BERONG NICKEL CORPORATION

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February 3, 2022

JOE AMIL M. SALINO
Regional Director
Environmental Management Bureau
Regional Office IVB (MIMAROPA)
6th Floor, DENR By The Bay Building
1515 Roxas Boulevard, Ermita
Manila

Subject: 2021 Aquatic Biota and Coastal Resource Monitoring Report

Dear RD J.M. Salino:

We are pleased to submit to your good office our 2021 Aquatic Biota and Coastal Resource Monitoring Report for our nickel mining project located in Brgy. Berong, Quezon, Palawan.

We hope that you will find the document in order.

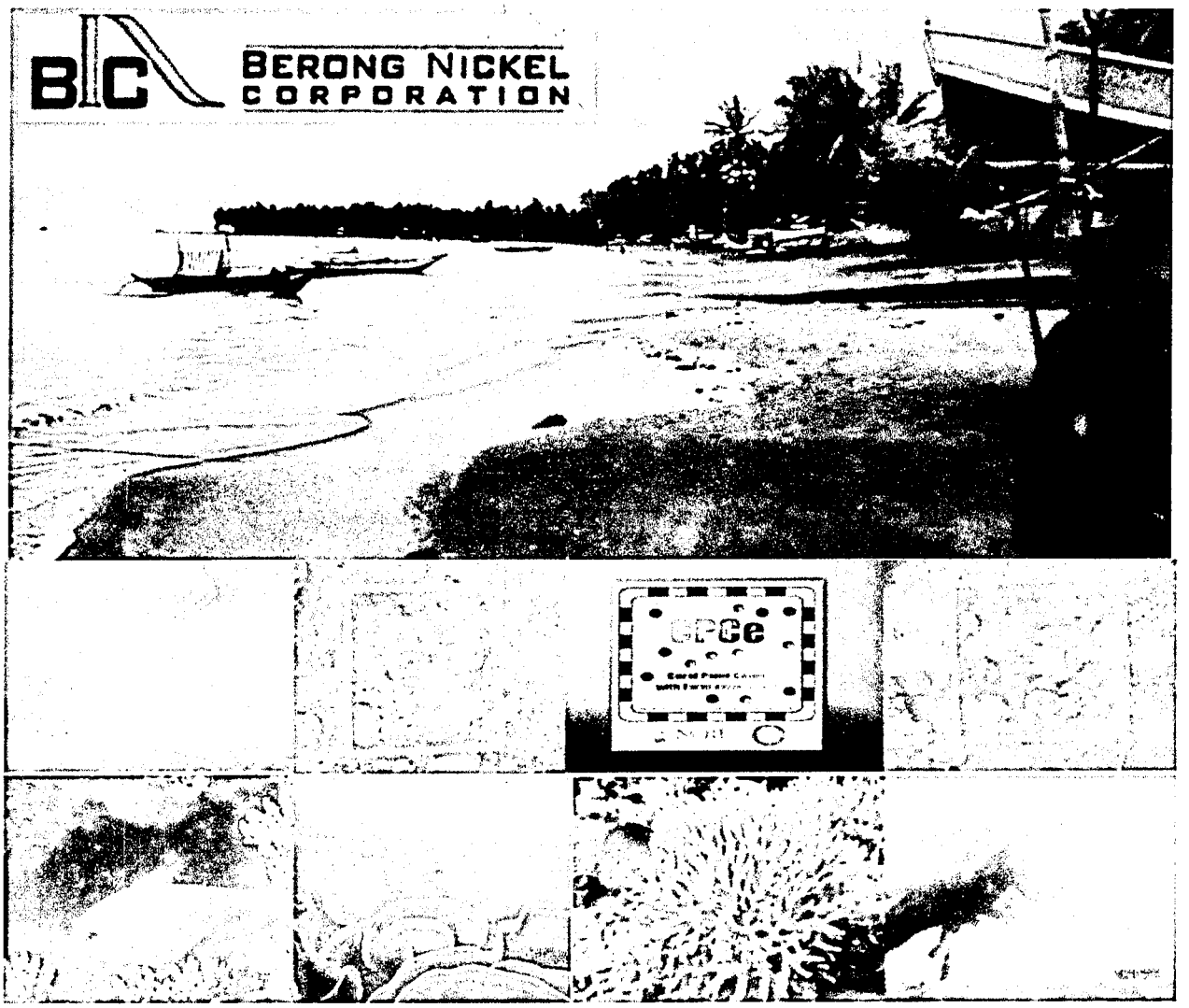
Thank you.

Very truly yours,

Ramon Manuel R. Briones
Vice President for Operations

AQUATIC BIOTA AND COASTAL RESOURCE MONITORING OF BERONG COASTAL WATERS, WEST COAST OF QUEZON MUNICIPALITY, PALAWAN, 2021

BERONG NICKEL CORPORATION



September 8-14, 2021
Barangay Berong, Quezon, Palawan

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Executive Summary

Berong Nickel Corporation (BNC) has been operational since 2006 which involved extraction of nickeliferous ore and transporting of metallic minerals from the mine site to pier site facilities which might affect the coastal waters of Barangay Berong in Quezon, Palawan. Also of equal important concern is the impact of possible discharge of suspended solids and siltation to its immediate coastal environment which may affect the marine environment.

In order to ensure its social and environmental accountabilities in compliance to BNC's Environmental Compliance Certificate (ECC) Conditionality No. 3 and BNC's Annual Environmental Protection and Environment Program (AEPEP), the Company commissioned Haribon Environmental Services with the assistance of the Palawan Community-Based Fisherfolk Alliance (PCBFAI) to monitor the conditions of the resources in relation to the operation of the Company.

The assessment was conducted in Barangay Berong coastal waters on September 8-14, 2021 by nine (9) researchers and assisted by the technical personnel of the Mine Environmental Protection and Enhancement Office (MEPEO).

Tow-sampling method was used following the parameters collected for plankton communities that inhabit in coastal waters of Barangay Berong while the Transect-Quadrat Sampling Method (*White et al* 2004) was employed in the assessment of sea grasses ecosystem.

Survey methods used followed English *et al*, 1997 for fish assemblage were established using Global Positioning System (GPS) coordinates while benthic life forms were assessed using Coral Point Count (CPCe) method, Kohler & Gill 2006 and coral codes data entry processing with the used of photo-quadrat platform underwater activity.

A total of eighteen (18) phytoplankton genera were listed representing twenty four (24) species of phytoplankton's identified in all stations, comprising twelve (12) taxonomic classes of Diatoms and three (3) taxonomic of Dinoflagellates. The mean overall phytoplankton density of the study area was 212.26 Indv/m^3 wherein the golden- brown algae (diatoms) dominated all samples and showed a mean density of 203.98 Indv./m^3 comprising 96.10% of all phytoplankton species.

A total of six (6) zooplankton genera were listed representing eight (8) species of zooplanktons identified in all stations comprising three (3) taxonomic classes of Copepods (crustaceans), Gastropods (mollusks) and Cephalopods (squids, octopus).

Mean overall zooplankton density of the study area was 275.57 Indv/m^3. The major taxa Copepods (crustaceans) represented a mean density of 206.21 Indv/m^3 dominated all samples collected comprising 75.11% of all zooplanktons species.

A total of eight (8) sea grass species were observed in all stations. The general condition of sea grass beds in four (4) sampling stations revisited were in fair resource status with an overall rating of 38.20% an increased for 2% growth except for Tagbolante Station 2 with a decrease 4.8% growth. This year's 2021 survey results have also affected by the poor visibility of the shorelines along sea grass ecosystem due to the effect of Typhoon Jolina.

For marine invertebrates, a total of twenty-two (22) species representing fourteen (14) families and three (3) phyla, Echinodermata, Mollusca and Annelida for a total of Nine Hundred Ninety twelve (912) individuals.

The Christmas tree worm (*Spirobranchus giganteus*) was the most dominant species were observed with a total of three hundred thirty (330) individuals during the survey activity. There were thirteen (13) species listed for echinoderm species with five (5) species for mollusk and two (2) species for annelids were recorded with a decrease of two (2) when compared to last year's assessment.

The abundance of all invertebrates species showed a minimal decreased of Ninety Seven (97) individuals from that of Nine Hundred twelve (912) individuals when compared last year's results of One Thousand Nine (1,009) individuals.

Reef fish's assemblages within the impacted areas for this year's study have presented a significant decreased due to Typhoon Jolina. A total of one hundred eighty eight (188) species of fish representing thirty (30) families were observed from all monitoring stations with a total abundance of seven thousand sixteen (7,016) individuals. When compared to last year's study of eleven thousand seven hundred (11,700) individuals, there was a significant decreased of four thousand six hundred eighty four (4,684) individuals of reef fishes in all of the study sites.

For the reefs, by the new application of the Coral Point Count (CPCe) methodology, the mean overall percentage condition of the coral reefs in the impacted areas was 59.91%, with other fauna 10.04%, dead corals 27.44%, algae 1.19% and abiotic component 1.41%. The result summary of the corals will served as the new baseline data under the CPCe program in all the impacted areas.

The result of the CPCe hard coral cover establishes 59.91% is under good condition status, however, most survey results was disturbed by effect of the typhoon resulting to the poor visibility was encountered during the activity.

The above situation as discussed, suggest that coastal resource status of corals under the new Coral Point Count (CPCe) software program establishes a good coral resource status as a baseline along the impacted areas of the BNC, however, due to the effect of typhoon in the West Philippine Sea, a significant decreased of reef fishes and invertebrates abundance have been observed. There was no observable negative impact in the physical condition of the resources during the period between September 2020 to September 2021 except for effect of Climate Change brought about the minimal disturbance of typhoon Jolina in the marine ecosystem of Berong coastal waters.

I. INTRODUCTION

The coastal marine waters in Barangay Berong have been characterized by the coastal operations of the Berong Nickel Corporation's ore stockyards, port facilities and barge-ship ore loading operations where shipment of nickel ore operates from the pier-jetty area to Berong marine impacted areas takes place. In compliance to potential and possible impacts, an annual activity for aquatic biota and coastal resources assessment has been conducted.

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Results of 2004 baseline aquatic biota assessment from the BNC's Environmental Impact Statement (EIS) prescribed annual monitoring of all surface water resources in the impacted areas. Periodic monitoring activities that followed were conducted in November 2014, November 2015, June 2016, December 2017, August 2018, June 2019, September 2020 and its present resource status for September 2021, form part of the company's Annual Environmental Protection and Enhancement Program (AEPEP).

This study aims to: (1) gather information on the status of resources in prescribed stations; (2) compare these information to the results of previous surveys as part of Biodiversity Monitoring Systems (BMS), (3) give recommendations on how to improve the coastal monitoring scheme for impact areas; and (4) provide recommendations for the rehabilitation of habitats and resources which may be influenced by the BNC operation.

Monitoring survey would warrant comparison of before and after conditions of the coastal waters of Barangay Berong existing habitats, which, if carried out through time, would detect changes and trends on the conditions of the resources. Thus, this study was carried out to methodologically evaluate possible biological and physical impacts of the BNC operations to marine ecosystems of the Berong coastal waters.

II. MATERIALS AND METHODS

1. General Methodology

The aquatic biota and coastal resource assessment were done in the coastal waters of Barangay Berong, Quezon, Palawan on September 8-14, 2021. Due to COVID 19 health protocol of the Company, a short entry meeting with the research team was conducted by the Staff of the BNC's Safety and Health Department and Mine Environmental Protection and Enhancement Office of the company, detailed schedule of activities and logistical arrangements were discussed.

Stations were located with GPS readings and with marked permanent transect lines. Plankton samples were collected in nine (9) stations (Table 1), coral cover, corals and reef fishes were surveyed in nine (9) stations (Table 2), and sea grass survey was carried out in four (4) stations (Table 3).

Tow-net sampling method was conducted in Romaraw, Tagbolante, Odiong, Pinagtapian, Tagbungsaing Lake Outlet, Dangla, Tagbungsaing Lake SW1 and Tagbungsaing Lake SW2 Stations in Berong coastal water vicinities for plankton community using GPS equipment.

The new survey study for coral cover was employed by using Coral Point Count (CPCe) with excel spreadsheet extension. CPCe is assessment software protocols to determine benthic database management and monitoring mechanisms towards data collection, data analysis, and data archiving program. This was conducted in all of the BNC monitoring stations within reef crest sites.

The reef crest is the highest (shallowest) part of the reef, and lies between the shoreward, protected back reef and the outer reef face. It is the narrowest of the three main coral reef zones in Berong coastal community standing like a massive wall that absorbs and dissipates the energy of incoming waves, resulting in the calm waters of the back reef zone (lagoon) of the coral reef biome.

With the directive of the BNC management, new baseline data assessment for Bansaluyan Reef located in Barangay Isugod was conducted to monitor the impacts of their ore-shipping operation activities.

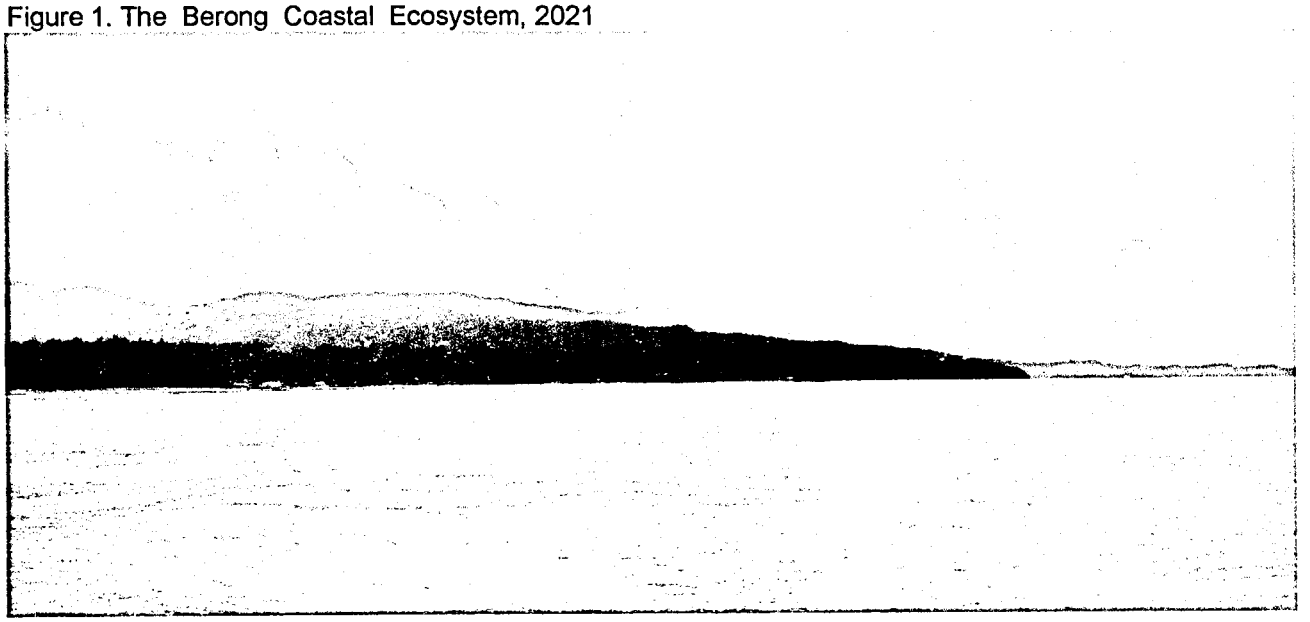
Fish assemblage and macro-invertebrates in the benthic community was done through Self-Contained Underwater Breathing Apparatus (SCUBA) diving and photo documentation using fiber glass transect lines in nine (9) stations, namely: Bitas Reef in Barangay Aramaywan, Talabonggan, Dangla, Berong, Odiong, Tagbolante, Catuayan and Romaraw Reefs, all of Barangay Berong and Bansaluyan Reef in Barangay Isugod in Quezon, Palawan.

The CRA was disturbed by a Tropical Depression "Jolina" where researchers aborted its activities for two (2) days with a maximum sustained winds of 95 km/h.

2. The Berong Coastal Ecosystem

The Berong coastal ecosystem is located in the vicinity of Quezon municipal waters in Palawan facing the West Philippines Sea. The coastal zone is vegetated by high dense of coastal forest which grows above the average mean sea level in the intertidal zone of riverine estuary areas emptying the coastal waters. Ecologically, in between low and high tide levels, adaptations to oxygen-deficient beach areas desalinate the nutrients that it takes in from the surrounding environment including the confluence waterway run-off from the river systems of Mount Berong.

Figure 1. The Berong Coastal Ecosystem, 2021



The coastal waters of Berong are naturally bounded by five (5) large rivers namely: Berong, Liabongan, Tagbungsaing, Tagbolante and Romaraw rivers. Draining downstream, is a huge source of natural freshwater from the headwaters of Romaraw and Tagbolante rivers, Liabongan and Berong confluence, and Tagbungsaing Lake.

These rivers are the main source of nutrients of the Bay and, as spillways from upstream. From these river mouths, the coastline encompasses a long white-sandy shores gradually sloping from 2m down to 3m tidal lines of sandy substrate- sea grass community.

From the mainland foreshore (between high and low water marks), irregular massive limestone Porites and sargassum communities were extended along community-type inner fringing reef area towards the coral environment of outer reefs: reef fronts, upper slope and lower slope growth of intact benthic corals of 10m to 20m depths.

Berong coastal waters contains near threatened species of wildlife described by the International Union for the Conservation of Nature (IUCN) categories such as the Green Sea Turtle (*Chelonia mydas),* Blue-spiny lobster (*Panulirus versicolor*) and fluted giant clam (*Tridacna squamosa*) are listed under Appendix I includes species threatened with extinction of the Convention on International Trade in Endangered Species (CITES).

3. Field Survey Methods

3.1 Plankton Community

The plankton collection involves primarily the filtration of water by net and the collection of water in bottles/water samplers. The success of sampling largely depends on the selection of mesh size for plankton nets, time of collection, and water depth of the study area and sampling activity.

Approximately one (1) liter of water sample bottles for the phytoplankton was separated from the zooplankton samples and was collected from the water surface and underwater areas.

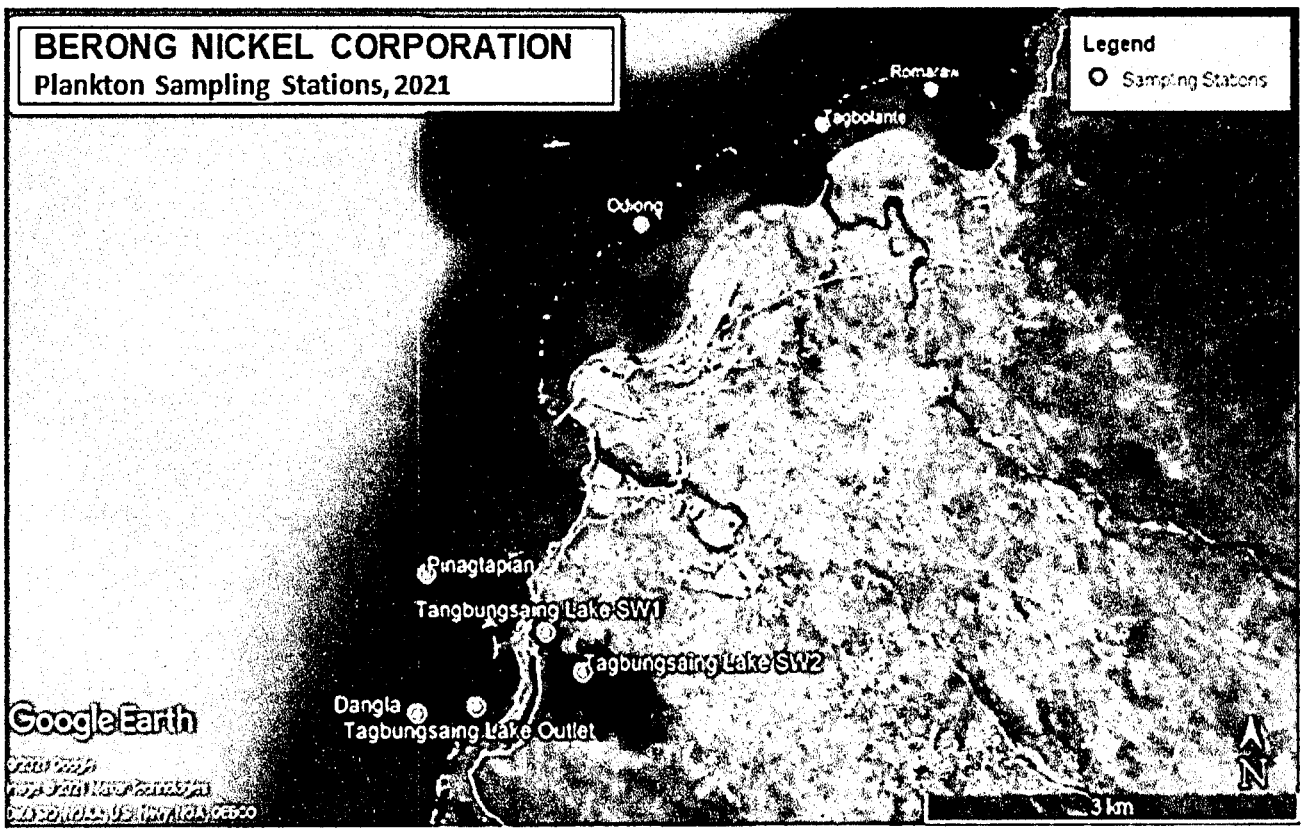
The zooplankton samples were fixed with 5% formalin solution for preservation purposes. The phytoplankton samples were allowed to settle for 5 days to avoid species disappearance and concentrated to about 50 ml prior to enumeration. Appropriate taxonomic keys were used to identify the samples to the lowest taxa possible

Plankton samples were collected in the vicinity of Berong coastal marine areas. The study areas are characterized as receiving bodies of water. Stations were located adjacent to coral and reef fishes stations which include in the inner Tagbungsaing Lake and its outlet (Table 1).

Table 1. Geographical locations of the Marine Plankton Community in Berong, 2021

Station No.	Component	Station Identification	Latitude	Longitude
MP1	Marine Plankton	Romaraw	9.29587	118.13555
MP2	Marine Plankton	Tagbolante	9.29439	118.13156
MP3	Marine Plankton	Odiong	9.29039	118.121212
MP4	Marine Plankton	Pinagtapian	9.27101	118.11101
MP5	Marine Plankton	Tagbungsaing Lake Outlet	9.26345	118.11270
MP6	Marine Plankton	Dangla	9.26327	118.11108
SW1	Freshwater Plankton	Tagbungsaing Lake SW1	9.26541	118.11454
SW2	Freshwater Plankton	Tagbungsaing Lake SW2	9.29540	118.11477

Figure 2. Map of Plankton Stations, Berong, Quezon, Palawan, 2021.



3.2 Marine Invertebrates

Survey and data collection of marine invertebrates were conducted in conjunction with calibrated transect lines for coral reef communities and fish visual census. Common species were identified to the lowest taxa possible and a taxonomic list was generated.

The organisms were classified according to phyla. Density and diversity of the important invertebrates were also determined.

Visual census of large invertebrates – giant clams, top shell, sea cucumber, sea urchins, sea stars, brittle stars and other species of mollusks – was conducted in every station by Scuba diving along a 100m line permanent transects and were recorded in underwater slate boards and photo documentation.

To compute density and diversity of marine invertebrates found in the survey area, the following formula was used:

$$\text{Density (ha)} = \frac{\text{Number of individuals observed}}{\text{Total area of belt transect}}$$

3.3 Coral Reef

Coral Reef stations are shown in Table 2. Benthic life forms were assessed using Coral Point Count (CPCe) method, Kohler & Gill 2006. CPCe methodology uses two (2) major tools, the computer CPCe software (Kohler & Gill, 2006) and coral codes data entry processing program with the used of photo-quadrat platform underwater activity.

Benthic life forms were categorized into Acropora and Non-Acropora for live hard corals component, Acropora branching (ACB), Acropora digitate (ACD), Acropora encrusting (ACE), Acropora sub massive (ACS), and Acropora tabulate (ACT).

Non-Acropora species were categorized into branching (CB), encrusting (CE), foliose (CF), massive (CM), sub massive (CS), Heliopora (CHL), Millepora (CME) and mushroom (CMR).

Other fauna species were categorized into soft coral (SC), sponge (SP), Zoanthids (ZO), and others (OT) to include all life forms which do not belong to hard coral component. Live coral cover percentage is expressed as the sum of percent cover of hard and soft corals, anemones and other fauna species.

Coral reef plants and algae were categorized into Algal assemblage (AA), Coralline algae, (CA), Halimeda (HA), Macro algae (MA) and Turf algae (TA). On the other hand, non-living components were categorized into dead corals (DC), dead corals with algae (DCA), coral rubbles ®, rock (RCK), sand (S), and silt (SI).

The geographical positions of these sites were determined using GPS (Table 2). Figure 3 shows the location map of coral and reef fish's stations.

Table 2. Geographical locations of fish and coral reef stations in Berong coastal area, 2021

Station No.	Component	Station Identification	Depth (m)	Latitude	Longitude
1	Corals and Fish	Romaraw Reef	3m	9.29587	118.13555
2	Corals and fish	Catuayan Reef	5m	9.29547	118.13467
3	Corals and Fish	Tagbolante Reef	3m	9.29439	118.13156
4	Corals and Fish	Odiong Reef	4m	9.29'61	118.12329
5	Corals and fish	Berong Reef	5m	9.29039	118.12123
6	Corals and Fish	Talabonggan Reef	7-8 m	9.25463	118.10580
7	Corals and Fish	Dangla Reef	5-8 m	9.26327	118.11108
8	Corals and Fish	Bitas/Aramaywan Reef	8-9m	9.24149	118.09008
9	Corals and Fish	Bansaluyan Reef	8-9m	9.212972	118.034229

Figure 3. Map of Berong coastal marine area showing sampling and survey stations, 2021

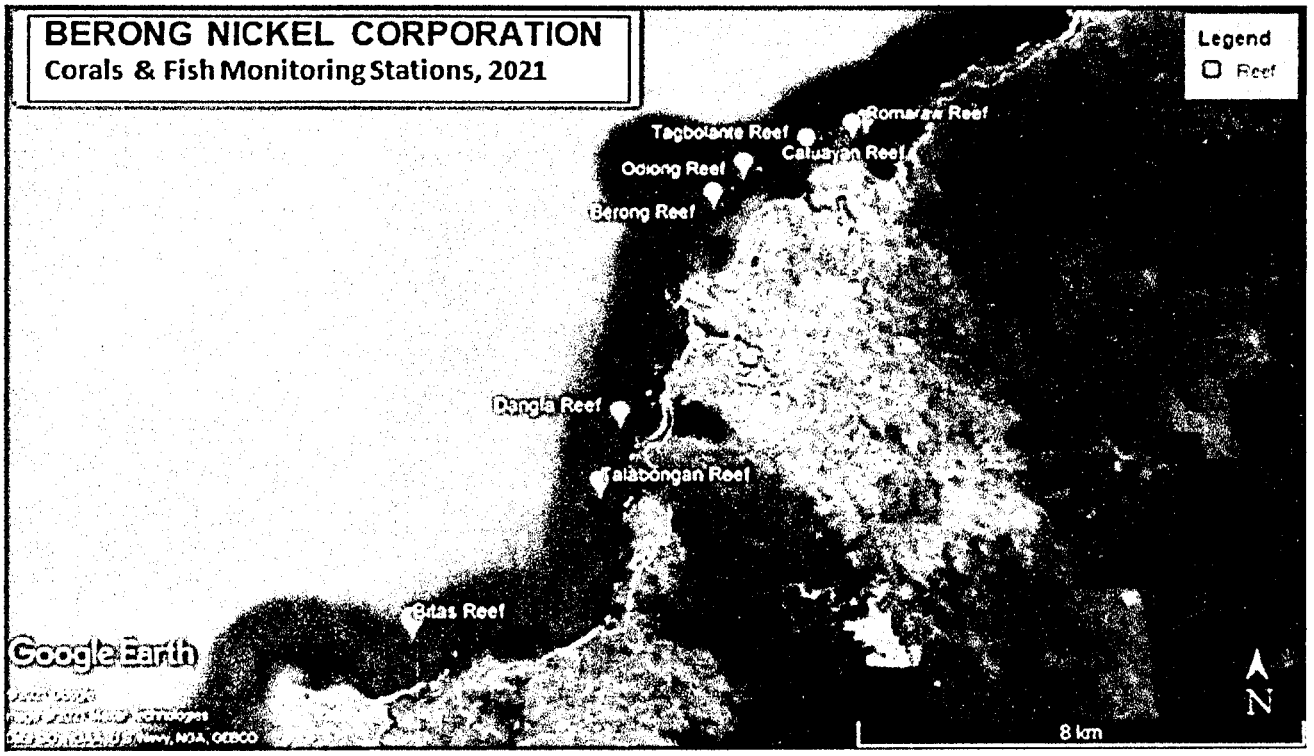
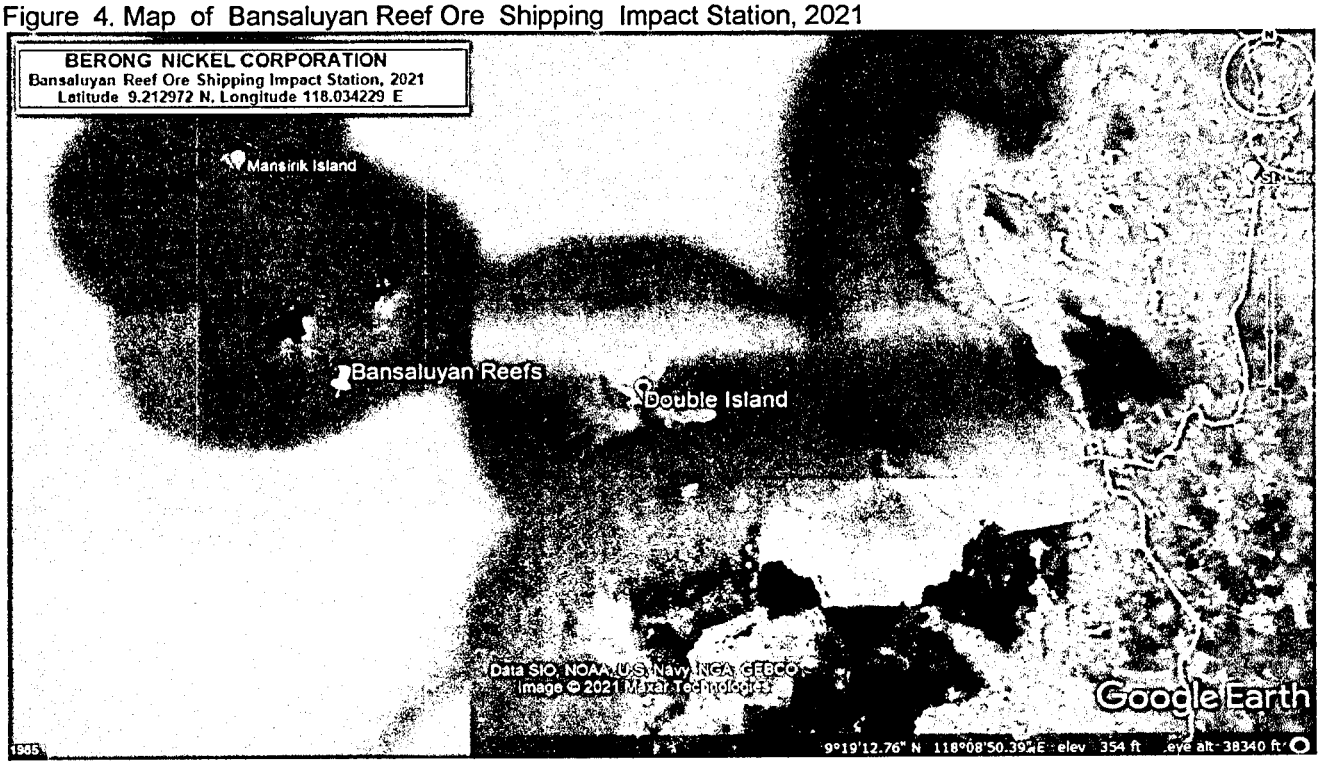


Figure 4. Map of Bansaluyan Reef Ore Shipping Impact Station, 2021



3.4 Reef Fishes

The fish survey followed the line-intercept transect (LIT) method by English et al. (1997) by Scuba diving. In order to standardize the methods and to readily compare results to other sites with similar studies conducted in Palawan, the same parameters and indicators used by FRMP-Nañola and Rodriguez (2001); Gonzales (2005) in Puerto Princesa Bay were followed.

Fish visual census dives were done simultaneously with coral cover assessment. These were observed from the same transect lines. References used for fish identification and biomass computation were: Gonzales (2005), Gonzales *et al* (2000), Kulbicki *et al*, (1993), and Myers (1999).

3.5 Sea Grass and Seaweeds

Four (4) sampling stations were surveyed for sea grass habitat namely: Catuayan Station, Tagbolante Station Odiong Station and Berong Proper Station at coastal waters of Barangay Berong, Quezon, Palawan were assessed.

Table 3. Locations and Description of Macrophyte Communities in four (4) stations, 2021

Station	Species	Description
Catuayan Station	*Enhalus acoroides, Halophila ovalis, Halodule pinifolia Thalassia hemprichii, Cymodocea rotundata*	Sandy-rocky substrate with *Padina, Halimeda Spp* were observed. *Sargassum spp. Caulerpa* (lato) was observed outside the transect. The area was observed to be sandy associated with young growth corals inhabited with 5 sea grass species with a depth of 1.30m at coordinates 9.29'547' N and 118.13467 E.
Tagbolante Station	*Enhalus acoroides, Halophila ovalis, Halodule pinofolia Thalassia hemprichii, Cymodocea rotundata*	Sandy-rocky substrate with patch of *sargassum* and *Halimeda spp* and school of juvenile catfish (hito). The area was totally occupied by seaweed planters inhabited with 5 sea grass species at coordinates 9.29487 N and 118.13240 E.
Odiong Station	*Thalasiahemprichii, Enhalus acoroides, Halodule uninervis*	Sandy muddy; dominated by *Enhalus acoroides.* The station has been occupied by sea cucumber (kurtido) culture as good indicator of healthy sea grass having a dominance of Sargassum spp. Inhabited with 3 sea grass species at coordinates 9.29538 N and 118.12318 E.
Berong Proper Station	*Enhalus acoroides, Thalassodendron ciliatum, Cymodocea serrulata, Halodule pinifolia, Halophila ovalis, Halodule uninervis*	Sandy- muddy substrate. Inhabited with 6 species cover with good recovery of *Enhalus acoroides* from 100cm to 130cm. Presence of *Halimeda sp. Padina*, shrimp at coordinates 9.28256 N and 118.12142 E

Methodology

Quadrat size of 1 x 1 meter was used in sea grass habitat assessment. Transect and Quadrat are laid where the sea grass habitat begins, and ends where observed habitat disappear.

The intervals between transect and between quadrats are determined by the size and expanse of the habitat. In this assessment, an interval of ten (10) meters was applied.

The specific locations of the stations were documented by the sea grass component team did the GPS reading in previous year's assessment.

Prior to the actual survey of the sea grass beds, sample stations were determined based on GPS reading. The Transect-Quadrat Sampling Method (*White et al, 2004*) was employed in assessment of the sea grass species.

A transect line of fifty (50) meters was laid perpendicularly to the shore starting from where the sea grasses appeared, and ends where the observed habitat disappear. It was placed within the water depth ranging from 1-2 feet to 1.5 meters.

After the transect line have been established, the 1 x 1 meter quadrat subdivided into four (4) grids to represent 25 percent (25%) per grid was placed along every ten (10) meters of the transect line.

For each quadrat in the transect line, the sea grass species, substrate present and their percentage cover were determined and recorded.

The percentage cover refers to the space verified by the living sea grass within the quadrat - from the top of the quadrat.

The percentage cover of existing sea grass observed in the respective quadrats served as the representative of sample of sea grass cover in the area. Total percentage cover observed per quadrat where then summed-up to represent the percentage of the total sea grass cover.

It simply follows:

Take the average percentage (%) cover of each transect by dividing total per transect by number of quadrats.

Add the average from each transect and divide the totals of the average of each component by the number of transect.

Then divide by the number of sampling station to get the overall percentage cover.

Category used to describe sea grass meadows:

Excellent	- 76 - 100%
Good	- 51 – 75%
Fair	- 26 – 50%
Poor	- 0 – 25%

III. RESULTS AND DISCUSSION

1. Plankton Density and Composition

Plankton communities are masses of microscopic swimming and drifting organisms in bodies of water which are divided into two main types, phytoplankton (plant) and zooplankton (animal) serving as the food source (basis of food web) and producer of oxygen in the photosynthesis of the marine environment and dominant species in the global carbon cycles.

The volume of collected samples from each station was standardized by 1 liter. Phytoplankton was identified by genera (lowest level possible) and was further grouped into major taxa: golden-brown algae and blue-green algae.

A total of eighteen (18) phytoplankton genera were listed representing twenty four (24) species of phytoplankton's identified in eight (8) stations, comprising twelve (12) taxonomic classes of Diatoms: *Bacillariaceae, Biddulphiaceae, Chaetocerotaceae, Coscinodiscaceae, Lithodesmiaceae, Rhizosoleniaceae,Naviculaceae,Leptocylindraceae,Pinnulariaceae,Pleurosigmataceae, Skelaeetonemace,* and *Thalassionemataceae* and Dinoflagellates belonging to three (3) taxonomic class: *Protoperidiniaceae*, *Dinophyceae* and *Noctilucaceae* respectively.

In general, diatom (golden-brown algae) genera Bacillariaceae dominated in most all the samples collected throughout the study sites as described in Table 4.

Table 4. Abundance of phytoplankton (no of individual/$m^{3)}$, Berong, Quezon Palawan, 2021

Family	Species	MP1 Romar aw	MP2 Tagbol ante	MP3 Odiong	MP4 Pinagtapia n	MP5 Tagbung saing	MP6 Dangla	SW1 Tagbung saing	SW2 Tagbung saing
acillariaceae	*Pseudo-nitzchia australis*	9.14	0	0	0	0	0	4.57	4.57
	Pseudo-nitzchia sp.	0	0	18.28	0	0	0	0	0
	Flagilariopsis oceanica	4.57	0	0	0	0	2.28	0	0
Biddulphiaceae	*Biddulphia sinensis*	0	0	0	0	0	2.28	0	0
	Eucampia sp.	0	0	0	0	4.57	4.57	0	9.14
haetocerotaceae	*Chaetoceros didymus*	9.14	0	0	0	0	0	0	0
oscinodiscaceae	*Coscinodiscus excentricus*	4.57	0	4.57	36.57	22.85	0	9.14	9.14
	Cyclotella eccentricus	4.57	0	0	4.571	0	0	0	0
	Cyclotella meneghiniana	0	0	0	4.571	0	0	0	0
ithodesmiaceae	*Ditylum brightwelli*	13.71	0	0	0	0	0	0	0
Rhizosoleniaceae	*Guinardia sp.*	0	0	9.14	4.57	0	0	0	0

	Guinardia cylindricus	129.71	51.14	0	59.42	64.0	122.85	27.42	27.42
	Guinardia delicatula	173.71	45.71	190.85	22.85	9.14	18.28	50.28	32
Naviculaceae	*Gyrosigma balticum*	0	0	0	13.7	0	2.28	9.14	0
	Navicula longa	0	0	0	13.7	13.71	22.85	0	0
Leptocylindraceae	*Leptocylindrus danicus*	9.14	4.57	13.71	4.57	13.71	22.85	9.14	9.14
Pinnulariaceae	*Pinnularia viridi*	4.57	0	0	0	0	2.28	0	0
Pleurosigmataceae	*Pleurosigma sp.*	0	0	9.14	0	0	0	9.14	9.14
Skelaeetonemace	*Detonula pumila*	0	0	0	0	0	9.14	0	0
Thalassionematace e	*Thalassionema nitzchioides*	0	45.71	4.57	4.57	4.57	4.57	0	0
Protoperidiniaceae (d)	*Protoperidiniu m sp.(d)*	2.85	0	2.86	5.71	5.71	5.71	5.71	5.71
	Protoperidiniu m sp. (d)	9.14	0	0	0	0	4.57	0	0
Dinophysaceae	*Dynophysis sp. (d)*	0	0	4.57	4.57	0	0	0	0
Noctilucaceae	*Noctiluca scitillans (d)*	0	4.57	0	4.57	0	0	0	0
Total Abundance (Indv/m^3)		**352.82**	**147.14**	**253.14**	**170.099**	**138.28**	**404.88**	**124.56**	**106.27**
Total Species/Station		**12**	**5**	**9**	**13**	**7**	**13**	**8**	**8**

As disturbed by the typhoon Jolina, sampling was conducted with poor visibility and affected by strong wave actions.

The highest density of major taxa of phytoplankton species is located in Dangla Reef Station of 404.88 Indv./m^3 with thirteen (13) species, a decreased of one (1) species from the last year's sampling, this is followed by Romaraw Station 352.82 Indv/m^3 with thirteen (13) species, Odiong 253.14 Indv./m^3 with ten (10) species, a decreased of one (1) species, Pinagtapian 170.99 Indv./m^3 for with thirteen (13) species, a decrease of two (2) species when compared to last year's sampling, Tagbolante 147.14 Indv./m^3 with five (5) species, a deceased of two (2) species, Tagbungsaing outlet 138.28 Indv/ m^3 with seven (7) species, Tagbungsaing SW1 124.56 Indv./m^3 with eight (8) species, and Tagbungsaing SW2 106.27 Indv./m^3 with eight (8) species for a total abundance of 1,698.08 Indv/m^3 of all phytoplankton stations.

Table 5. describes the density per station indicating phytoplankton's productivity assessment as primary producers and the representation of its species diversity per sampling stations in Berong coastal vicinity.

Table 5. Phytoplankton Density and Species Diversity/Station, 2021

Station	Density (Indv./m³)		Status	Species Diversity		Family	
	2020	2021		2020	2021	2020	2021
Dangla	409.45	404.88	Decreased	14	13	8	8
Romaraw	367.68	352.82	Decreased	14	13	10	10
Odiong	260.57	253.14	Decreased	10	9	8	8
Pinagtapian	186.85	170.99	Decreased	15	13	10	10
Tagbolante	154.57	147.14	Decreased	7	5	5	5
Tagbungsaing Outlet	138.28	138.28	Maintained	7	7	7	7
Tagbungsaing SW1	124.56	124.56	Maintained	8	8	7	7
Tagbungsaing SW2	106.27	106.27	Maintained	8	8	7	7
Total abundance	**1,748.66** Indv./m³	**1,698.08** Indv./m³					

A decreased of five (5) phytoplankton species have been observed for this year's study due to Typhoon. This means that the photosynthesis and calcifying element for both golden brown and blue green algae have been disturbed. With its current eight (8) monitoring station, the Dangla Reef station has the more productivity in terms of food chain capacity to carbon cycles contribution for micro- organisms which are always dependent through carbon and oxygen producing cycles via photosynthesis.

The mean overall phytoplankton density of the study area was 212.26 Indv./m³ wherein the golden-brown algae (diatoms) dominated all samples and showed a mean density of 203.98 Indv./m³ comprising 96.10% of all phytoplankton species as described in Table 6.

Table 6. Mean density (Indv. /m³) and percentage composition of major taxa of phytoplankton, 2021

Major Taxa	2020 Mean Density (Indv./m³)	2020 Percentage Composition	2021 Mean Density (Indv./m³)	2021 Percentage Composition
Diatoms	214.17	98%	203.98	96.10%
Dinoflagellates	4.35	2%	8.28	3.9%
TOTAL	**218.52 Indv./m³**		**212.26 Indv./m³**	

The productivity of the phytoplankton, on the other hand, described as the capacity to produce, and is commonly used as quantitative on abundance values (Indv./m³), and a qualitative term for plankton species diversity indicating the fertility level and primary productivity comprising all the receiving water bodies of the BNC, both the primary impact areas and secondary impact areas.

Due to the effect of Typhoon Jolina, there was no Arthropods were identified during the analysis. There were six (6) zooplankton genera were listed representing eight (8) species of zooplanktons identified in all stations comprising three (3) taxonomic classes of Copepods: *Calanidae, Centropagidae* and *Paracalanidae*, Gastropods belonging to *Gastropod veliger* and Cephalopods belonging to *Crustacean larvae* as described in Table 7.

Table 7. Abundance of Zooplankton (no of individual/$m^{3)}$ in Berong, Quezon Palawan, 2021

Scientific Name	MP1 Romaraw	MP2 Tagbolante	MP3 Odiong	MP4 Pinagtapian	MP5 Tagbungsaing	MP6 Dangla	SW1 Tagbungsaing	SW2 Tagbungsaing
Copepods								
Calanus sp.	2.86	14.28	0	0	0	8.57	8.57	8.57
Calanoides sp.	2.86	5.71	2.86	8.57	8.57	17.14	0	0
Calocalanus pavo	2.86	2.86	2.86	2.86	5.71	0	5.71	2.86
Calanoides cf. carinatus	0	18.28	18.8	0	0	0	4.57	4.57
Undinula vulgaris	0	2.86	2.86	0	2.86	0	0	0
Paracalanusparvus	0	5.71	5.71	5.71	0	11.43	2.86	5.71
	8.58	**49.7**	**33.09**	**17.14**	**17.14**	**37.14**	**21.71**	**21.71**
Gastropods								
Mid Gastropod veliger	4.57	9.14	9.14	9.14	4.57	0	0	0
	4.57	**9.14**	**9.14**	**9.14**	**4.57**	**0**	**0**	**0**
Cephalopods								
Crustacean nauplius larvae	22.86	0	0	0	0	9.14	0	0
	22.86	**0**	**0**	**0**	**0**	**9.14**	**0**	**0**
Total abundance (no of Indv/m^3)	**36.01**	**58.84**	**42.32**	**26.28**	**21.71**	**46.28**	**21.71**	**21.71**
No. of species	**5**	**7**	**6**	**4**	**4**	**4**	**4**	**4**

Mean overall zooplankton density of the study area was 275.57 Indv/m^3. The major taxa Copepods (crustaceans) represented a mean density of 206.21 Indv/m^3 dominated by all samples collected comprising of all zooplankton observed as described in Table 8.

Table 8. Mean Density and Percentage Composition of Major Taxa of zooplankton, 2021

Major Taxa	Mean Density(Indv/m^3)	Percentage Composition
Copepods	206.91	75.11%
Gastropods	36.56	13.27%
Cephalopods	32.00	11.62%
TOTAL	**275.47 (Indv/m^3)**	

Results shows the zooplankton abundance per station of major taxa for Tagbolante Station, 58.84 Indv./m^3, with seven (7) species, a decreased of two (2) species, followed by Dangla Station 46.28 Indv./m^3 with four (4) species, a decreased of one (1) species, Odiong Station 42.32 Indv/m^3 with six (6) species, a decreased of three (3) species, Romaraw 36.01 Indv/m^3 with five (5) species, a decreased of four (4) species, Pinagtapian Station 26.28 Indv/m^3 with four (4) species, a decreased of one (1) species, Tagbungsaing Outlet Station, 21.71 Indv/m^3 with four (4) species, a decreased of one (1) species, Tagbungsaing Lake SW1 21.71 Indv/m^3 with four (4) species, a decreased of three (3) species, and Tagbungsaing Lake SW2 21.71 Indv/m^3 with four (4) species, a decreased of three (3) species.

Table 9. Zooplankton Density and Species Diversity/Station, 2021

Station	Density (Indv./m³)	Species Diversity
Tagbolante	**58.84**	7
Dangla	**48.26**	4
Odiong	**42.32**	6
Romaraw	**36.01**	5
Pinagtapian	**26.28**	4
Tagbungsaing Outlet	**21.71**	4
Tagbungsaing SW1	**21.71**	4
Tagbungsaing SW2	**21.71**	4

The identification of taxonomic family and validation of this report is in accordance with the published World Register of Marine Species (WoRMS) taxon details.

Table 10. Taxonomic Composition of Zooplankton Species, Berong, Quezon, Palawan, 2021

Family	Scientific Name	Genus	Taxonomic Classification
Calanidae	*Calanoides sp.*	*Calanus*	Copepod
Calanidae	*Calanoides cf. carinatus*	*Calanus*	Copepod
Calanidae	*Calanus sp.*	*Calanus*	Copepod
Calanidae	*Undinula vulgaris (Dana, 1849)*	*Calanus*	Copepod
Paracalanidae	*Paracalanus parvus*	*Paracalanus*	Copepod
Paracalanidae	*Calocalanus pavo* (Dana, 1849)	*Calocalanus*	Copepods
	Crustacea naupilus larvae	N/A	Cephalopod
	Mid Gastropod veliger	N/A	Gastropod
Total zooplankton genera : 6			
Total Species : 8			
Family : 5			

2. Invertebrates Composition

Table 11. Taxonomic Composition and Abundance of Marine Invertebrates, 2021

ecies/ Station	BITAS	DANGLA	ODIONG	TAGBOLANTE	ROMARAW	CATUAYAN	BERONG	TALABONGAN	Total
HYLUM ECHINODERMATA									
ass Crinoidea (Feather ar)									
Family Comasteridae									
Comantina schelegelii (Green)		8	6	2	5	6	7	11	45
Comanthus parvicirrus (Blue)	4	2	2	4			4	3	19
manthus alterans (Black white)	5	2	3						10
Comaster multifidus (Orange)		2	7	2	2	3	3	13	32
amily Colobometridae									
Colobometra perspinosa (Black)	5	18	9	8		10	5	20	75
amily Himerometridae									
Himerometra robustipinna(Red)	2	12	2					10	26
lass Ophiuroidea (Brittle Stars)									
Family Ophiocomidae									
Ophiomastix sp.	6	15	15	10	23	8	10	7	94
Ophioderma appressum		12		3			5	8	28
Class Echinoidea (Sea Urchins)									
Family Diadematidae									
Diadema setosum	3	4	2	4		1		14	28
Echinotrix calamaris	2	2					1	5	9
Class Asteroidea									
Family Ophidiasteridae									
Linkia laevigata		3		2				5	10
Family Oreasteridae									
Protoreaster nodosus					1				1
Family Ophidiasteridae									
Celerina heffernani	1							1	2
YLUM MOLLUSCA									
Class Bivalvia									
Family Tridacnidae									
Tridacna squamosa				1				1	2
Tridacna crocea	1	1							2
Family Pectinidae									
Pedum spondylodium	22			2				2	26
Family Pinnidae									
Atrina vexillum								2	2
Class Gastropoda									
Family Muricidae									
Drupella cornus	43	15	23	8	2	8	22	14	135

Family Strombidae									
Lambis sp.								1	1
PHYLUM ANNELIDA									
Class Polychaeta									
Family Serpulidae									
Spirobranchus giganteus	70	7	26	21	96		12	98	330
Family Sabellidae									
Sabellastarte spectabilis	16	3		2				23	44
TOTAL INDIVIDUALS/STATION	180	106	95	69	129	36	69	228	912
NUMBER OF FAMILIES/STATION	13	11	7	10	5	6	6	14	N/A
SPECIES/STATION	14	15	10	13	5	6	9	18	
Total Species									22
Total Individuals									912
No.of Family									14

A total of twenty-two (22) species representing fourteen (14) families were recorded during the survey. The Christmas tree worm (*Spirobranchus giganteus*) was the most dominant species were observed with a total of three hundred thirty (330) individuals during the survey activity.

There were thirteen (13) species listed for echinoderm species with five (5) species for mollusk and two (2) species for annelids were recorded with a decrease of two (2) when compared to last year's assessment.

The abundance of all invertebrates species showed a minimal decreased in population of Nine Hundred Ninety twelve (912) individuals when compared to One Thousand Nine (1,009) individuals of last year's data collected due to the effect of Typhoon Jolina's poor visibility.

3. Coral Cover

Coral reefs are one of the most diverse and more highly threatened ecosystems in biodiversity conservation. It is the most critical marine habitats that provide a significant contribution to the functioning of underwater benthic ecosystems.

A coral is usually the common name for the Order Scleractinia, all members of which have hard skeleton which in a sessile-benthic ecosystem, there are stony corals called hermatypic reef-building corals. It is practically a mineral called calcium carbonate (CaCO3), similar to limestone. Reefs grow best in warm, shallow, clear and sunny waters.

Corals occupy less than 1% of the world ocean surface, and they provide a home for at least 25% of all marine species, including fishes, mollusks, echinoderms and sponges. In the Philippines, corals reefs are the most critical and important biodiversity in sustaining our fisheries and food security having 34,000 sq. km which 60% or 20,400 sq. km are located in the Province of Palawan.

Berong Bay surrounding communities, it occupies a long and vast sandy- tidal reef flats along seaward areas going to coral reef environment comprising eight (8) sites of outer reef type community, and a fringing reef located at BNC's Pier site jetty vicinities.

In order to protect and monitor the improvement of coral growth in the impacted area of Berong Nickel Corporation, there a need is to develop the efficiency of coral monitoring efforts through Coral Point Count with Excel extensions (CPCe) program.

The CPCe methodology aims to increase the efficiency and ease of performing the large number of coral image analyses and features in the comprehensive identification coral life forms required and to contribute a meaningful assessment protocols by providing a reliable means of data archiving, data collection and data analysis and monitoring mechanisms.

Coral Point Count with Excel extensions (CPCe) is a visual basic program which automates, facilitates, and speeds the random point count analysis process of a coral substrate which were taken from an underwater photo- quadrat platform.

Excel spreadsheet contents include header information, statistical parameters of each species/substrate type (relative abundance, mean, standard deviation, standard error) and the calculation of the Shannon–Weaver diversity and Simpson index for each species were presented in every coral reef stations in this report.

The Shannon diversity index (H) is an index computed in the CPCe that is commonly used to characterize species diversity in a community that accounts for both abundance and evenness of the species present.

It equitability assumes a value between 0 and 1 with 1 being complete evenness as shown in nine (9) BNC's reef monitoring stations.

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. In essence it measures the probability that two individuals randomly selected from an area will belong to the same species.

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

where n_i = the total number of organisms of each individual species
N = the total number of organisms of all species

The value of **D** ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. That is, the bigger the value the lower the diversity.

Table 12 is the CPCe summary of percentage cover of live hard coral coverage, other fauna, dead corals, abiotic and algae component in all the monitoring stations.

Table 12. CPCe Percent Substrates Cover by Sessile-Benthic categories/Station, 2021

Station	Live Hard Corals	Other Fauna	Dead Corals	Algae	Abiotic
Bitas	62.92%	5.61%	27.72%	3.00%	0.75%
Talabonggan	68.52%	6.9%	22.64%	1.65%	0.30%
Dangla	63.45%	9.18%	26.57%	0.81%	0.00%
Berong	50.37%	13.97%	33.82%	1.10%	0.74%
Odiong	64.19%	9.33%	22.81%	1.06%	2.60%
Tagbolante	55.43%	18.07%	24.50%	2.01%	0.00%
Catuayan	50%	8.33%	33.33%	0.00%	8.33%
Romaraw	55.96%	11.92%	31.61%	0.52%	0.00%
Bansaluyan	68.38%	7.12%	23.92%	0.58%	0.00%
Mean Total	**59.91%**	**10.04 %**	**27.44%**	**1.19%**	**1.41%**

Through the new application of the Coral Point Count (CPCe) methodology, the mean overall percentage condition of the coral reefs in the impacted areas was 59.91%, other fauna 10.04%, dead corals 27.44%, algae 1.19% and abiotic component 1.41%.

The result of the CPCe hard coral cover which establishes 59.91% is under good condition status, however the said survey result was disturbed by the typhoon Jolina, the poor visibility was encountered during the activity.

The result summary of the corals will served as the new baseline data under the CPCe program in all the impacted areas.

Below are the results summary of the nine (9) stations under the CPCe methodologies:

Figure 5 CPCe results summary in Talabonggan Reef Station comprising live hard coral of 62.92%, dead corals 27.72%, other fauna 5.61%, algae 3.00% and abiotic component 0.75%.

Figure 5. Summary of percent substrates cover by sessile-benthic categories of Bitas Reef, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	159	59.55	1.40	0.71
NON ACROPORA (NA)	9	3.37	0.94	0.57
DEAD CORALS (DC)	74	27.72	0.65	0.46
SOFT CORALS (SC)	12	4.49	0.00	0.00
OTHER ORGANISM (OT)	3	1.12	0.00	0.00
ALGAE (AL)	8	3.00	0.74	0.41
ABIOTIC COMPONENT (AC)	2	0.75	0.00	0.00
TAPE (T)	13	4.64		
TOTALS	280	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 6 CPCe results summary in Talabonggan Reef Station comprising live hard coral of 68.52%, dead corals 22.64%, other fauna 6.9%, algae 1.65% and abiotic component 0.30%.

Figure 6. Summary of percent substrates cover by sessile-benthic categories of Talabonggan Reef, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	441	66.12	1.47	0.74
NON ACROPORA (NA)	16	2.40	1.24	0.63
DEAD CORALS (DC)	151	22.64	0.62	0.43
SOFT CORALS (SC)	41	6.15	0.00	0.00
OTHER ORGANISM (OT)	5	0.75	0.00	0.00
ALGAE (AL)	11	1.65	0.60	0.31
ABIOTIC COMPONENT (AC)	2	0.30	0.00	0.00
TAPE (T)	33	4.71		
TOTALS	700	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 7 CPCe results summary in Dangla Reef Station comprising live hard coral of 63.45%, dead corals 26.57%, other fauna 9.18%, algae 0.81% and abiotic component 0%.

Figure 7. Summary of percent substrates cover by sessile-benthic categories of Dangla Reef, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	377	60.71	1.16	0.61
NON ACROPORA (NA)	17	2.74	1.54	0.74
DEAD CORALS (DC)	165	26.57	0.58	0.39
SOFT CORALS (SC)	54	8.70	0.00	0.00
OTHER ORGANISM (OT)	3	0.48	0.00	0.00
ALGAE (AL)	5	0.81	0.67	0.48
ABIOTIC COMPONENT (AC)	0	0.00	0.00	1.00
TAPE (T)	9	1.43		
TOTALS	630	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 8 CPCe results summary in Berong Reef Station comprising live hard coral of 50.37%, dead corals 33.82%, other fauna 13.97%, algae 1.10% and abiotic component 0.74%.

Figure 8. Summary of percent substrates cover by sessile-benthic categories of Berong Reef, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	84	30.88	0.79	0.40
NON ACROPORA (NA)	53	19.49	0.57	0.34
DEAD CORALS (DC)	92	33.82	0.52	0.34
SOFT CORALS (SC)	37	13.60	0.00	0.00
OTHER ORGANISM (OT)	1	0.37	0.00	0.00
ALGAE (AL)	3	1.10	0.00	0.00
ABIOTIC COMPONENT (AC)	2	0.74	0.00	0.00
TAPE (T)	8	2.86		
TOTALS	280	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 9 CPCe results summary in Odiong Reef Station comprising hard coral cover of 64.19%, dead corals 22.81%, other fauna 9.33%, algae 1.06% and abiotic component 2.60%.

Figure 9 .Summary of percent substrates cover by sessile-benthic categories, Odiong Reef Station, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	496	58.63	1.45	0.73
NON ACROPORA (NA)	47	5.56	0.89	0.44
DEAD CORALS (DC)	193	22.81	0.62	0.43
SOFT CORALS (SC)	76	8.98	0.00	0.00
OTHER ORGANISM (OT)	3	0.35	0.00	0.00
ALGAE (AL)	9	1.06	0.35	0.20
ABIOTIC COMPONENT (AC)	22	2.60	0.30	0.17
TAPE (T)	34	3.86		
TOTALS	880	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 10 CPCe results summary in Tagbolante Reef Station comprising hard coral cover of 55.43%, dead corals 24.50%, other fauna 18.07%, algae 2.01% and abiotic component 0.00%.

Figure 10. Summary of percent substrates cover by sessile-benthic categories, Tagbolante Station, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	122	49.00	1.17	0.61
NON ACROPORA (NA)	16	6.43	0.38	0.22
DEAD CORALS (DC)	61	24.50	0.47	0.30
SOFT CORALS (SC)	45	18.07	0.00	0.00
OTHER ORGANISM (OT)	0	0.00	0.00	1.00
ALGAE (AL)	5	2.01	0.50	0.32
ABIOTIC COMPONENT (AC)	0	0.00	0.00	1.00
TAPE (T)	1	0.40		
TOTALS	250	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 11 CPCe results summary in Catuayan Reef station comprising hard coral cover of 50%, dead corals 33.33%, other fauna 8.33%, algae 0.00% and abiotic component 8.33%.

Figure 11. Summary of percent substrates cover by sessile-benthic categories, Catuayan Station, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	10	20.83	1.33	0.72
NON ACROPORA (NA)	14	29.17	1.28	0.69
DEAD CORALS (DC)	16	33.33	0.69	0.49
SOFT CORALS (SC)	1	2.08	0.00	0.00
OTHER ORGANISM (OT)	3	6.25	0.64	0.44
ALGAE (AL)	0	0.00	0.00	1.00
ABIOTIC COMPONENT (AC)	4	8.33	0.56	0.38
TAPE (T)	2	4.00		
TOTALS	50	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 12 CPCe results summary in Romaraw Reef station comprising hard coral cover of 55.96%, dead corals 31.61%, other fauna 11.92%, algae 0.52% and abiotic component 0.00%.

Figure 12. Summary of percent substrates cover by sessile-benthic categories, Romaraw Station, 2021

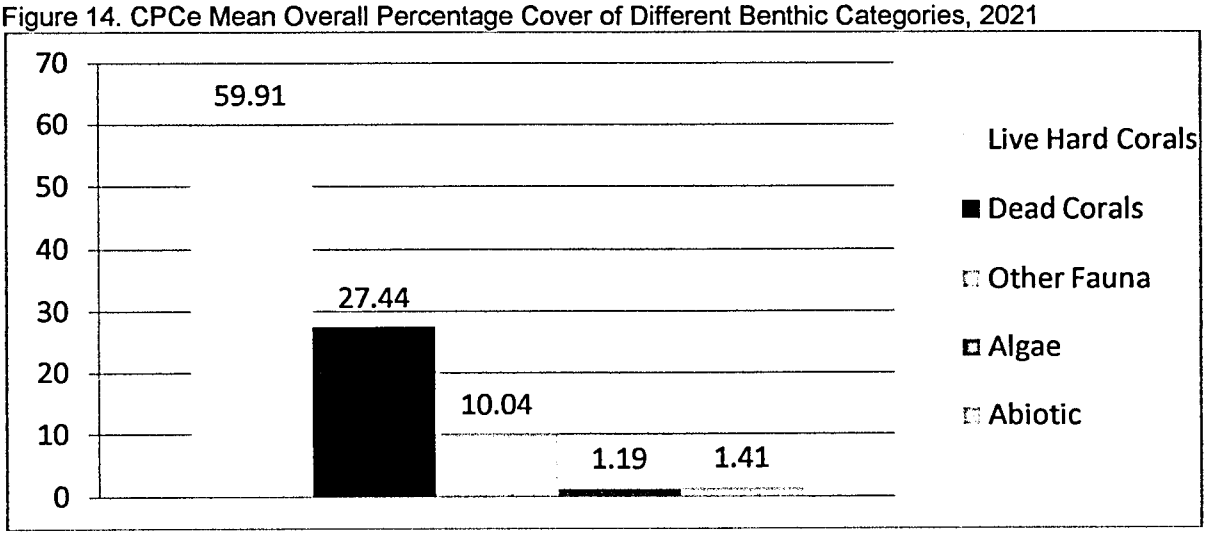
RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	206	53.37	1.29	0.69
NON ACROPORA (NA)	10	2.59	1.47	0.74
DEAD CORALS (DC)	122	31.61	0.57	0.38
SOFT CORALS (SC)	45	11.66	0.00	0.00
OTHER ORGANISM (OT)	1	0.26	0.00	0.00
ALGAE (AL)	2	0.52	0.69	0.50
ABIOTIC COMPONENT (AC)	0	0.00	0.00	1.00
TAPE (T)	4	1.03		
TOTALS	390	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 13 CPCe results summary in Bansaluyan Reef station comprising hard coral cover of 68.38%, dead corals 23.92%, other fauna 7.12%, algae 0.58% and abiotic component 0.00%.

Figure 13. Summary of percent substrates cover by sessile-benthic categories, Bansaluyan Station, 2021

RESULTS SUMMARY CHART	# Points	%	SW Index	Simpson (1-D)
ACROPORA (A)	552	64.41	0.98	0.50
NON ACROPORA (NA)	34	3.97	1.51	0.71
DEAD CORALS (DC)	205	23.92	0.62	0.43
SOFT CORALS (SC)	57	6.65	0.00	0.00
OTHER ORGANISM (OT)	4	0.47	0.00	0.00
ALGAE (AL)	5	0.58	0.67	0.48
ABIOTIC COMPONENT (AC)	0	0.00	0.00	1.00
TAPE (T)	13	1.49		
TOTALS	870	100.00		
NOTES (% of transect)				
NOTES (% of coral)				

Figure 14. CPCe Mean Overall Percentage Cover of Different Benthic Categories, 2021



The overall CPCe results observed carries the condition of good coral cover status and presented healthy condition respectively. The live hard coral stands to have 59.91% under good coral condition status. The mean overall percentage condition of the coral reefs in the impacted areas was 69.95% (live hard & other fauna species).

4. Reef Fishes

Reef fish's assemblages within the impacted areas for this year's study have presented a significant decreased due to Typhoon Jolina. A total of one hundred eighty eight (188) species of fish representing thirty (30) families were observed from all monitoring stations with a total abundance of seven thousand sixteen (7,016) individuals.

Table 13 is the analysis of fish assemblage in all survey stations describing family and species, abundance, fish categories and the current fish resource status in all of the monitoring stations of BNC in Berong coastal waters.

Table 13. Fish abundance, fish diversity (family and species) per Category, 2021

Parameters/Category	Abundance (No. of Individuals)	Species Diversity
Major Species	4,249	107
Commercially-Important Species	2,596	69
Indicator Species	171	12
Total Individuals	7,016	
Total Species	188	
No. of Family	30	

Analysis shows that the species diversity for major species were recorded at one hundred seven (107) species, while commercially- important (target) species is at sixty (69) species and twelve (12) indicator species for a total of one hundred eighty eight (188) species.

Diversity wise, there was a decreased of twelve (12) species from that of two hundred (200) species to one hundred eighty eight (188) species for this year's survey due to poor visibility due to poor visibility.

In the classification of fish categories, a total of four thousand two hundred forty nine (4,249) individuals were recorded for major species, and two thousand five hundred ninety six (2,596) individuals for commercially important species and one hundred seventy one (171) individuals for indicator species for a total abundance of seven thousand sixteen (7,016) individuals.

When compared to last year's study of eleven thousand seven hundred (11,700) individuals, there was a significant decreased of four thousand six hundred eighty four (4,684) individuals.

Table 14 shows the comparative analysis of fish abundance and species diversity per category between 2020 and 2021 surveys.

Table 14. Comparative Analysis of Fish Abundance and Diversity (Family and Species) per Category, 2020- 2021

Parameters	Reef Fishes Status Monitoring Years		Current Status /Trends Comparison of 2020 and 2021 Results
	2020	2021	
Abundance	11,700	7,016	Decreased by 4,684 individuals
Family	33	30	Decreased by 3 families
Species	200	188	Decreased by 12 species
Major	116	107	Decreased by 9 species
Target	74	69	Decreased by 5 species
Indicator	9	12	Increased by 3 species

This year results in the fish visual census as indicated in Table 5 presented an increased of species richness and abundance along sets of nine (9) permanent transects which include the Bansaluyan Reef Station in Barangay Isugod, Quezon, Palawan.

Fish populations presented during this year survey exhibited an overall trend of significant decreased within belt transects relative to 2021 levels due to unexpected typhoon disturbance, there was a decreased of four thousand six hundred eighty four (4,684) individuals.

For this 2021 fish survey, table 15 is the overview of indicators for reef fish's status and trends of all stations in the impacted areas describing the results of abundance and density (Indv./250m^2) indicating significant decreased in six (6) major stations of this year's study when compared to previous to 2020 results.

Table 15. Mean estimated fish abundance/density (individual/250m^2) /Station, 2020-2021

Overall Fish Abundance (Individual/250m^2)			
Reef Station	Monitoring Years		Status/Trends/Comparison of 2020 and 2021 Results
	2020	2021	
Romaraw Station	779	533	Decreased by **246** Individuals
Odiong Station	353	412	Increased by **59** Individuals
Tagbolante Station	1,086	859	Decreased by **227** Individuals
Berong Station	444	1,021	Increased by **577** Individuals
Talabonggan Station	1,759	784	Decreased by **975** Individuals
Dangla Station	1,771	159	Decreased by **1,612** Individuals
Bitas Station	4,132	1,448	Decreased by **2,684** Individuals
Catuayan	1,376	470	Decreased of **906** Individuals
Bansaluyan	N/A	1,330	Baseline
Total Individuals	**11,700** Indv/250m^2	**7,016** Indv/250m^2	Decreased by **4,684 Individuals**

Table 16 shows the statistical data of fish abundance per density (Indv./250/m^2) of individual species diversity and their category classification in all sites in Berong coastal marine areas during the conduct of the survey.

Table 16. Number of Fish Family, Species Categories and Abundance (Indv./250/m^2) per Stations, 2021

Reef Station	Romaraw	Tagbolante	Odiong	Berong Reef	Bitas Reef	Dangla	Talabonggan	Catuayan	Bansaluyan
Total Individuals	533	859	412	1,021	1,448	159	784	470	1,330
Total Species	57	59	41	66	63	40	72	51	76
Families	19	23	14	23	11	13	16	19	19
Indicator Species Diversity	5	6	1	7	2	3	6	5	5
Major Species Diversity	34	36	25	40	47	28	44	31	40
Target Species Diversity	18	18	15	20	13	9	23	16	31

5. Sea Grass Composition and Associated Algae

5.1 Sea Grass

For this year's study, a total of eight (8) sea grass species were identified. Species of round tipped sea grass (*Cymodocea rotundata*), toothed sea grass (*Halodule pinifolia* and *Halodule uninervis*), spoon grass (*Halophila ovalis*), Dugong Grass (*Thalassia hemprichii*), and tropical eel grass (*Enhalus acoroides*), and (*Cymodocea serrulata)* were recorded along designated survey stations.

Thalassodendron ciliatum, a very rare species was found to have thrived in Berong Proper Station. This year's study, presence of invertebrates and other related animals in most of the sea grass stations were observed to be less abundant species.

Table 17. Distribution of sea grass species in four (4) stations, 2021

SPECIES	CATUAYAN	TAGBOLANTE	ODIONG	BERONG PROPER
Thalassia hemprichii	✓	✓	✓	
Enhalus acoroides	✓	✓	✓	✓
Halophila ovalis	✓	✓		
Halodule uninervis			✓	✓
Halodule pinifolia	✓	✓		✓
Cymodocea rotundata	✓	✓		✓
Cymodocea serrulata				✓
Thalassodendron ciliatum				✓
No. of species/Station	5	5	3	6

Species Diversity

Seagrass diversity ranged from 3 to 6 and was represented by six (6) species *Enhalus acoroides, Thalassia hemprichii, Thalassodendron ciliatum, Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halophila ovalis* and *Halodule uninervis.*

.

In Catuayan, Station, five (5) species were recorded, *Cymodocea rotundata, Enhalus acoroides, Halodule pinifolia, Thalassia hemprichii* and *Halophila ovalis.*

In Tagbolante, Station, there were five (5) species, *Enhalus acoroides, Thalassia hemprichii, Cymodocea rotundata. Halophila ovalis* and *Halodule pinifolia*

In Odiong Station, there were only three (3) species recorded, *Halodule uninervis, Thalassia hemprichii* and *Enhalus acoroides.*

In Berong *Proper, there* were six (6) species recorded, *Halodule uninervis, Thalassia hemprichii* and *Enhalus acoroides, Cymodocea rotundata, Cymodocea serrulata* and *Thalassodendron ciliatum*, a very rare species in the Province of Palawan.

Percent Cover

The assessment recorded in four (4)stations surveyed and assessed, all the sea grass station were observed to be in fair stands due to sea level rise and disturbance of local communities sea weed plantation and sea cucumber farming resulting to a significant decreased in growth and percent cover.

Table 18. Percentage Cover of Sea grass per Survey Sites, 2021

Stations	No. of Species	Percentage Cover, 2019	Percentage Cover, 2020	Percentage Cover, 2021	Condition	Current Status/Comparison of 2020 & 2021 Results Trends
Catuayan	5	57.81%	31.67%	35.67%	Fair	Increased
Tagbolante Sta 2	5	45%	29.28%	24.48%	Fair	Decreased
Odiong	3	76.40%	41.0%	44.51%	Fair	Increased
Berong	6	62.92%	42.85%	48.5%	Fair	Increased

Overall, the general condition of sea grass beds in four (4) stations surveyed and assessed is in fair category with an overall rating of 38.20% an increased for 2.0% growth except for Tagbolante Station 2 with a decrease 4.8% growth. This year's 2021 survey results have also affected by the poor visibility of the shorelines along sea grass ecosystem.

Another factor of decreasing trends to the growth of the sea grass in Tagbolante Station 2 is that the designated survey area were already occupied by seaweed plantation farms and sea cucumber culture farming of kurtido species are installed with small cottages make shift coverings.

The initial increase of sea grass growth coverage from the results of the survey show that area now has been less-disturbed. There have been observed that the sea grass leaves have not been affected by the increased of algal bloom.

All leaves samples that have been collected by our hands due zero visibility of the water reveals that the growth of every sea grass leaves were observed to be on healthy status.

5.2 Seaweeds

A total of seven (7) species belonging to two (2) families were identified *Sargassum sp. Turbinaria conoides, Padina australis* and *Padina minor* belong to family *Phaeophyceae* while *Halimeda opuntia, Halimeda macroloba* and *Caulerpa sentularoides* belong to family *Chlorophyceae* (Table 19).

Table 19. Species of Sea grass Associate Algae in Four (4) Sampling Stations, 2021

Species	Catuayan	Tagbolante	Odiong	Berong
Family Phaeophyceae *Sargassum sp.*	√		√	
Turbinaria conoides	√	√	√	
Padina australis	√			√
Padina Minor	√			
Family Chlorophyceae *Halimeda opuntia*			√	√
Halimeda macroloba			√	
Caulerpa sertularioides				
No. of Species	4	1	4	2

Table 20 shows the overview of the overall resource status of all impacted areas per station describing the results of coastal resource assessment of the Berong Nickel Corporation monitoring years of 2019, 2020 and 2021 respectively.

Table 20. Resource status and trends of resources found in different stations in the impacted areas. Indicators Used are: Plankton(Indv./m^3), Fish Abundance, (Indv/250m^2); Corals, (hard & other fauna, % cover), Sea Grass %), 2019- 2021

Station	Resources /Parameters	Resource Status Monitoring Years			
		2019	2020	2021	Current Status/Trends/ Comparison of 2019, 2020 2021 Results
Romaraw Station	Phytoplankton (Indv./m^3)	357.67	367.68	352.82	Decreased
	Zooplankton (Indv./m^3)	38.29	54.29	36.01	Decreased
	Fish (Indv/250m^2)	743	779	533	Decreased
	Live Corals	29.7%	62.34%	55.96%	Baseline
OdiongStation	Phytoplankton (Indv./m^3)	213.14	260.57	253.14	Decreased
	Zooplankton (Indv./m^3)	28	58.8	42.32	Decreased
	Fish (Indv/250m^2)	636	353	412	Increased
	Live Corals	39.63%	61.60%	64.19%	Baseline
	Seagrass Sta 4	76.40%	41.0%	44.51%	Increased
Pinagtapian	Phytoplankton (Indv./m^3)	183.99	186.85	170.99	Decreased
	Zooplankton (Indv./m^3)	30.28	26.28	26.28	Maintained
Tagbungsaing Outlet	Phytoplankton (Indv./m^3)	150.27	138.28	138.28	Maintained
	Zooplankton (Indv./m^3)	57.14	30.85	21.71	Decreased
Tagbung Saing Lake SW1	Phytoplankton (Indv./m^3)	94.28	124.56	124.56	Maintained
	Zooplankton (Indv./m^3)	35.99	30.85	21.71	Decreased
Tagbung Saing Lake SW2	Phytoplankton (Indv./m^3)	71.42	106.27	106.27	Maintained
	Zooplankton (Indv./m^3)	17.71	44.56	21.71	Decreased
CatuayanStation	Seagrass Sta 1	57.81%	31.67%	35.67%	Increased
	Live Corals	39.98%	51.89%	50%	Baseline
	Fish (Indv/250m^2)	1,042	1,376	470	Decreased
Tagbolante Station	Phytoplankton (Indv./m^3)	100.57	154.57	147.14	Decreased
	Zooplankton (Indv./m^3)	58.85	62.84	58.84	Decreased
	Fish (Indv/250m^2)	1,764	1,086	859	Decreased
	Live Corals	38.23%	55.39%	55.43%	Baseline
	Sea Grass Sta 2.	45%	29.28%	24.48%	Decreased
	Sea grass Sta 3	53.2%	N/A	N/A	N/A
BerongStation	Fish (Indv/250m^2)	36	444	1,021	Increased
	Live Corals	49.02%	48.09%	50.37%	Baseline
	Sea grass Sta 5	62.92%	42.85%	48.50%	Increased
Talabonggan	Fish (Indv/250m^2)	887	1,759	784	Decreased
	Live Corals	63.92%	70.91%	68.52%	Baseline
Dangla Station	Phytoplankton (Indv./m^3)	394.68	409.45	404.88	Decreased
	Zooplankton (Indv./m^3)	44.57	50.85	48.26	Decreased
	Fish (Indv/250m^2)	2,575	1,771	159	Decreased
	Live Corals	62.21%	75.71%	63.45%	Baseline
BitasStation	Fish (Indv/250m^2)	3,888	4,132	1,448	Decreased
	Live Corals	61.31%	72.25%	62.92%	Baseline
Bansaluyan	Fish (Indv/250m^2)	N/A	N/A	1,330	Baseline
	Live Corals	N/A	N/A	68.38%	Baseline

IV. CONCLUSION

The results on the application of Coral Point Count (CPCe) methodology shall be served as a new baseline data for all the substrate categories in the impacted areas of the BNC since it was applied totally in the reef crest–reef front zones along outer reefs types in the coastal waters of Berong. These results could also be a reference to previous coral surveys under *English et al.* Method with a minimal data-resource status difference because previous surveys were done at the most-deeper reef fronts going down to upper and lower slopes of the reef.

The reef fronts in Berong coastal waters are some of the narrow zone that becomes exposed at low tide and is the part of the reef which takes much of the force of the ocean swell wherein the corals are short and stocky and have the appearance of being moved down. The most dominant reef fronts species were branching corals of Acropora and non-reef building corals, they are the most common corals in these areas exposed to extreme wave actions especially during typhoon events.

The CPCe methods aims to increase the efficiency and ease of performing the large number of coral image analyses and features in the comprehensive identification coral life forms required and to contribute a meaningful assessment protocols by providing a reliable means of data archiving, data collection, and data analysis and monitoring mechanisms which automates, facilitates, and speeds the random point count analysis process of a coral substrate which were taken from an underwater photo- quadrat platform.

The abundance and diversity of all the surveys were greatly affected by the disturbance of Typhoon Jolina wherein the fish assemblage has significantly affected due to seawater poor visibility. In underwater survey activity, our movement have been limited with irregular forces of current but sometimes there being observed in normal waters movement but when going up to surface, the strong waves strikes, unsafe as we have to immediately abort the activity for the day. It is recommended that a proper forecasting of weather be scheduled before sampling and biodiversity assessment has to be conducted in the next coastal resource assessment.

On the other hand, the planned coral survey within the BNC Pier Jettison vicinity have not been conducted, however, it was observed during the emergency dive that the coral (garden) transplantation project has been observed on its successful growth. This coral community should be form part of the company's primary impact area where ore barge loading operations are conducted by trucking and ship loading activities.

V. RECOMMENDATIONS

It is recommended that the fringing reefs within Pier site vicinity will be form part of the impacted area. The said site has a high diversity and density of encrusting, tabulate, branching, encrusting plates, and massive Porites corals where extensive colonies of one species or genus have been observed in an apparently random fashion. Based on our initial dive activity, the Pier Site coral vicinity is a community-type fringing reef area is along the mainland foreshore of Barangay Berong, as it was extended to other outer reef flats to seaward. It is also recommended that and IEC and PCRA workshops for coral conservation program be conducted by both the BNC and the researchers as good practices in environmental management planning under AEPEP to adopt an LGU adopt a Coral Garden Transplantation Program in order to encourage the stakeholders to participate in biodiversity conservation. The Pier Site vicinity is a potential site.

VI. ACKNOWLEDGMENTS

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VIII. APPENDICES

Appendix 1. Abbreviations, 2021

AEPEP	Annual Environmental Protection and Enhancement Program
BNC	Berong Nickel Corporation
BMS	Biodiversity Monitoring System
CITES	Convention of International Trade in Endangered Species
CPCe	Coral Point Count with Excel extension
DENR	Department of Environment and Natural Resources
ECC	Environmental Compliance Certificate
EIS	Environmental Impact Statement
EMP	Environmental Management Program
FRMP	Fisheries Resource Management Program
FVC	Fish Visual Census
GPS	Global Positioning System
IEC	Information and Education Campaign
ISO	International Standard Organization
IUCN	International Union for the Conservation of Nature
MEPEO	Mine Environmental Protection and Enhancement Office
PCBFAI	Palawan Community-Based Fisherfolk Alliance, Inc.
PCO	Pollution Control Office of BNC
SCUBA	Self-Contained Underwater Breathing Apparatus

Appendix 2. BNC Reef Fishes Observed in Nine (9) Stations, September 2021

Total Species Database				Reef Sites									
MILY	SCIENTIFIC NAME	English/ Common Name	CATEGORY	Romaraw	Tagbolante	Odiong	Berong Proper	Bitas	Dangta	Talabongga n	Catuayan	Isugod Bansaluyan Island (NEW)	TOTAL
[illegible]idae	*Zanclus cornutus*	Moorish Idol	Indicator	18	6	8	6	2	4	3	6	4	**57**
[illegible]scidae	*Aeoliscus strigatus*	Shrimpfish	Indicator		8		6				8	24	**46**
l[illegible]erida	*Scolopsis bilineata*	Twolinespinechee k	Indicator	4	2		2		1	4		2	**15**
	Scolopsis ciliata	Ciliate spinecheek	Indicator									6	**6**
	Scolopsis affinis	Onelinespinechee k	Indicator	2	4					3		6	**15**
	Scolopsis margaritifer	Pearly spinecheek	Indicator				2	3		2			**7**
	Pentapodus trivittatu s	Three-striped whiptail	Indicator	1	2		2			2			**7**
[illegible]ontida	*Synodus dermatoge nys*	Clearfin lizardfish	Indicator		2		2			1	1		**6**
	Synodus variegatos	Reef lizardfish	Indicator								2		**2**
[illegible]e	*Blenniela chrysospilos (NEW)*	Red spotted blenny	Indicator								1		**1**
	Salarias fasciatus	Jeweled blenny	Indicator				1						**1**
	Aspidontus taeniatus	Cleaner mimic	Indicator	4					4				**8**
													Indicator (171)
[illegible]ae	*Bodianus mesothorax*	Split level hogfish	Major	6	6	6	1	22	2	6	6	1	**56**
	Bodianus bilunulatus	Saddleback hogfi sh	Major	5									**5**
	Anampses caeruleopunctatus	Blue-spotted wrras se	Major							2			**2**
	Oxycheilinus unifasciatus	Slender maori wrasse	Major							2	1		**3**

Oxycheilinus celebecus	Slender maori wrasse	Major					4		1				5
Oxycheilinus orientalis	Oriental wrasse	Major	6										6
Cirrhilabrus cyanopleura	Blueside wrasse	Major					1						1
Cheilinus chlorourus	Floral wrasse	Major			2		8	1	4	2			17
Cheilinus fasciatus	Redbreasted wrasse	Major					6						6
Cheilinus oxycephalus	Snooty wrasse	Major		1	4					2	2		9
Cheilinus trilobatus	Tripletail wrasse	Major	10				4		1				15
Coris batuensis	Dapple coris	Major				2							2
Coris gaimard (NEW)	Yellowtail coris	Major				4							4
Diproctacanthusxanthurus	Wandering cleaner wrasse	Major		2	8	4	14	2	8				38
Macropharyngodon meleagris	Leopard wrasse	Major		3									3
Epibulus sp.	Dwarf slingjaw wrasse	Major		2	2				2		20		26
Epibulus insidiator	Slingjaw wrasse	Major					4		3	2			9
Gomphosus varius	Bird wrasse	Major	3		2	1	2	1	1		2		12
Halichoeres biocellatus	Two-spotted wrasse	Major					2						2
Halichoeres chloropterus	Darkblotch wrasse	Major			2								2
Halichoeres leucurus	Greyhead wrasse	Major				2	2						4
Halichoeres hortulanus	Checkerboard wrasse	Major	1	2	6		14		2	1			26
Halichoeres melanurus	Pinstriped wrasse	Major						2	2				4
Halichoeres margaritaceus	Weedy surge wrasse	Major							2		4		6
Hemigymnus	Blackeyethicklip	Major					12	1	2				15

melapterus													
Hemigymnus fasciatus	Barred thicklip	Major						1					1
Labroides dimidiatus	Bluestreak cleaner wrasse	Major	10	6	12		18	2	8	2	4		62
Labrichthys unilineatus	Tubelip wrasse	Major	3			1		2	2				8
Thalassoma hardwicke	Sixbar wrasse	Major			6						4		10
Thalassoma lunare	Crescent wrasse	Major	6	12	9		28	6	1				62
Choerodon anchorago	Yellow-checked tuskfish	Major	2	2	2		4		2	2			14
Pseudocheilinus hexataenia	Sixline wrasse	Major					2						2
Pseudocheilinus tetrataenia	Fourline wrasse	Major	3										3
=odonti *Chaetodon auriga*	Butterflyfish	Major	4	2			2		6		6		20
Chaetodon adiergastos	Panda butterflyfish	Major	1							2			3
Chaetodon baronessa	Eastern triangular butterflyfish	Major	4	2	4	2	1	2	1		4		20
Chaetodon lunula (NEW)	Raccoon butterflyfish	Major	1										1
Chaetodon lineatus	Lined butterflyfish	Major				2		1					3
Chaetodon mesoleucus	Vermiculated angelfish	Major							2				2
Chaetodon octofasciatus	Eight-banded butterflyfish	Major		2		1			2				5
Chaetodon punctofasciatus	Spot banded butterflyfish	Major				2							2
Heniochusacuminatus	Longfinbannerfish	Major							1				1
Heniochuschrysostomus	Pennant bannerfish	Major	4	2	2	4			2	2	12		28
Heniochusmonocerus	Masked bannerfish	Major					1						1

	Coradionchrysozonus	Orange-banded butterflyfish	Major	1	1	4	4		1		2	4	**17**
╒ ▬nidae	*Apogonaugustatus (NEW)*	Broad-striped cardinalfish	Major				10						**10**
	Apogoncompressus	Ocre-striped cardinalfish	Major									30	**30**
	Apogoncyanosoma	Yellow-striped cardinalfish	Major				20						**20**
	Apogonhartzfeldii	Silverlinedcardinal fish	Major		8		17				15		**40**
	Apogon lateralis	Humpback cardinalfish	Major									60	**60**
	Apogonnonatus	Spotnape cardinalfish	Major								90		**90**
	Apogonkallopterus	Iridescent cardinalfish	Major		2		2						**4**
	Apogonguamensis	Pearl cardinalfish	Major								11	2	**13**
	Sphaeramianematoptera	Pajama cardinalfish	Major								60		**60**
	Chilodipterusartus	Lined cardinalfish	Major								22	40	**62**
	Chilodipterusmacrodon	Largetoothcardinalfish	Major				30						**30**
	Chilodipterusquenquilineatus	Five-lined cardinalfish	Major	10			30					20	**60**
'omacentrid ∈	*Amphiprionclarkii*	Clark's anemonefish	Major	4									**4**
	Amphiprionfrenatus	Tomato anemonefish	Major				2	2			2	3	**9**
	Amphiprionmelanotus	Dusky anemonefish	Major		2								**2**
	Amblyglyphidodon aureus	Golden damsel	Major					16			3	20	**39**
	Amblyglyphidodon curacao	Staghorn damsel	Major	18	70	40	16	24	10	18	16	100	**312**
	Amblyglyphidodonleucogaster	Whitebelly damsel	Major					28		14			**42**
	Hemiglyphidodonplagiometopon	Giant farmerfish	Major			6		7				4	**17**

Lepidozygustapeinosoma	Fusilier damsel	Major		180	30	35	120		60	40		**465**
Chromisamboinensis	Ambon chromis	Major		40		22						**62**
Chromisagilis	Bronze reef chromis	Major								6		**6**
Chromisanalis	Yellow chromis	Major					20					**20**
Chromiscaudalis	Blue-axilchromis	Major	10	35		27	35	6	18	13	10	**154**
Chromisternatensis	Ternate chromis	Major		60	9	18	40		20	6	40	**193**
Chromisscotochilopt era	Philippine chromis	Major					35					**35**
Chromisviridis	Blue-green damsel	Major	50			40						**90**
Chromisxanthura	Black chromis	Major		35	14	15	25		11	3	80	**183**
Chrysipterabrownrigi (NEW)	Surge demoseille	Major					6					**6**
Chrysiptera glauca	Gray demoiselle	Major					12		22			**34**
Chrysipteracyanea	Blue devil	Major		14		6	11		10		15	**56**
Chrysipteratricincta	Threeband demoiselle	Major										
Pomacentrusadelus	Obscure damsel	Major					25		9		20	**54**
Pomacentrusamboinensis	Ambon damsel	Major							13			**13**
Pomacentrusmoluccensis	Lemon damsel	Major						2	4	4	4	**14**
Pomacentrusnigromanus	Black-axil damsel	Major	5			15		4				**24**
Pomacentrus brachialis	Charcoal damsel	Major					14					**14**
Pomacentrusgrammorhynchus	Bluespot damsel	Major						2				**2**
Pomacentruslepidogenys	Scaly damsel	Major	30				3	10			5	**48**
Neoglyphidodon melas	Black damsel	Major	30	2		10	17	23			6	**88**

	Neoglyphidodonnigroris	Yellowfindamsel	Major	10		1	10	4	20	3		8	**56**
	Premnasbiaculeatus	Spinecheek anemonefish	Major						2	2		4	**8**
	Plectroglyphidodonlacrymatus	Jewel damsel	Major	15	11		27	15	8	15		20	**111**
	Plectroglyphidodonphoenixensis (New)	Phoenix Island damsel	Major									6	**6**
	Abudefdufseptemfasciatus	Banded sergenat	Major	20		16		30					**66**
	Abudefdufsexfasciatus	Scissortail sergeant	Major	40	30			60		40	30	30	**230**
	Dascyllusaruanus	Humbug dascyllus	Major		50	40	30	4	2	40	14	40	**220**
	Dasyllusreticulatus	Reticulated dascyllus	Major	6	60		20	40	4		10	11	**151**
	Dasyllustrimaculatus	Three-spot dascyllus	Major		12							60	**72**
	Dischistodusmelanotus	Blackvent damsel	Major	4	6		6	18	2	4		6	**46**
	Dischistodusperspicillatus	White damsel	Major		2		2	16		3		6	**29**
[illegible]idae	*Gerresacinaces*	Smallscale mojarra	Major		2						16		**18**
[illegible]nerida	*Pempherisoualensis*	Bronze sweeper	Major	40	40	24	40	6		16		30	**196**
	Pempherisschwenkii	Silver sweeper	Major				6						**6**
[illegible]omacanthid∈	*Centropygemultifasciatus*	Multi-barred angelfish	Major	4					3		2	4	**13**
	Chaetodontoplusmesoleucus	Vermiculated angelfish	Major	2									**2**
[illegible]dontide	*Canthigasterpapua*	Papuan toby	Major			3							**3**
	Arothronmanilensis	Striped puffer	Major				1			1			**2**
	Arothronnigropunctatus	Black-spotted puffer	Major		1		1		1				**3**
[illegible]ulostomida	*Aulostomuschinensis*	Trumpetfish	Major								1		**1**

)=—iidae	*Ostracioncubicus (NEW)*	Yellow Boxfish	Major		1		1						2
													Major (4,249)
enida	*Scorpaenopsis sp.*	Spinycrown scorpionfish	Target		1							1	2
ae	*Cheilinusundulatus*	Humphead wrasse\mameng	Target									1	1
iganidae	*Siganusdoliatus*	Pencil streak rabbitfish	Target		2								2
	Siganuspuellus	Masked rabbitfish	Target				2						2
ae	*Scarusglobecips*	Roundhead parrotfish	Target							1			1
	Scaruspsittacus	Palenose parrotfish	Target	11	4	12		8	10	4	4		53
	Scarushypselopterus (NEW)	East indies parrotfish	Target				2	2		1			5
	Scarusforsteni	Rainbow parrotfish	Target					4					4
	Scarusniger	Swarthy parrotfish	Target					4					4
	Scarusflavipectoralis	Yellowfin parrotfish	Target									20	20
	Scarusquoyi	Quoy's parrotfish	Target	1			1						2
	Cetoscarus bicolor	Bicolor parrotfish	Target									3	3
	Chlorurusbleekeri	Bleeker's parrotfish	Target							2		5	7
	Chlorurusbowersi	Bower's parrotfish	Target			6				12			18
	Chlorurusmicrorhinos	Pacific steephead parrotfish	Target									5	5
	Chlorurussordidus	Bullethead parrotfish	Target	4		7			4		2		17
	Leptoscarusvaigiensis (NEW)	Seagrass parrotfish	Target									20	20
	Hipposcaruslongiceps	Pacific longnose parrotfish	Target					2		2		20	24
lotidae	*Plotuslineatus*	Hito, Striped eel	Target				100						100

		catfish												
l=entrida	*Myripristisviolacea*	Violet soldierfish	Target		6	2	4			6	8	90	**116**
	Myripritismurjan	Blotcheyesoldierfish	Target								4		**4**
	Myripritispraslinia	Scarlet soldiefish	Target			16							**16**
	Neoniponargenteus	Clearfish squirrelfish	Target									6	**6**
	Sargocentronspinife rum	Sabre squirrelfish	Target		1					1	2	2	**6**
,=huridae	*Acanthurusnigrofusc us*	Brown Surgeonfish	Target		30	30	60	4	1	18	3	30	**176**
	Acanthurusblochii	Ringtail surgeonfish	Target	7			10		4				**21**
	Ctenocheatusstriatu s	Striped bristletooth	Target	4								35	**39**
	Nasolituratus	Orangespineunicornfish	Target							60			**60**
	Nasolopenzi	Slender unicornfish	Target				10						**10**
	Zebrasoma scopas	Brushtail tang	Target		4	4	6		2	2	2		**20**
ethrinidae	*Gnathodentesauroli neatus*	Yellow-spot emperor	Target									14	**14**
	Lethrinuserythracant hus	Orangefinemperor	Target							4			**4**
	Lethrinusrubrioperc ulatus	Spotcheek emperor	Target	2									**2**
	Lethrinuslentjan	Redspot emperor	Target	4					1			7	**12**
alistidae	*Balistapusundulatus*	Orange-striped triggerfish	Target	1				1	1	1	1	1	**6**
arangidae	*Atule mate*	Yellowtail scad	Target	10	16	20	6			80		70	**202**
	Caranxsexfasciatus	Bigeye trevally	Target				30						**30**
	Carangoidesorthogr amus	Yellow-spotted trevally	Target				70						**70**
aesionidae	*Caesiocuning*	Dalagang-bukid	Target	10		25	200	35		90	18	40	**481**

	Caesiocaerulaurea	Fusilierfish	Target		22	18		240				30	**310**
	Caesiolunaris	Lunar fusilier	Target		17			120				30	**167**
	Pterocaesiotessellata	Mosaic fusilier	Target		12			180		60			**252**
	Pterocaesiotrilineata	Three-striped fusilier	Target						2				**2**
l▬▬ulidae	*Plectorhincuslessonii*	White-belly sweetlips	Target	1	2		1					1	**5**
M▬▬e	*Parupeneusbarberinus*	Dash-dot Goatfish	Target	12	1	4	2		1		2	6	**28**
	Parupeneuscyclostomus	Yellow saddle goatfish	Target		1							2	**3**
	Parupeneusmultifasciatu	Multibarred goatfish	Target				2						**2**
	Upeneustragula	Frekled goatfish	Target									6	**6**
	Upeneusarge	Bandtail goatfish	Target									30	**30**
;erranidae	*Cephalopholismicroprion*	Flickered hind/Grouper	Target	1	2		2	2		2	4		**13**
	Cephalopholiscyanostigma	Blue-spotted hind	Target		2	1	1	1		2	1	1	**9**
	Cephalopholisboenack	Chocolate hind	Target		1	2	1				2		**6**
	Cephalopholisleopardus	Leopard hind	Target							2			**2**
	Cephalopholisargus	Peacock grouper	Target		1							1	**2**
	Anyperodonleucogrammicus	Slender grouper	Target			1	1						**2**
	Liopropomasusumi (NEW)	Striped basslet	Target	1									**1**
	Epinephelusfasciatus	Blacktip grouper	Target								3		**3**
	Epinephelusmelanostigma	Blackspot grouper	Target									1	**1**
	Epinephelusongus	Specklefin grouper	Target									1	**1**
	Epinepheluscoioide	Orange-spotted	Target							1			**1**

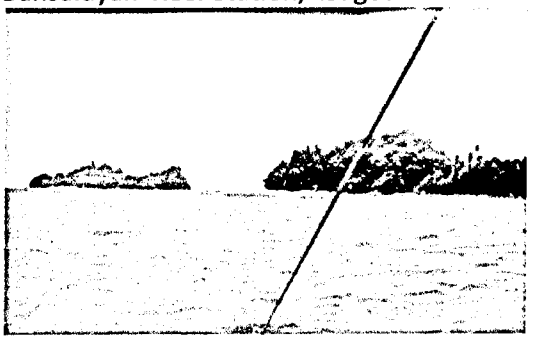
	s	grouper									
	Plectropomusareolatus	Squaretail grouper (Brown suno)	Target						2	2	4
uti idae	*Lutjanusdecussatus*	Checkered snapper	Target		2			4	2		8
	Lutjanus bohar	Twinspot snapper	Target							60	60
	Lutjanus fulvus	Blacktail snapper	Target			2					2
	Lutjanus fulviflamma	Longspot snapper	Target	4							4
	Lutjanusehrenbergi	Blackspot snapper	Target					18			18
	Lutjanusrivulatos	Scribbled snapper	Target					6			6
	Lutjanuskasmira	Blacktail snapper	Target	60							60
	Lutjanussemicinctus	Haft-barred snapper	Target	1							1
	Lutjanusvitta	Brownstriped snapper	Target	2							2
											Target (2,596)
Abundance											7,016
	Total Individuals			533	859	412	1,021	1,448	159	784	470	1,330	
	Number of Families			19	23	14	23	11	13	16	19	19	
	Indicator Species Diversity			5	6	1	7	2	3	6	5	5	
	Major Species Diversity			34	36	25	40	47	28	44	31	40	
	Target Species Diversity			18	19	15	20	13	9	23	16	31	

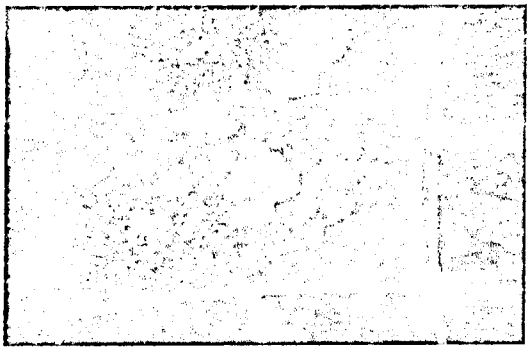
Summary

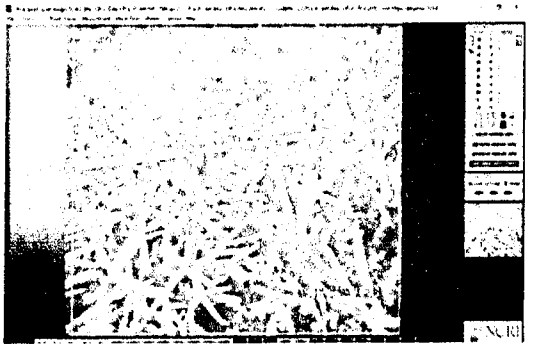
Total Species Diversity	188
Total Number of Fish Family	30
Total Number of Indicator Species	171
Total Number of Major Species	4,249
Total Number of Target Species	2,596
Total Abundance	7,016

Pictorial Plates, 2021

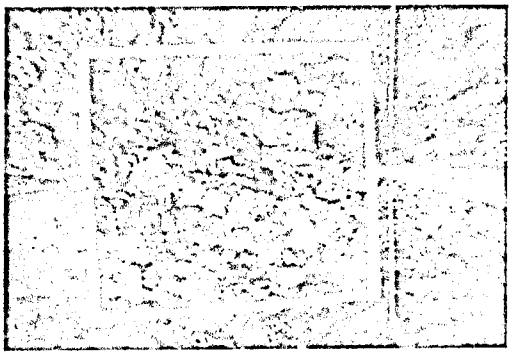
Bansaluyan Reef Station, Isugod

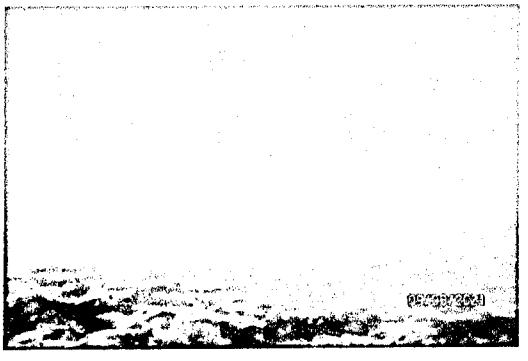




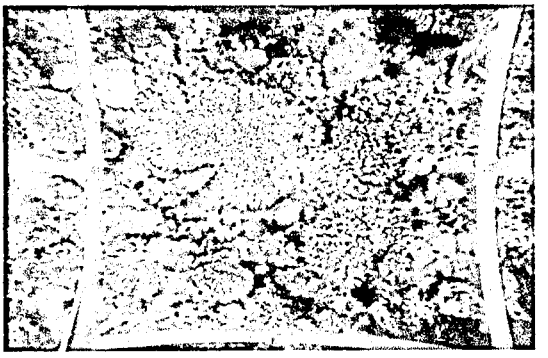


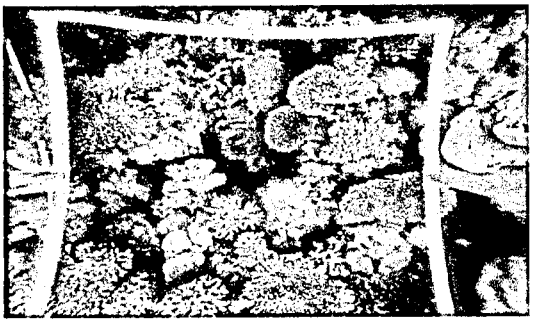
Bitas Reef Station, Aramaywan



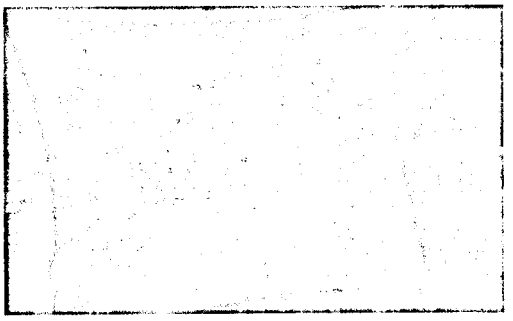
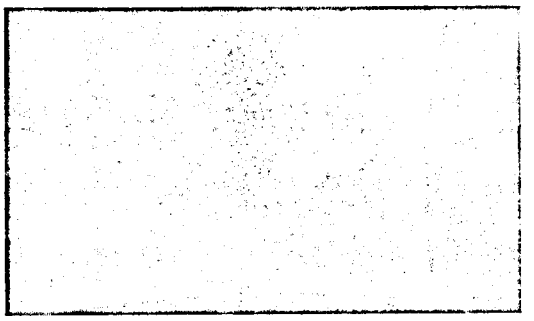
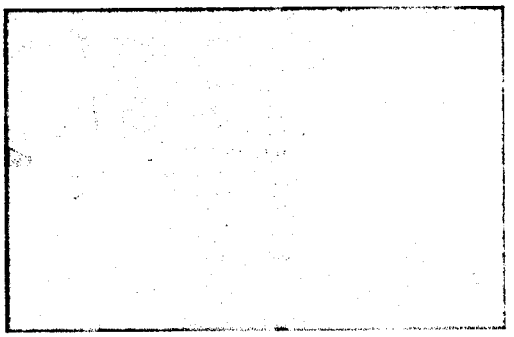
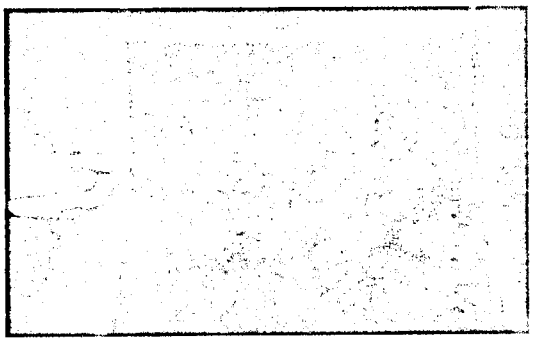


Talabonggan Reef Station

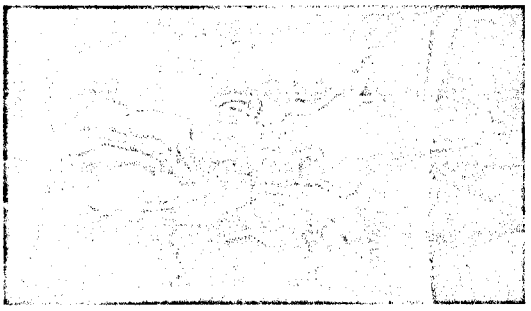



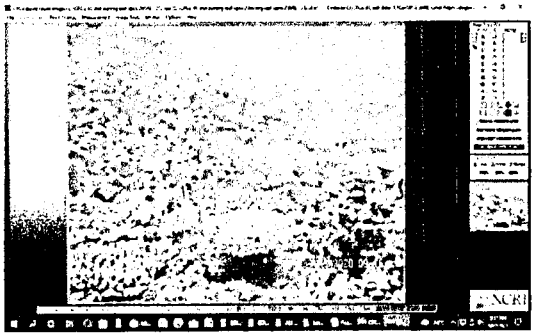


Dangla Reef Station, Berong

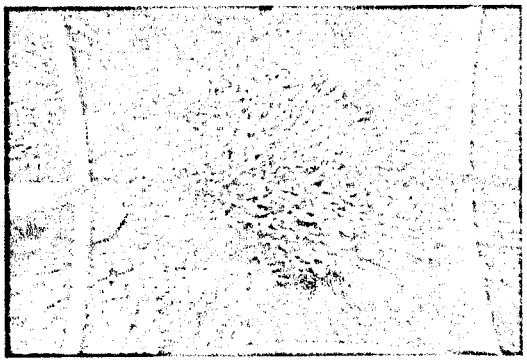





Berong Reef Station, Berong

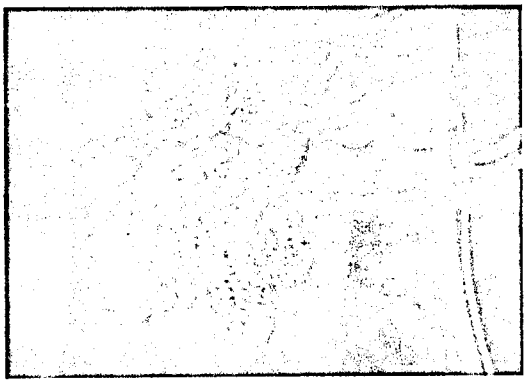


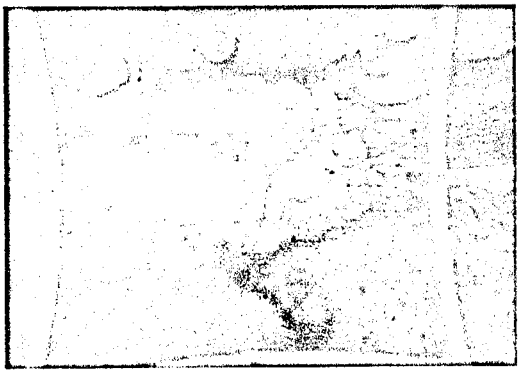


Odiong Reef Station, Berong

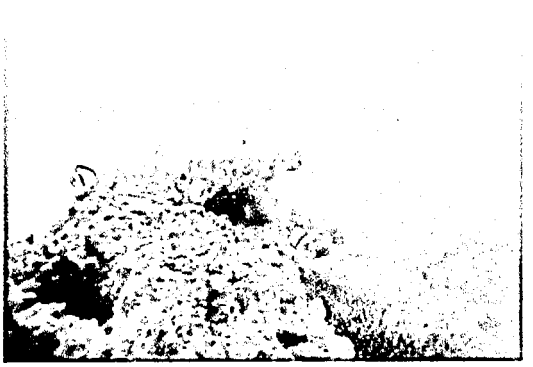


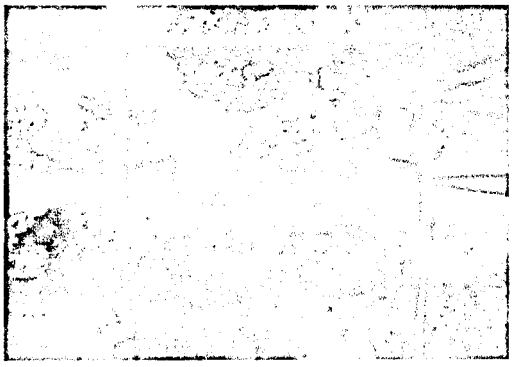
Tagbolante Reef Station, Berong

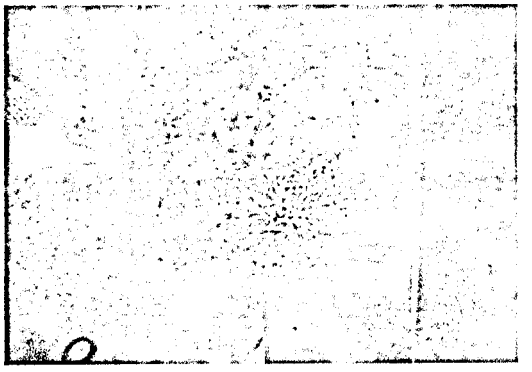




Catuayan Reef Station, Berong







Romaraw Reef Station