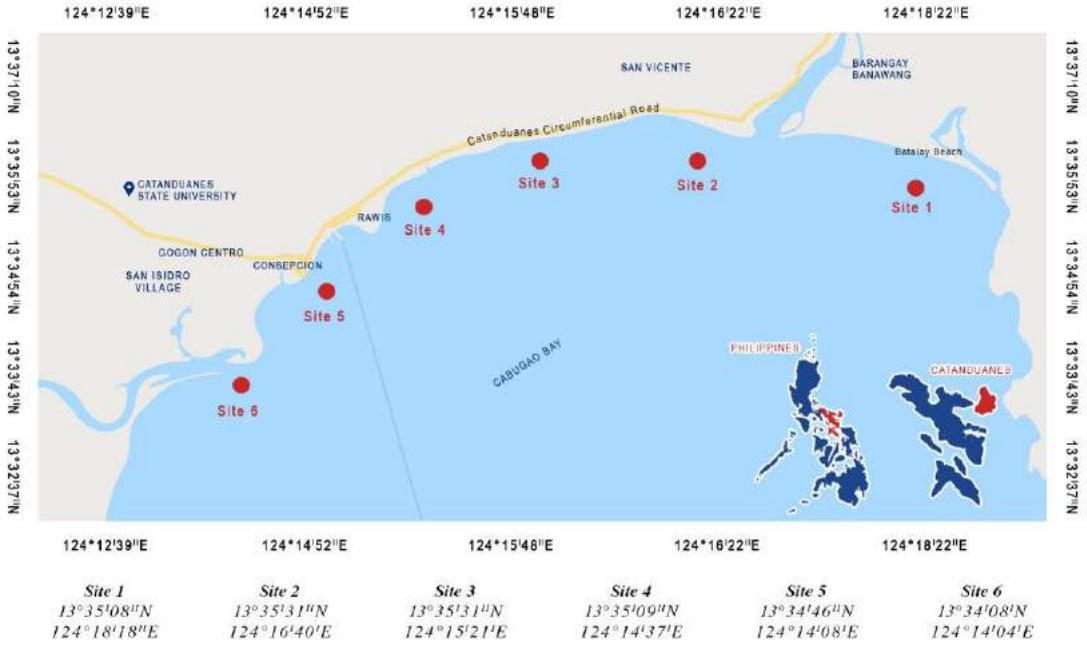


Figure 1. Map of Cabugao Bay showing the six study sites

Samples were collected during the months of November and December 2017 and January 2018 in six stations at the study area. Collection of water samples was done twice for November 2017 and January 2018. In December 2017, the collection was done once due to heavy rains and weather disturbances causing rough seas which made it impossible for the researcher to gather the samples during those times.

Water samples for phytoplankton were collected using vertical and horizontal net towing (160 um mesh size). The process used by [8] in the identification of the composition of cell counts into carbon biomass was adapted in this study.Collections of phytoplankton were made not deeper than 1.5 m in all the stations established in Cabugao Bay. Phytoplankton collections were made at each station via whole water samples from 0.1 to 0.5 m (representing surface) and between 1.0 to 1.5 m. No bottom whole water sample collections were done due to logistical limitation for bottom sampling. Samples were collected in the morning from 4:00 to 6:00 and in the afternoon from 4:00 to 6:00.

Each whole water sample was filtered by using ordinary commercial tissue paper and Whatman filter paper. Collected water samples for phytoplankton were concentrated by allowing cells to settle for three days following the work of [9]. Using 1.5 L of plastic bottles the 50 ml phytoplankton samples emptied into amber bottles. The samples were stored in a cooler maintaining a temperature of at least 15ºC in until microscopic observation. Phytoplankton cell counting was done in a Sedgwick-Rafter counting chamber. Two ml of the sample was dropped onto slide and three predetermined horizontal micro transect strips were followed. Microscopic observation was accomplished under high power objective (HPO) at 1,000 magnifications of Olympus microscope. Each organism encountered was counted. In the absence of a photomicroscope hand drawings were made. Taxonomic identification was done afterwards using several references [10], [11], [12].Individual cells represent the unit of phytoplankton density during microscopic examination. Phytoplankton occurring in colonies, filaments, and in pairs were counted as one cell as well as those undergoing cellular division. Other unique and distinguishable features such as *theca* or *lorica* that might suggest an organism's presence were considered when identifying so that they could be used to classify an organism down to its genus.

Collections of fishes were done using fishing gears of the cooperating fishermen. Actual fishing was done during the months of November and December in 2017, and in January 2018. Fishing nets were placed on selected area in the bay at around 6:00 in the afternoon and these nets were taken out from the bay early in the following morning from 5:00 until 8:00. Fish samples were identified using a Guidebook [13].

Simplecounting and arithmetic mean were used in the analysis of the data.

3. RESULT AND DISCUSSION

3.1 Fish Population

Table 7 summarizes the listing of the different taxa of fishes obtained from Cabugao Bay during the study period November 2017 to January 2018. A total of 31 families and 52 *genera* of fishes were obtained during the study period from November-December 2017 to January 2018.

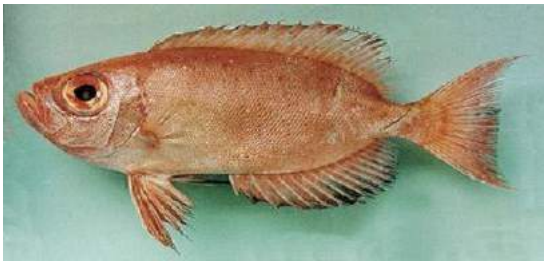
Table 1 *Different Taxa of Fishes Obtained from Cabugao Bay during the Study Period November 2017 to January 2018*

	FAMILY	GENUS	SPECIES	Local Name, English Name
1	Acanthuridae	*Acanthurus*	sp.	Surahanputi
	Acanthuridae	*Acanthurus*	*A. olivaceus*	Gurisan, surahahn. Labahita
2	Bothidae	*Arnoglossus*	sp.	Scaldfish
3	Carangidae	*Carangoides*	*C. ciliarus*	Longfin cavalla
	Carangidae	*Megalaspis*	*M. cordyla*	Pak-an
	Carangidae	*Selaroides*	sp.	Cavalla
	Carangidae	*Selar*	*S. crumenolpthalmus*	Matangbaka
4	Clupeidae	*Sardinella*	*S. fimbriata*	Sardines
5	Decapteridae	*Decapterus*	*D. macrosama*	Sibubog
6	Ephiphidae	*Platax*	*P. pinnatus*	Batfish,
7	Gerreidae	*Gerres*	*G. filamentosus*	Sakalan
8	Gobiidae	*Preolepis*	sp.	Biya
9	Haemulidae	*Pomadasys*	*H. hasta*	Painted sweet lips
	Haemulidae	*Plectorhincus*	*P. gobosssus*	Hot lips
10	Hemiramphidae	*Hemiramphus*	*H. far*	Bugiw
	Hemiramphidae	*Hemirampus*	*H. lutkei*	Luke's
11	Holocentridae	*Myripristis*	sp.	Holocenctrid fishes
12	Labridae	*Cheilinus*	*C. chlorourus*	Wrasse
13	Lethrindae	*Lates*	*L. calcalifer*	Bulgan, apahap, barramundi
	Lethrinidae	*\Gymnocranius*	*L. elongates*	Agoot
	Lethrinidae	*Lethrinus*	*L. nebulosus*	Bukhawan, spangled emperor
	Lethrinidae	*Lethrinus*	*L. miniatus*	Dugso, trumpet emperor
14	Leiognathidae	*Leiognathus*	*L. bindus,*	Sapsap
	Leiognathidae	*Leignathus*	*L. canaliculatus*	Sapsap
	Leigonathidae	*Equulites*	*E. leuciscus*	Whipfin pony fish
15	Lutjanidae	*Lutjanus*	*L. gibbus*	Hurabas, maya-maya
	Lutjanidae	*Aprion*	*A. virescens*	Adgaon, green jobfis
16	Megalopidae	*Megalops*	*M. cyprinoides*	Buanbuan
17	Muraenosocidae	*Gavialiceps*	sp.	Eel
	Muraenosocidae	*Muraenesox*	*M. cinereus*	Eel
18	Mugilidae	*Valamugil*	*V. buchanani*	Bisugo, kanasi, ornate threadin
19	Nemipteridae	*Gymnocranius*	sp.	Nemipterid
20	Paralichthydae	*Pseudorhombus*	*Arsius*	Palad
21	Polynemidae	*Eleotheronema*	*Tetradactylum*	Buka-dulce, bungot
22	Priacanthidae	*Priacanthus*	*P. tayenus*	Malaki mata
	Priacanthidae	*Priacanthus*	*P. harmur*	Kuwaw, moontail bulls eye
23	Rachycentridae	*Rachyentron*	*R. canadum*	Canadian grunt
24	Scaridae	*Leptoscarus*	*L. vagiensis*	Molmol, angol
25	Scombridae	*Scomberomorus*	*S. commerson*	Tangigue, barred Spanish mackerel
	Scombridae	*Scomberoides*	*S. tala*	Bagaongon
26	Serranidae	*Variola*	*V. albimarginata*	Lapu-lapu, lana, rana
	Serranidae	*Epinephelus*	*E. sexfasciatus*	Grouper, lapu-lapu
	Serranidae	*Epinephelus*	*E. tauvina*	Balaka, Baraka, grouper
	Serranidae	*Plectorhinchus*	sp.	Sapan, alatan
27	Siganidae	*Siganus*	*S. analiculatus*	Turos, tulos, kataway
	Siganidae	*Siganus*	*S. guttatus*	Mublad, sandig
28	Sillaginidae	*Sillago*	*S. sihama*	Asohos
29	Soleidae	*Dexilus*	*D. muelleri*	Palad
30	Sphyreanidae	*Sphyraena*	*S. zygaena*	Barracuda
	Sphyraenidae	*Sphyraena*	*S. forsteri*	Titso, barracuda
31	Therapontidae	*Terapon*	*T. jarbua*	Bagaong
	Therapontidae	*Pelates*	*P. quadrilineatus*	Bagaong, spangled emperor

Number of Family = 31; Number of Genera = 52

The different fish species caught in Cabugao Bay as documented by this study are hereby presented.

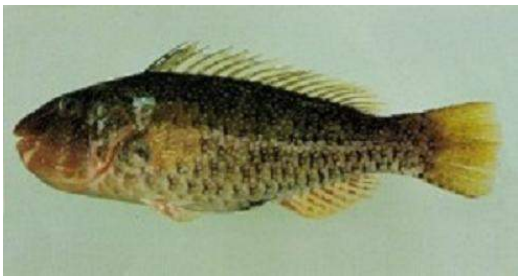
Local/Common Name: *kuwaw*
English Name: Moontailbullseye
Scientific Name: *Priacanthushamrur*



Local/Common Name: *kuwaw*
English Name: Red bigeye
Scientific Name: *Priacanthusmacracanthus*

Local/Common Name: *Rana, Lana, Lapu-lapu*
English Name: White-edged lyretail
Scientific Name: *Variolaalbimarginata*

Local/Common Name: *Buka-dulce, Bungot*
English Name: Fourfinger threadfin
Scientific Name: *Eleutheronematetradactylum*



Local/Common Name: *Molmol, Angol*
English Name: Marbled parrotfish
Scientific Name: *Leptoscarusvaigiensis*

Local/Common Name: *Balaka, baraka*
English Name: Longfin grouper
Scientific Name: *Epinephelusquoyanus*

Local/Common Name: *Adgawon,malagono*
English Name: Green jobfish
Scientific Name: *Aprion sp.*

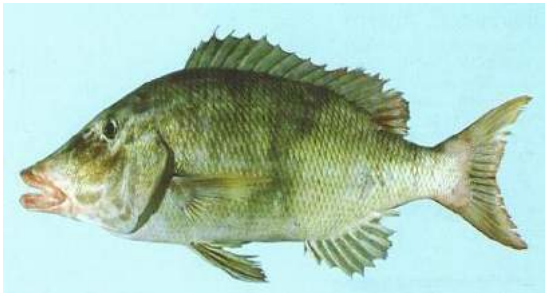
Local/Common Name: *Mublad, sandig*
English Name: Goldlinedspinefoot
Scientific Name: *Siganusguttatus*

Local/Common Name: *Bukhawon, malagaas*
English Name: Ornate emperor
Scientific Name: *Lethrinusornatus*

Local/Common Name: *Gurisan, Surahan, Labahita*
English Name: Orangespot surgeonfish
Scientific Name: *Acanthurusolivaceus*

Local/Common Name: *Arungan, madarag, alongan*
English Name: Russell's snapper
Scientific Name: *Lutjanusrussellii*

Local/Common Name: *kiskisan, alatan*
English Name: Harry hotlips
Scientific Name: *Plectorhincusgibbosus*



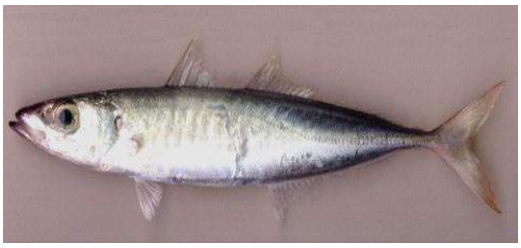
Local/Common Name: *Dugso*
English Name: Trumpet emperor
Scientific Name: *Lethrinusminiatus*

Local/Common Name: *Talad, Lambongayaw*
English Name: Cigar wrasse
Scientific Name: *Cheilioinermis*

Local/Common Name:*Arungan, alongannadarag*
English Name: Dory snapper
Scientific Name: *Lutjanusfulviflamma*

Local/Common Name: *Atoloy, matangbaka*
English Name: Bigeye scad
Scientific Name: *Selarcrumenopthalmus*

Local/Common Name: *Balanak*
English Name: Bluetail mullet
Scientific Name: *Valamugilbuchanani*



Local/Common Name: *sibobog*
English Name: Shortfin scad
Scientific Name: *Decapterusmacrosoma*

Local/Common Name: *Talakitok*
English Name: Longfin cavalla
Scientific Name: *Carangoidesciliarius*

Local/Common Name: *sulaybagyo, butete*
English Name: pupper like fish
Scientific Name: *Tetraodon sp*

Local/Common Name: *tiki*
English Name:
Scientific Name:

Local/Common Name: *Bugiw*
English Name: Lutke's halfbeak
Scientific Name: *Hemiramphuslutkei*

Local/Common Name: *bulgan, apahap*
English Name: Barramundi
Scientific Name: *Latescalcarifer*

Local/Common Name: *Sapsap (lopani)*
English Name: ponyfish/slipmouth
Scientific Name: Leiognathidae

Local/Common Name: *Dugso*
English Name: Trumpet emperor
Scientific Name: *Lethrinusminiatus*

Local/Common Name: *turos, tulos, kataway*
English Name: rabbit fish
Scientific Name: *siganus canaliculacus*

Local/Common Name: *hurabas, mayamaya*
English Name: Humpback red snapper
Scientific Name: *Lutjanusgibbus*

Local/Common Name: *pak an*
English Name: Torpedo scad
Scientific Name: *Megalaspiscordyla*

Local/Common Name: sapan, alatan
English Name: Trout sweetlips
Scientific Name: *Plectorhincus sp.*

Local/Common Name: *bagaongon*
English Name: Barred queenfish
Scientific Name: *Scomberoidestala*

Local/Common Name: *agoot*
English Name: Forktail bream
Scientific Name: *Gymnocranius elongates*

Local/Common Name: *palad*
English Name: Largetooth flounder
Scientific Name: *Pseudorhombusarsius*

Local/Common Name: *Tangigue (natural)*
English Name: Narrow-barred Spanish mackerel
Scientific Name: *Scomberomoruscommerson*

3.2 Occurrence of Phytoplankton

The occurrence of phytoplankton in the six different study sites established in Cabugao Bay during the months of November-December 2017 and January 2018 is summarized in Table 2. It was found that the phytoplankton species were dominated by Coscinodiscus, Navicula, and Rhizosolenia.

Navicula is one of the genera of phytoplankton which was found in abundance in Cabugao Bay as determined by the present study. It is a genus of boat-shaped algae, primarily aquatic, eukaryotic, photosynthetic organisms, ranging in size from a single cell. Navicula is latin for "small ship", and also a term in English for a boat-shaped incense-holder [14].

Rhizosolenia is another abundant genus of phytoplankton in Cabugao as determined by the present study. It is long, cylindrical, straight or slightly curved cells with a spine-like process on one end. Cells may be solitary or in short chains. Valves are conical or subconical and usually have otaria and claspers. It is widespread throughout the world's oceans [15].

Table 2 Phytoplankton Genera Obtained from Different Stations November-December, 2017 and January 2018

No. of classes	Classes	No. of Genera	Genera	November 2017						December 2017						January 2018					
				Station						Station						Station					
				1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1	Bacillariophycae	1	*Nitzchia*		+	+											+	+			
2	Biddulphiaceae	2	*Biddulphia*	+												+					
3	Chaetocerotaceae	3	*Bacteriastrum*	+						+				+		+				+	
		4	*Monoraphidium*													+					
4	Ceratiaceae	5	*Ceratium*					+		+				+		+				+	
5	Cocconeidaceae	6	*Cocconeis*								+					+	+			+	
6	Coscinodiscoceae	7	*Coscinodiscus*	+		+				+		+				+	+	+	+	+	
		8	*Chaetocerus*		+				+	+		+			+	+	+	+			+
		9	*Skeletonema*		+				+	+					+		+	+	+	+	+
7	Cyanophyceae	10	*Oscilatoria*													+					
8	Dinophyceae	11	*Gonyolaux*													+					
		12	*Protoperidinium*													+					
		13	*Prorocentrum*								+				+						+
9	Fragillariophysceae	14	*Thalasionema*														+		+		+
		15	*Asterionella*																+	+	
		16	*Fragillaria*													+					
10	Leptocylindreceae	17	*Leptocylindrus*							+						+					
11	Naviculaceae	18	*Navicula*			+	+	+	+				+			+		+	+	+	+
12	Oscillatoriaceae	19	*Lyngbya*							+						+					
		20	*Periastrum*															+			
13	Peridiniaceae	21	*Peridinium*								+						+				
14	Prorocentrceae	22	*Dynopyxis*													+		+			
15	Rhizosoleniaceae	23	*Rhizosolenia*	+	+		+	+	+	+	+		+		+	+	+	+	+	+	+
16	Thallasionematoceae	24	*Thallasiotrix*							+						+					+

Legend: (+) indicates presence of phytoplankton (No entry) indicates absence of phytoplankton

The occurrence of *Coscinodiscus wailesii* Grant et Angst as a large centric diatom (280-500 µm diameter) from marine phytoplankton is characterized by a cylindrical frustule with flat valvar surface, two marginal rings of *rimoportulae* on the mantle, and two *macrorimoportulae* [16]. These are found in Paranagua Bay, Parana, southern Brazil. The species' distribution in Brazilian waters was revised, and a discussion on possible vectors of transport was made. Blooms of the species occur sporadically in the coast of Parana, seeming to affect the local trophic chain.

The species of *Coscinodiscus* as the most dominant in Sepanggar Bay, Sabah, Malaysia [17]. Phytoplankton act as an important component of the marine ecosystem, as they liberate oxygen during photosynthesis and aid in energy exchange process [18]. Phytoplankton species composition, development and quantification are highly influenced by physico-chemical parameters of a particular environment [19]. Hence, the abundance of phytoplankton in Cabugao Bay is a good sign of the bay's health. Thus, Cabugao Bay can provide the services that people are expecting from its coastal waters and the marine ecosystem.

In 2006,Taklong Island National Marine Reserve (TINMAR) samples were primarily characterized by the dominance of fast growing centric diatoms of Class *Coscinodiscophyceae* like *Chaetoceros*, *Skeletonema*, *Rhizosolenia*and *Bacteriastrum* [20]. Diatoms represented by Classes *Bacillariophyceae*, *Coscinodiscophyceae* and *Fragilariophyceae* dominated the data gathered in 2001 and 2006.

In this study, the bulk of the population in all six stations is heavily distributed in only three genera, namely: *Chaetoceros, Rhizosolenia*and *Skelotonema*. Accordingly, these three genera were bioindicators of an oil-stressed phytoplankton community. This might be due to the fact that pennates in general were more sensitiveto pollutants like PAHthan centrics.

3.3 Blue Green Algae in Water Samples

Results on the blue green algae in cells per mL of water ranging from 0.89 to 2.69 and a mean of 1.81 indicate the utilization of nutrients by the phytoplankton. Looking at the data on chlorophyll content, it suggests that productivity varies at a range of 0.39ug/1 – 1.56ug/1. Almost within this range of chloropyll productivity is also the maximum chloropyll productivity recorded in Palk Bay, India of 1.48 ug/1, while the minimum was 0.28 ug/1 [21].

The abundance of blue green algae and chlorophyll content of the body of water, as in the case of Cabugao Bay, provide food to other bio-resources such as phytoplankton. Phytoplankton are the primary source of a food chain, which contributes to the major fishery resource around the world [22]. They are responsible for the formulation of a biological community and regulate the food web [23], [24]. Phytoplankton act as an important component of the marine ecosystem, as they liberate oxygen during photosynthesis and aid in energy exchange process [18].

5. CONCLUSION AND RECOMMENDATION

Blue green algae population and phytoplankton population are evident in Cabugao Bay. Three species of phytoplankton dominated the species found in the study. Fish population substantially increased (>50% increase) as compared to previous studies having determined total of 31 families and 52 genera. Studies in the future may tackle the correlation of physico-chemical parameters between blue green alga and phytoplankton population considering diurnal or tidal fluctuations in Cabugao Bay. Correlation studies on zooplankton and phytoplankton population may likewise be carried out to determine non-point pollution attributed to oil, gasoline, and the presence of microplastics.

ACKNOWLEDGEMENT

The researchers are grateful to the assistance provided by three fisherfolks who accompanied them in gathering data on fishes and water samples for blue green algae determination. Likewise, the assistance of research aides in the analysis of data in the laboratory is worth mentioning for their kind gestures in realizing this study. Most importantly, words of gratitude would not be enough to thank the administration of the Catanduanes State University Natural Science Department for the use of the science laboratory.

REFERENCES

[1] M. D. Spalding, C. Ravilious and E. P. Green, *World Atlas of Coral Reefs*. Berkeley: University of California Press, 2001.

[2] L. Burke, K. Reytar, M. Spalding and A. L. Perry, *Reefs at Risk Revisited in the Coral Triangle*. World Resources Institute, The Nature Conservancy, WorldFish Center, International Coral Reef action Network, UNEP World Conservation Monitoring Center and Global Coral Reef Monitoring Network. Washington, D.C., 2012.

[3] K. Q. Aldea, M. I. Morales, A. E. Araojo andJ. T. Masagca, "Biodiversity in the Kuroshio region: Challenges and trends in the upstream",*Kuroshio Science, 9*(1), 45-56, 2015.

[4] R. B. Cabral, P. M. Alino,A. C. M. Balingit, C. M. Alino, H. O. Arceo, C. L. Nanola Jr. and R. C. Geronimo, "Marine Protected Area Support Network (MSN)". *Philippine Science Letters, 7*(2), 300-308, 2014.

[5] R. C. Geronimo and R. B. Cabral, Fish production in the coral triangle: Status, trends, and challenges. In Asian Development Bank (2014), *Economics of Fisheries and Aquaculture in the Coral Triangle*. Asian Development Bank, Mandaluyong City, Philippines, 2014.

[6] A. T. White et al., Management of fisheries, coastal resources and the coastal environment in the Philippines: Policy, legal and institutional framework 11. ICLARM, *Working Paper, No.5*, 2000.

[7] H. Townsend, "Comparing and coupling a water quality and fisheries ecosystem model of the Cheasapeake Bay for the exploratory assessment of resource management strategies". *ICES Journal of Marine Science, 71*(3), 703-712, 2014. DOI: http://doi.org/ 10.1093/icesjms/fst060

[8] S. Menden-Deuer and E. J. Lessard, "Carbon to volume relationships for dinoflagellates, diatoms, and other protest plankton". *Limnology and Oceanography, 45*(3), 569-579, 2000.

[9] N. D. Canini, E. B. Metillo and R. V. Azanza, "Monsoon-influenced phytoplankton community structure in a Philippine mangrove estuary". *Tropical Ecology*54(3): 331-343, 2013.

[10] J. Tempère and H.Peragallo, Diatomeés du Monde Entière. *Fascicule* 13-16: 209-256, 1910.

[11] I. Yamaji,*Illustrations of the Marine Plankton of Japan*. Japan Hoikusha Publication Co., Tokyo, 1982.

[12] A. Shirota, *The Plankton of South Vietnam (freshwater and marine plankton)*. Overseas Technical Cooperation Agency, Japan, 1966.

[13] V. L. Olaño and N. S. B. Lanzuela, *Guide in Identifying Common Fishes in Lagonoy Gulf and Sorsogon Bay*. Atlas, Bureau of Fisheries and Aquatic Resources 5, National stock Assessment Program, Tayhi, Tabaco City, Albay, Philippines, 2016.

[14] "NaviculaPerminutaGrunow: Algaebase", 2010, Retrieved from www.algaebase.org/ search/species/detail/species_id=31831

[15] "RhizosoleniasetigeraBrightwell: Algaebase", 2018, Retrieved from www.algaebase. org/search/ species/detail/ species_id=32058

[16] L. F. Fernandez,Zehnder-Alves andJ. C. Bassfeld,"The recently established diatom Coscinodiscus wailesii (Coscinodiscales, Bacillariophyta) in Brazilian waters: Remarks on morphology and distribution". *Phycological Research, 49*, 89-96, 2001.

[17] M. D. Sidik, M. R. Un-Nabi andM. A. Hoque, "Distribution of phytoplankton community in relation to environmental parameters in cage culture area of Sepanggar Bay, Sabah, Malaysia."*Estuarine, Coastal and Shelf Science,* 80,251-260. DOI: 10.1016/j.ecss.2008.08.004, 2008.

[18] T. A. Khan, Limnology of four saline lakes in Western Victoria, Australia. *Limnologica, 33*(4), 327-339, 2003. Retrieved from http://dx.doi.org/10.1016/S0075-9511(03)80027-0

[19] M. Vajravelu, Y. Martin, S. Ayyapan and S. Mayakrishnan (2017). Seasonal influence of physic-chemical parameters on phytoplankton diversity, community structure and abundance at Parangipettai coastal waters, Bay of Bengal, South East Coast of India".*Oceanologia, 136-149*, 2017. Retrieved from http://dx.doi.org/ 10.1016/j.oceano.2017. 08.003

[20] A. V. Hallare, K. J. A. Lasafin and J. R. Magallanes, "Shift in phytoplankton community structure in a tropical marine reserve before and after a major oil spill event". *Int. J. Environ. Res., 5*(3):651-660, 2010.

[21] R. Sridhar, T. Thangaradjou, S. S. Kumar andL. Kannan, "Water quality and phytoplankton characteristics in the Palk Bay, southeast coast of India". *Journal of Environmental Biology, 27*(3), 561-566, 2006.

[22] P. G. Falkowski, T. Fenchel, T. andE. F. Delong,"The microbial engines that drive Earth's biogeochemical cycles. *Science 320* (5879), 1034-1039, 2008. Retrieved from http://dx.dot.org/10.1126/ science.1153213

[23] C. B. Field, M. J. Behrenfeld, J. T. Randerson and P. Falkowski, "Primary production of the biosphere: integrating terrestrial and oceanic components".*Science 281* (5374): 237-240, 1998. Retrieved from http://dx.doi.org/10.1126/science.281. 5374.237

AUTHORS' BIOGRAPHIES

The principal author, Mr. Ryan Paul C. Brillante, earned his Master of Arts in Teaching Biology and Bachelor's Degree in Nursing from Catanduanes State University (CSU) in Virac, Catanduanes. Mr. Brillante holds two professional licenses: Registered Nurse and a Professional Teacher. He is a faculty member of the College of Arts and Sciences Natural Science Department at CSU.Just recently his paper, as principal author, titled "Assessing the Water Quality of Cabugao Bay in Catanduanes Island, Luzon, Philippines" was published in the Journal of Water Resources and Ocean Science with ISSN: 2328-7969 (Print); ISSN: 2328-7993 (Online). Has presented a paper titled "Fish and Plankton Resources of Cabugao Bay" in the 5th Philippine International Biodiversity Meeting (BIOME5) held at CSU on October 19, 2018. He likewise presented a paper on "The Role of Small-scale Fisheries on Food Security and Employment Opportunity of Fisherfolksin Catanduanes Island, Philippines" at the International Research Conference in DLSU-Dasmariñas.

The co-author, Dr. Jimmy T. Masagca, is an Associate Professor of Aquatic Biology of the Natural Science Department, College of Arts and Sciences (CAS), Catanduanes State University in Bicol Region, Philippines. He was an expatriate teacher in Eritrea Northeast Africa Ministry of Education; former graduate faculty and distinguished professorial chairholder in biology and graduate director of research and academic linkages at De La Salle University-D. He is a member of the IUCN-Commission on Education and Communication (CEC) and sits as Member of the Editorial Advisory Board of Elsevier's Ocean & Coastal Management Journal and reviewer of various international refereed journals. He has published numerous papers in refereed journals and had given oral/poster presentations in national/international meetings in the fields of fish cytogenetics, mangrove biodiversity, crabs, MPAs, coastal and ocean governance, ICT integration/e-Learning in biology and food security programs in fish, indigenous rice and mangroves (FIRM) at CSU.