Reference No.: EMO-MNL-2022-E-001

DATE : 20 January 2022

TO : **DIR. JOE AMIL M. SALINO**
Regional Director
ENVIRONMENTAL MANAGEMENT BUREAU
6th Floor, DENR By the Bay Bldg.,
Roxas Blvd., Ermita, Manila

FROM : **BENJAMIN ARMAND A. TANSINGCO**
VP-Environmental Management

SUBJECT : **Coastal Resources Assessment Report for the 1st Half of 2021**

Dear Director Salino:

We are herewith submitting to your office copy of the report entitled: '**Aquatic Biota-Marine Biology Assessment**." This report presents the results of the assessment conducted last June 8-11, 2021 at Coral Bay, Rio Tuba, Bataraza, Palawan by our consultant, Three Sevens Management Consultancy.

The submission of this report is in compliance to the EMoP of the December 2018 Environmental Performance Report and Management Plan (EPRMP) of Coral Bay Nickel Corporation.

We shall take note of the recommendations made by the assessment team in the monitoring report and will make our best effort to implement those recommendations that our company is capable and has the authority to undertake.

Thank you very much.

Very truly yours,

BENJAMIN ARMAND A. TANSINGCO
VP- Environmental Management

Copy furnished:

Dir. William P. Cuñado
EMB Central Office

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MGB IV-B MIMAROPA

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AQUATIC BIOTA-MARINE BIOLOGY ASSESSMENT

8-11 June 2021

CORAL BAY NICKEL CORPORATION
BATARAZA, PALAWAN

Abbreviations Used

ACB	Acropora Branching
ACT	Acropora Tubular
ACS	Acropora Submassive
BMB	Biodiversity Management Bureau
Bgy	Barangay
CBNC-HPP	Coral Bay Nickel Corporation Hydrometallurgical Processing Plant
CB	Non-Acropora Branching
CE	Non-Acropora Encrusting
CF	Non-Acropora Foliose
CHL	Heliopora
CM	Mushroom Coral
CME	Mellipora
CMR	Mushroom
CPCe	Coral Point Count with Excel extensions
CRA	Coastal Resource Assessment
CS	Non-Acropora Submassive
D	Dominance Index
DC	Dead Coral
DENR	Department of Environment and Natural Resources
EPEP	Environment Protection and Enhancement Program
EMP	Environmental Monitoring Plan
FVC	Fish Visual Census
HC	Hard Coral
HCC	Hard Coral Cover
H	Shannon Index
IV	Importance Value
Is	Island
LIT	Line Intercept Transect
MA	Macroalgae
MPA	Marine Protected Area
OT	Others
PCSD	Palawan Council for Sustainable Development
Pt	Point
RB	Rubble
SC	Soft Corals
SD	Sand
SI	Silt
SP	Sponge
TAU	Taxonomic Amalgamation Units
1-D	Simpson Index

Units of Measurement Used

cm	centimeter
g	gram
m	meter
km	kilometer
m^2	square meter
ha	hectare
km^2	square kilometer
MT	metric ton
$cells/m^3$	cells per cubic meter
m^2/ha	square meter per hectare
ind/ha	individual per hectare
ind/m^2	individual per square meter
cells/L	cells per liter

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EXECUTIVE SUMMARY

Coral Bay Nickel Corporation (CBNC) started its operation in 2005 as a hyrdometallurgical processing plant that utilizes the principles of High-Pressure Acid Leaching to produce high grade nickel and cobalt ore from low grade nickel ores. Cognizant of environmental and health risks and impacts, the CBNC has committed to ensure protection of the immediate environment and the surrounding communities. This commitment has been put in placed and regularly implemented through the Department of Environment and Natural Resources – Mines Geosciences Bureau (DENR-MGB) approved Environmental Protection and Management Plan (EPEP). The EPEP provides for the conduct of annual assessment of aquatic biota-marine biology in fresh and marine water bodies in impact areas of CBNC.

This technical report presents the results of assessment for the first semester of 2021 conducted on 8-11 June 2021. A total of 11 sites were assessed in terms of five components, namely: seagrass, mangroves, planktons, coral reefs and reef fishes. The monitoring sites were established and identified based on the potential impacts of the CBNC operations to the environment. These monitoring stations include the primary impact areas namely: Discharge Point, Lower Kinurong Pond, Causeway, Mooring Dolphin, and Tagdalungon and secondary impact area, the Ocayan River. Other coastal marine monitoring sites are Rio Tuba MPA, Small Sandbar, Ameril Island, Maranto Pt. and Ursula Island.

Seagrass assessment was conducted to determine the seagrass species composition, canopy height, mean cover (total, per species, epiphytes) and associated fauna. The transect length ranged from 70 m to 900 m. The line transect-quadrant method was used wherein three transect lines were laid per sampling site. A 0.5 m x 0.5 m quadrat was laid at 5 m interval on each side of the transect.

In mangrove assessment, transects and quadrats in each site were established to determine the species composition, mean diameter at breast height (DBH), mangrove stand per hectare (MSH), diversity indices and condition. A 100 m transect line was laid wherein three plots measuring 10 m x 10 m were established in each sampling plots in Tagdalungon. Within each 10 m x 10 m plot, a smaller 5 m x 5 m quadrat was made and with this quadrat, a smaller 1 m x 1 m quadrat was established wherein all trees (>3 m), saplings (2-3 m) and seedlings (heights < 1 m) inside the plots and quadrats were identified and counted.

In coral cover assessment, a 100-m transect line per station was laid parallel to the shore. Data collection started by taking photos in the shallower portion of the transect line using a GoPro camera mounted in a monopod with

1 m interval. Collected photos were analyzed and scored using Coral Point Count with Excel extension (CPCe) program. The condition of the hard coral (HC) cover was determined following Licuanan et al. (2017) categories.

The reef fish communities were assessed using the transect lines used for substrate/coral cover assessment. Species composition, population density, biomass and trophic group were assessed using fish visual census (FVC) survey method (English et al. 1997), wherein all fish species encountered in the belt transects were identified, the total lengths were estimated, counted and listed. Fishes encountered were also categorized as "target", "indicator" and "major" groups, and their trophic groups were also determined.

Nine (9) seagrass species were documented in all sampling stations. The occurrence of *Halophila minor* was observed and reported for the first time in Small Sandbar and Rio Tuba MPA. Stations in Ocayan River, Tagdalungon and Ursula Island have "Poor" overall seagrass cover while Small Sandbar and Rio Tuba MPA have "Fair" condition.

There were 15 species of seagrass-associated seaweeds found in the surveyed seagrass beds. Eight of these species are Chlorophytes (green seaweeds), three Phaeophytes (brown seaweeds), and four Rhodophytes (red seaweeds). Furthermore, 12 macro-invertebrates were identified in seagrass beds of the sampling stations.

Five (5) mangrove species were documented in monitoring station. Three of these species, the *Rhizophora apiculata*, *Rhizophora mucronata*, and *Sonneratia alba,* were observed inside the 10 m by 10 m plot, while the two other species, the *Brugueira gymnorrhiza* and *Ceriops tagal,* were found outside the established plot. Generally, the surveyed mangrove forest has low species richness, tree densities and basal area.

There are five sites sampled for plankton, covering saltwater, estuary and freshwater areas. Results showed a total of 33 species (28 phytoplankters and 5 zooplankters) with a range of 2-20 species per site. Concentrations of 252 to 325,796 cells per cubic meter of water.

Thirty-eight (38) genera belonging to 15 coral families were encountered in monitored reefs. Among these families, only Acroporidae, Merulinidae, Pocilloporidae and Poritidae were noted across all stations. Per station, Ursula Is. 1 recorded 13 families, Maranto Pt. have 11, followed by Mooring Dolphin (9), Ameril Is. (8), Causeway (8), Small sandbar (8), Ursula Is. 2 (8) and Rio Tuba MPA (7).

In terms of reef fish communities, a total of 188 fish species belonging to 34 families were identified in nine stations within the shallow reefs in the identified primary impact areas of the CBNC operations. Mean species diversity of reef fishes was estimated at 66 species/1,000 m^2, (moderate).

There were 48 species monitored in CBNC Causeway, 43 species in Mooring Dolphin and 26 species in Discharge Point. Fish communities in surveyed reefs of CBNC operations impact areas are largely represented by major group (95 species), followed in importance by targeted species (80 species) and indicator group (13 species).

Discharge Point harbors schools of large sized commercially important fish species belong to the families Carangidae, Monodactylidae, Caesionidae, Serranidae, Lutjanidae, Haemullidae, Scaridae, Acanthuridae and Siganidae. It is also worth mentioning that Mooring Dolphin and Causeway harbors almost similar fish species with Discharge Point, which substantiates connectivity among the three stations.

The following recommendations are drawn from the results of assessment:

1. Coastal clean-up, scope of Information, and Education Campaign (IEC) should be expanded. Succeeding mangrove tree planting activities should consider the most appropriate planting site, seedlings, and planting methods to attain a much higher survival rates of seedlings.
2. Mapping of entire seagrass bed in all sampling stations is recommended.
3. In terms of coral reefs assessment, the establishment of a 75 m x 25 m permanent monitoring station is recommended to which the monitoring activities should be conducted to determine the changes within the area.
4. The shallow reef habitats that mostly harbor small-sized reef fish, played crucial role in life stages of the fish as nursery ground and must be prioritized as areas for protection and conservation.

September 2021

Threesevens Management Consultancy and Services

AUTHORSHIP AND REVIEW

DOCUMENT TITLE: **AQUATIC BIOTA-MARINE BIOLOGY ASSESSMENT**

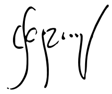
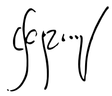
DATE: 22 November 2021

AUTHOR: **THREESEVENS MANAGEMENT CONSULTANCY SERVICES**

MR. RAFFY R. PEREZ
Chief Operating Officer

REVIEWER: **MR. RODULF ANTHONY T. BALISCO**

REVISION HISTORY

REVISION	DATE OF ISSUE	DESCRIPTION	AUTHORITY	
			NAME	SIGNATURE
0	4 September 2021	For CBNC's Review	**Raffy R. Perez** Chief Operating Officer	
1	22 November 2021	Submission of Final Report	**Raffy R. Perez** Chief Operating Officer	

1. INTRODUCTION

The Coral Bay Nickel Corporation Hydrometallurgical Processing Plant (CBNC-HPP) operates a nickel processing plant located in Rio Tuba, Bataraza, Palawan. It utilizes High-Pressure Acid Leaching technology to produce high grade nickel and cobalt ore from low grade limonite ores. It is also known as one of the largest producers of nickel and cobalt mixed sulfide in the world.

Since 2005, the CBNC-HPP has been processing low grade nickel ore to produce nickel and cobalt. The whole production process involves chemicals and produces wastes that are harmful to the environment if not properly manage, hence, the safety of the people and the environment has been always a priority of the company.

The implementation of pollution control and mitigation measures of CBNC-HPP are guided by the Department of Environment and Natural Resources – Mines Geosciences Bureau (DENR-MGB) thru the approved CBNC Environmental Protection and Enhancement Plan (EPEP) to ensure continuous protection of the environment. It includes the operation and maintenance of environmental proctection and pollution control facilities, regular monitoring of ambient air, water and land; solid wastes management; and regular assessment of flora, fauna and coastal resources.

The CBNC-HPP maintains facilities along the Coral Bay, such as storage of sulfuric acid and methanol, unloading area and pipeline for these chemicals. The supernatant or effluent water coming from the HPP operations also drains in the Coral Bay. Thus, monitoring stations have been established to determine the impacts of the operation to the immediate coastal marine environment.

The Coral Bay is geographically located in Bgy. Rio Tuba, bounded by two major rivers, the Ocayan and Rio Tuba Rivers. The water from Lower Kinurong Siltation Pond drains to the sea via the Ocayan River. Among other features found around the Coral Bay are the portions of sand bars, coral reefs and coralline-sandy beaches of Small Sandbar, Big Sandbar (now designated as Rio Tuba MPA), and a small island called Ameril Island (Gonzales and Gonzales, 2016). In 2007, the live corals in the bay ranged between 46.10-55.70% live coral cover, categorized between "fair" and "good" condition (Haribon Palawan, 2007; Gonzales and Gonzales, 2016).

Marine biodiversity in Coral Bay is being monitored for conservation purposes. Rich coastal ecosystem has been documented in this area, but the inland operation of mining companies may pose danger to its aquatic biota. Hence, CBNC is committed to provide assistance in monitoring and impact evaluation of their company's operations on the state of coastal marine environment. As such, the CBNC has been providing annual budget for Barangay Council of Rio Tuba and people's organization for the protection and management of these coastal marine ecosystems.

Objectives

The main objective of this assessment is to determine the status of aquatic biota-marine biology in impacted areas of CBNC operation. It also aims to ensure the compliance of the CBNC in the provisions of an Environmental Monitoring Plan (EMP) as part CBNC's commitment in its Environmental Performance Report and Management Plan.

Specifically, the 2021 first semester assessment aimed to determine the latest condition and identify changes through time of the aquatic biota and marine biology on identified monitoring sites based on the five components, namely: seagrass, mangroves, coral reefs, plankton and reef fishes.

Components of Aquatic Biota-Marine Biology Assessment

This aquatic biota-marine biology resource assessment focused on five components: mangroves, seagrass, plankton, coral reefs, and reef fish communities.

Mangroves

Mangrove forest is one of the significant ecosystems in the Philippines. Mangroves filter upland run-off, serve as habitat for several marine organisms (e.g. fish, crabs, oysters, invertebrates) and wildlife (e.g. birds and reptiles), and produce large amounts of detritus that may contribute to productivity in offshore waters (Feller and Sitnik [eds.], 1996).

Mangroves, like other coastal marine resources such as the seagrasses and corals, are also susceptible to degradation due to anthropogenic disturbances. Mangrove tree cutting due to expanding human population, solid waste aggregation within the forest, and forest conversion into fishponds, are the common observed causes of mangrove destructions in Palawan (Dangan-Galon et al., 2016).

Seagrass

Seagrasses are vital part of the coastal marine environment. Seagrass meadows provide shelter, protection, and nursery grounds to a wide array of marine species such as the siganids, sea urchins, sea cucumbers, and *dugongs*. They also stabilize the sea bottom and contribute a huge amount of carbon sink to the ocean (Stancovic et al., 2021).

Seagrasses, including other associated organisms, are inherently sensitive to changes in water quality and some environmental conditions.

Any changes in productivity and biodiversity of seagrass communities are significant determinant of the overall health of coastal ecosystem (httpps://myfwc.com/research/seagrass/ information/importance).

Plankton

Plankton or plankters are diverse organisms that provide crucial food source in the food web, and are excellent producer of oxygen in the aquatic environment. These include bacteria, archaea, algae, protozoa and drifting and floating animals that inhabit saltwater, estuary and freshwater bodies. Hence, plankters are not just important component of the food web, but are likewise good bioindicators of ecosystem/environmental health. For example, a diverse and dense plankton community would indicate a healthy ecosystem/environment as they attract diverse consumer biota, while a less diverse and scarce plankton community may indicate unhealthy ecosystem.

Coral Reefs

Coral reefs are one of the important coastal habitats and mostly found in tropical shallow waters. It has significant role in feeding and protecting ecologically and economically important marine species, and protect coastal communities from natural calamities (Klein et al., 2010; Knowlton et al., 2010). In spite its wide ecological and economic significance, coral reefs face enormous threats. Human activities are the common and direct threats to reefs worldwide, but the most significant stressors and hard to manage are damages caused by climate change due to global warming (Hughes et al., 2017b; Hoegh-Guldberg et al., 2018). With the worldwide decline in coral cover because of these different stressors, and coral reefs are among the top priorities for conservation and monitoring to ensure food security, livelihood of the coastal communities and environmental sustainability (Asaad et al., 2018; Wagner et al. 2020).

In Palawan waters, destructive activities such as poaching and illegal fishing were recorded which threaten the status of coastal habitats (Benavente-Villena and Pido, 2004). To protect these coral reefs and other marine habitats from further degradation, it is vital to recognize the importance of assessment and regular monitoring to identify the status of these habitats and marine resources, and to what extent of protection they made need against various threats. These assessments can be used in formulating resource utilization policies to effectively manage the resources with the context of local management.

Reef Fish Communities

Fish communities are major components of healthy and complex coral reefs where the role in coral reef ecosystem (e.g. the role of grazers controlling algal growth) is very vital, and are commercially important for both fisheries and more recently, tourism industry.

Fish and other fishery products are one the most widely traded commodities in the country, providing livelihood for millions of people living in coastal areas. Surrounding waters of Palawan is known to be highly productive, harboring wide variety of reefs and other fishery resources. Similar to other coastal areas, fishing also played crucial role in the economy of Bataraza, where it is one of the major livelihoods of its constituents. Aside from fishing as a source of food, it is also used by some coastal communities for eco-tourism activities wherein some tourists are willing to pay to go on-board a marine vessel to observe fishing activities of the fishermen.

This report provides information on the current status of seagrass, mangroves, planktons, coral reefs, and reef fishes in the impact areas and nearby marine ecosystem surrounding the operations of the CBNC in Bgy. Rio Tuba, Bataraza, Palawan. It also compares the current data vis-à-vis previous assessment reports. Such information is a relevant input to environmental monitoring program of the CBNC and assess compliance to its commitment to protect the environment and its people. This report also provides recommendations towards habitat protection and conservation in the area.

2. METHODOLOGY

2.1 Monitoring Sites

There are 11 identified monitoring sites in the vicinity of CBNC-HPP, which represent the possible impact areas of the operation. The adjacent sand bars, coral reefs and coralline-sandy beaches around the Coral Bay and Ursula Island (Table 1, Figure 1) are also included as coastal marine monitoring sites.

Table 1. Monitoring sites and monitored components for aquatic biota and marine biology assessment in Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan.

Monitoring Sites	Seagrass	Mangroves	Plankton	Coral Reefs	Reef Fishes
Primary Impact Areas					
Discharge Point			✓	✓	✓
Causeway			✓		✓
Mooring Dolphin			✓	✓	✓
Tagdalungon	✓	✓			
Lower Kinurong Siltation Pond			✓		✓
Secondary Impact Area					
Ocayan River	✓		✓		
Other Monitoring Areas					
Small Sandbar	✓			✓	✓
Rio Tuba MPA	✓			✓	✓
Maranto Pt.				✓	✓
Ameril Island				✓	✓
Ursula Island				✓	✓
Total	**4**	**1**	**5**	**7**	**8**

Detailed description of stations per site and components are presented in section 2.2.

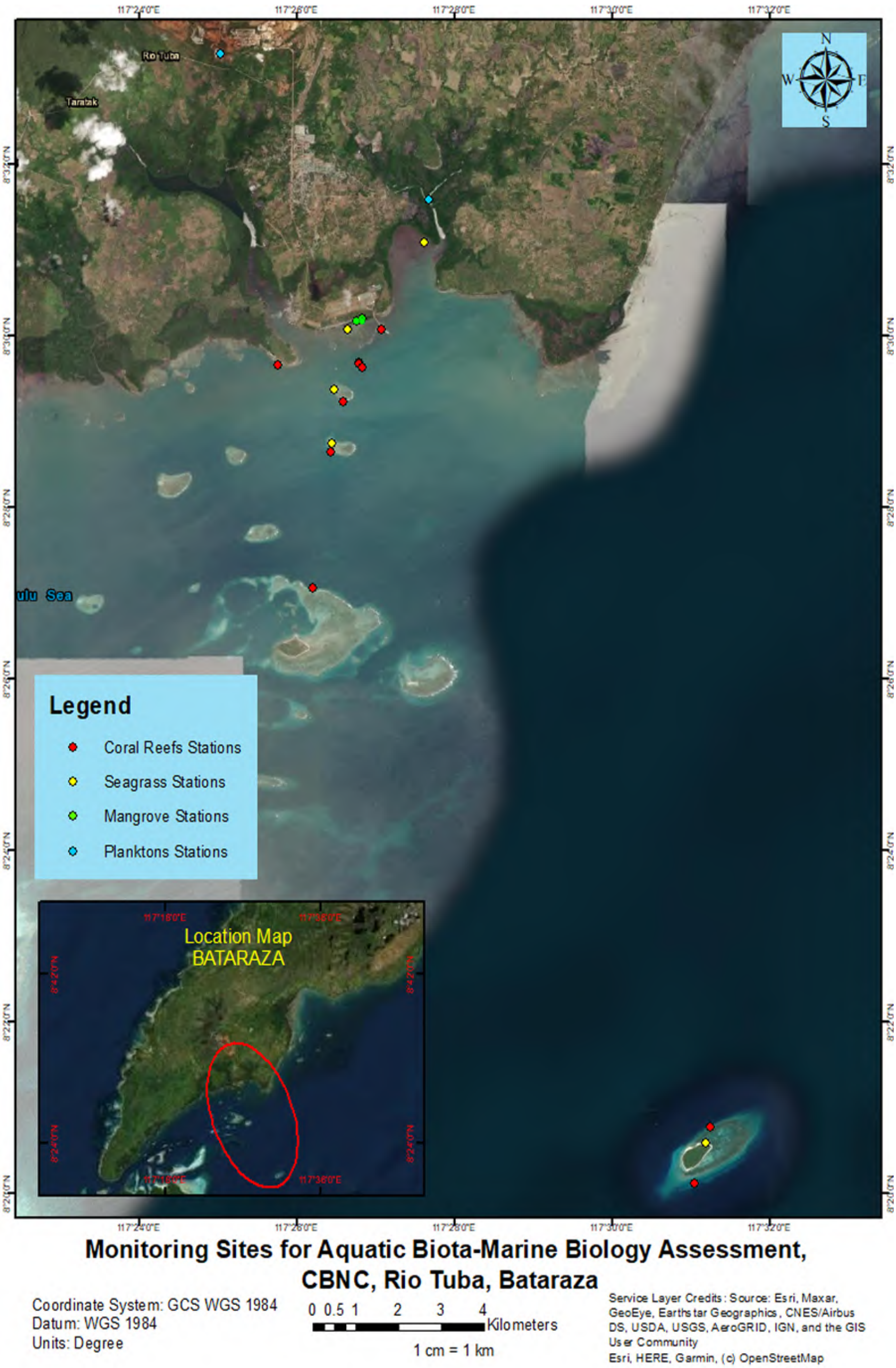


Figure 1. Location map of Bataraza showing the monitoring sites for aquatic biota-marine biology of Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan.

2.1.1 Seagrass

Seagrass assessment was conducted in five sampling stations representing the primary impact area (Tagdalungon), secondary impact area (Ocayan River, estuary area) and the adjacent islets of Small Sandbar and Rio Tuba MPA, Bgy. Rio Tuba, Bataraza, Palawan. These included the seagrass beds near the Ocayan River, at intertidal and sand bar waters of Tagdalungon, and in Ursula Island (Figure 2).

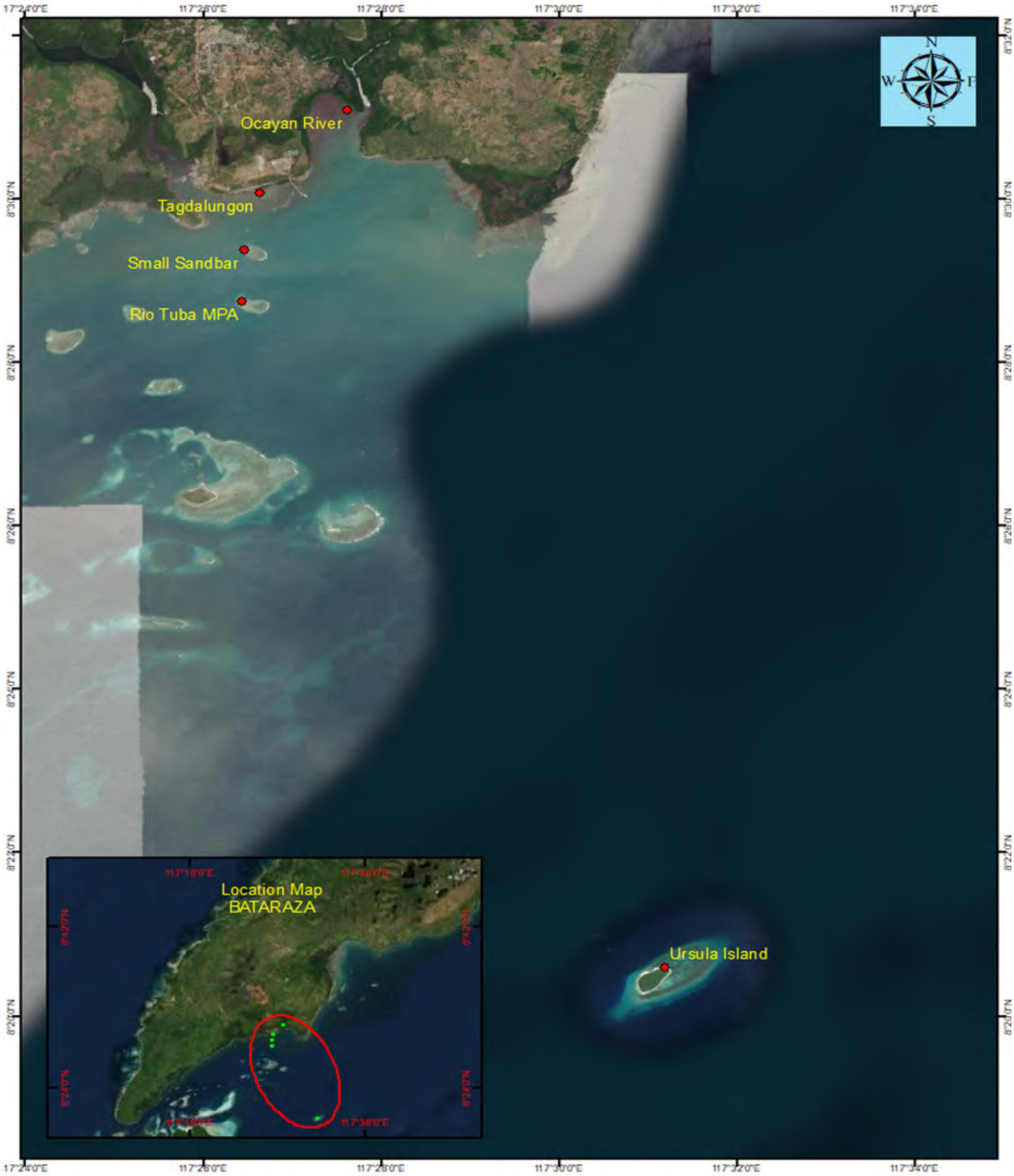


Figure 2. Geographical locations of seagrass monitoring stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

2.1.2 Mangroves

The assessed mangrove area is a narrow fringe-typed forest along the Tagdalungon shoreline that extends from 8.50264°N to 8.50329°N and 117.44699°E to 117.44719 °E with an estimated area of 1.35 ha. The established plots for mangrove vegetation analyses and the corresponding coordinates are shown in Figure 3.

Figure 3. Geographical locations of mangrove monitoring plots in Tagdalungon shore, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

2.1. 3 Plankton

Pre-identified geographic coordinates of the sampling sites based on the previous monitoring activities were used in this assessment. Four (4) out of five (5) monitoring stations are identified as primary impact areas, namely; Lower Kinurong Siltation Pond (freshwater), Causeway, Mooring Dolphin and Discharge Point, while the Ocayan River station is located at the secondary impact area. Figure 4 shows the geographical locations of the plankton monitoring stations around the vicinity of CBNC in Bgy. Rio Tuba, Bataraza.

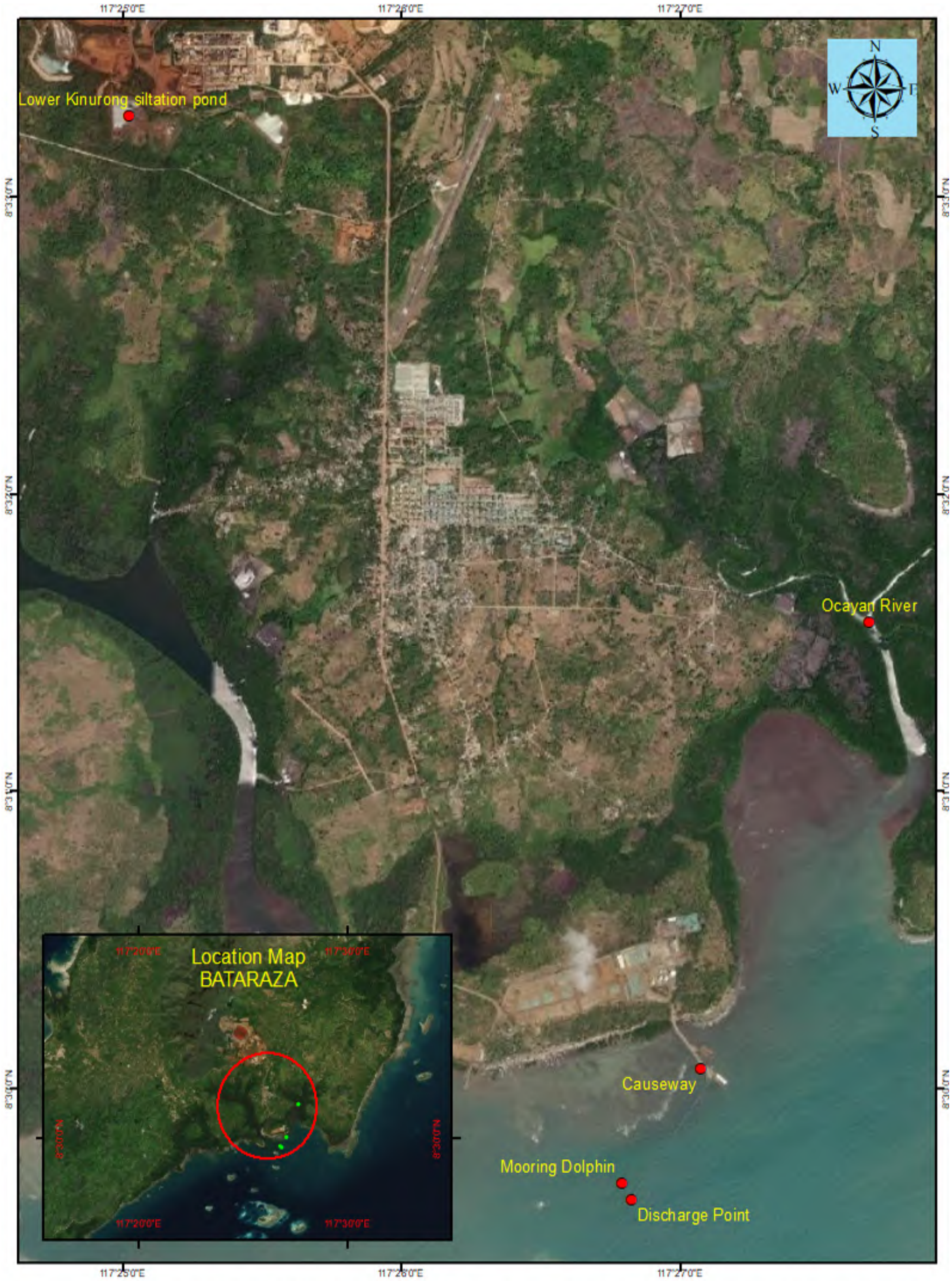


Figure 4. Geographical locations of plankton monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

2.1.4 Coral Reefs/Substrate Cover and Reef Fish Communities

Eight coral reef stations and nine reef fish stations were monitored in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan last June 8-11, 2021. Three of which are identified as primary impact areas; Causeway, Discharge Point and Mooring dolphin, while additional monitoring stations in the Coral Bay such as Ameril Island, Maranto Point, Rio Tuba MPA, Small Sandbar; and Ursula Island (Figure 5). Samples of freshwater fishes were also collected from Lower Kinurong Siltation Pond.

Figure 5. Geographical locations of coral reefs and reef fishes monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Both substrate/coral cover and reef fish communities were assessed in each station, except in Discharge Point wherein only reef fishes where assessed. The substrate in Discharge Point is muddy and no coral colony was observed in this monitoring station. The sampling depths ranged between 3 m and 10 m, with Causeway and Maranto Pt. being the shallowest (3-4 m), and Ursula Is. 2 being the deepest (10 m) (Figure 5, Appendix 2).

Pre-site reconnaissance survey in each station was done through snorkeling to estimate depth, visibility and extent of the reef area. The depth of the surveyed reefs ranged from 3 m to 10 m. All surveys were conducted from 8:00 AM to 3:30 PM.

2.2 Sampling Methods and Evaluation of Data

2.2.1 Seagrass

The seagrass assessment procedure described in DENR Biodiversity Management Bureau (BMB) Technical Bulletin No. 5 (series of 2017) was used as reference in this survey. However, instead of using a 50 m transect per replicate site, two100 m transect lines, at 25 to 50 m intervals, were laid perpendicular to the shore. The transect-quadrat method described in English et al., 1994 (Figure 6) was then employed. Particularly, a 0.5 m x 0.5 m quadrat was laid at 10 m interval on right and left sides of the transect starting at 0 m as initial point. Coordinates were recorded at the start and end points of each transect line.

Seagrass species within the quadrat were identified and the diversity and evenness of the beds were analyzed using the BioDiversity Professional Version2 software (McAleece et al., 1997).

Seagrass shoot density was determined by counting the number of shoots per species within the quadrat multiplied by 4 to obtain the per m^2 unit. Seagrass cover was estimated based on the method of Saito and Atobe (1970) as thoroughly discussed by Ganzon-Fortes (2011) and shown in the equation below:

$$\%\ \text{Seagrass Cover} = \frac{\sum(Mi \times fi)}{\sum f}$$

where:

Mi : the midpoint percentage of each species;
f : number of sectors with the same class of dominance;
∑f : total number of grids in the quadrat, which is 25.

Status or condition of the assessed seagrass beds was obtained following the criteria as stated (PCSD 2013):

Seagrass Cover Condition	**%**
Excellent	76–95
Good	51–75
Fair	26–50
Poor	1–25

Seagrass canopy height was also determined by measuring the length of at least three leaves randomly taken from the quadrat. The percent cover of epiphytes on each leaf was estimated and the mean value was obtained. Seagrass-associated seaweeds and macro-invertebrates were likewise identified and quantified.

Figure 6. The Transect-Quadrat Method employed in the assessment of seagrass beds in monitoring stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan.

2.2.2 Mangroves

Mangrove vegetation was assessed following the standard protocol described by English et al. (1997) where two transects were laid perpendicular to the shore. In each transect line, a 10 m by 10 m plot was established at an interval of 10 m due to a very narrow mangrove stands in the area (Figure 7).

Mangroves found within the plot were identified following the nomenclature of Primavera et al. (2004). For each identified species, basic vegetation parameters such as the tree density, canopy height, and basal area were measured. Mangrove basal area was derived from measurements of the tree diameter at breast height or dbh. Mangrove saplings and seedlings in 1 m by 1 m quadrat established within the 10 m by 10 m plot with four replicates were also counted. Direct observation on the surrounding environment was likewise done to record the existing potential threats to mangrove resources in the area.

Figure 7. The Transect-Quadrat Method employed in the assessment of mangrove forest in Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

2.2.3 Plankton

Collection of water samples for plankton analysis was conducted following the vertical tow method. During the sampling (Figure 8), a plankton net, 20 µm mesh size, with flow meter was towed from 1 m above the sediment to the sea surface. After towing, at least 100 ml of water samples with three replicates per sampling station were collected from the net bucket.

The water samples, upon collection, were preserved using a 5% formalin solution. In the laboratory, three subsamples of 1ml aliquot per sampling bottle (three sampling bottles per station) were placed in the Sedgewick Rafter for plankton examination. An inverted, Euromex "Oxion" series microscope was used for such purpose while the books of Perry (2003), Al-Yamani et al. (2011), Conway (2012), and Omura et al. (2012) served as the references for plankton identification. Measurements of water depth and readings (initial and final) from the flow meter were recorded to determine the volume of the sampled water.

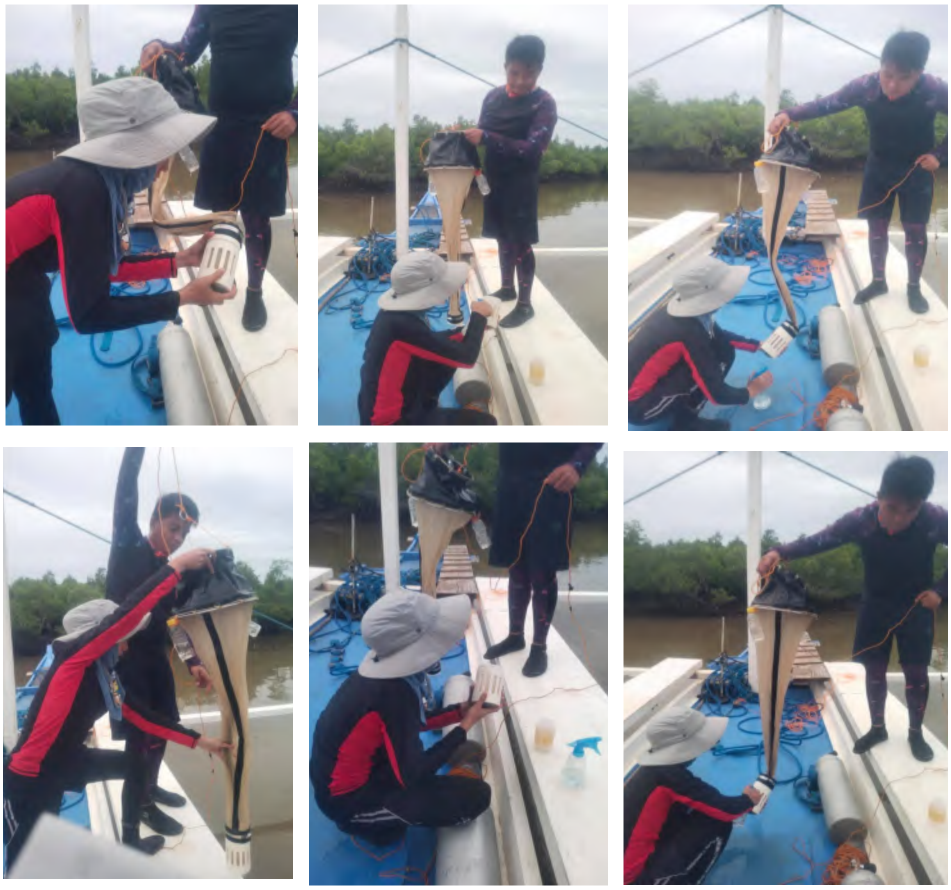


Figure 8. Collection of samples for planktons in Ocayan River, Bgy. Rio Tuba, Bataraza, Palawan (July 2021).

Plankton density was computed using the equation:

$$\# \, of \, \frac{cells}{L} = \left(\frac{\# \, of \, cells \, counted}{\# \, of \, scanned \, squares} * \frac{1000 \, squares}{1ml}\right) * \frac{1}{CF} * \frac{1000ml}{L}$$

where, $CF = \frac{Original \, Volume}{Sample \, Volume}$

2.2.4 Coral Reefs

The modified photo-quadrat method (Luzon et al. 2019) was used in the assessment of substrate/coral cover of the monitoring stations. In this method, a 100-m transect line (containing four segments) per station was laid parallel to the shore. Data collection started by taking photos in the shallower portion of the transect line using a GoPro camera mounted in a monopod with 1 m interval. Colony shots were also taken to document other coral genera present within the vicinity. The data collection was conducted between 9 AM and 3 PM (Figure 9).

Figure 9. Substrate/coral cover monitoring in coral reefs monitoring stations of CBNC, Bgy. Rio Tuba, Bataraza, Palawan: actual monitoring using photo-quadrat method (upper left); photo-documentation of coral genera within the vicinities (upper right); example of a frame collected using photo-quadrat method (lower left); and Coral Point Count with Excel extensions (CPCe) program used to analyze collected substrate photos (lower right).

Photos collected were analyzed and scored using the Coral Point Count with Excel extension (CPCe) (Kohler and Gill, 2006) program installed in a laptop computer (Kohler and Gill 2006). In scoring photos, the 10-point scheme was used to identify the benthic life forms, particularly the hard coral (English et al. 1997).

Benthic life forms used include: hard coral (HC), dead coral (DC), macroalgae (MA), others (OT), rubbles (RB), soft corals (SC), sand (SD), silt (SI) and sponge (SP). The HC cover were further categorized into: *Acropora* branching (ACB), *Acropora* digitate (AC), *Acropora* submassive (ACS), *Acropora* tabulate (ACT), *Heliopora* (CHL), *Mellipora* (CME), mushroom

(CMR), non-*Acropora* branching (CB), non-*Acropora* encrusting (CE), non-*Acropora* foliose (CF), non-*Acropora* massive (MC) and non-*Acropora* submassive (CS). The mean values of HC cover for all segments transects were computed and interpreted following Licuanan et al. (2017) categories. To determine the HC diversity, the categories of Licuanan (2020) were used (Table 2).

Table 2. Assessment scales for hard coral cover and hard coral diversity (as taxonomic amalgamation units or TAUs) used in this study (Licuanan et al. 2017[1]; Licuanan 2020[2]).

Hard coral cover (HCC)[1]			Hard Coral Diversity[2]	
Excellent	>44%		Diversity Category A	>26 TAUs
Good	>33% - 44%		Diversity Category B	>22 - 26 TAUs
Fair	>22% - 33%		Diversity Category C	>18 - 22 TAUs
Poor	0 - 22%		Diversity Category D	0 - 18 TAUs

The identification of coral genera was also carried out by examining the morphological features of coral colonies based on collected photos (Veron et al., 2021). The valid genus names of each coral were verified using the World Register of Marine Species (http://www.marinespecies.org/index.php) website.

2.2.5 Reef Fishes Communities

Two 50 m replicate transects per station were established during the field assessment. Transects were spaced approximately 10 m apart, and laid parallel to the shoreline. A belt transect was established in wherein a 50 m long transect with a 10-meter arbitrary corridor to enclose an approximately area of 500 m^2 was established. The same replicate transects were also used to assess the substrate/coral cover.

To determine the density and biomass of reef fish communities in each station, daytime fish visual census (FVC) technique was utilized (English et al. 1997; Uychiaoco et al. 2010). In each transect, the count, length estimates of diurnally-active and non-cryptic reef fishes with a minimum length of 1 cm were recorded. Underwater photographs were also taken during the surveys to verify the identification of the reef fishes. The works of Allen et al. (2003) and Kuiter and Tonozuka (2004) served as the basis for identification. Fish biomass were estimated using the formula:

$$W = aL^b$$

where:

W	:	weight of fish in grams,
L	:	estimated total length of fish (in cm)
a, **b**	:	regression parameters obtained from Fish Base and works of Kulbicki et al. (1993)

Fishes encountered were categorized as target, indicator and major groups. "Target" fishes are species of interest in reef fisheries due to its high market value, decrease in numbers of these fish species is a good measure of fishing exploitation in concerned reef areas. Target fish species include surgeonfishes (Acanthuridae – except genus *Zebrasoma*), fusiliers (Caesionidae), jacks/pompano (Carangidae), sweetlips (Haemulidae), wrasses (Labridae – subfamily Cheilininae only), snappers (Lutjanidae), goatfishes (Mullidae), threadfin breams (Nemipteridae), parrotfishes (Scaridae), groupers (Serranidae), and rabbitfishes (Siganidae). "Indicator" fishes mostly feed on coral polyps (good indicators of live coral cover) and are highly territorial species. While, "major" fishes are neither categorized as target nor indicator groups. In addition, fish species were further classified according to their food habit, and were categorized as benthic invertivore, corallivore, detritivore, herbivore, omnivore, piscivore and planktivore. These parameters are based on information per species available in Fish Base database *(*www.fishbase.org*)*.

2.2.6 Freshwater Fishes

Identification of freshwater fishes in Lower Kinurong Siltation Pond utilized a bottom-set gillnet (*lambat palubog*) with sufficient number of lead sinkers and floaters installed to keep the net in upward position and catch fish through entanglement. The net consisted of one layer of netting with 7 cm mesh size, with length of 200 m and depth of 2 m. The net was positioned in the deeper portion of the pond for two hours and any movement in the net was regularly checked for any indication of fish catch.

3. RESULTS AND DISCUSSION

3.1 Seagrass Assessment

3.1.1 Seagrass Species Composition and Diversity

Nine seagrass species were documented in all sampling stations. This number represents 50% of the total seagrass species in the Philippines, which consists of 18 species (Meñez et al., 1983) and 82 % of the total seagrass species found in Palawan, comprising of 11 species (PCSD, 2015).

Table 3 presents the seagrass species recorded in the monitoring stations. All seagrass species were recorded in Small Sandbar namely: *Cymodocea serrulata, Cymodocea rotundata, Enhalus acoroides, Halodule pinifolia, Halodule uninervis, Halophila minor, Halophila ovalis, Syringodium isoetifolium* and *Thalassia hemprichii*. At Rio Tuba MPA station, there were seven species while sampling station in Ocayan River had the lowest species richness, with only two recorded species namely; *E. acoroides* and *C. serrulata*.

Table 3. Seagrass species composition, importance value, diversity and evenness indices in monitoring stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Family/ Species	Species relative "Importance Value" (%)				
	Ocayan River	**Tagda-lungon**	**Small Sandbar**	**RioTuba MPA**	**Ursula Island**
Hydrocharitaceae					
Enhalus acoroides	82.8	18.6	1.5	0.2	0.1
Halophila minor	--	--	2.4	1.2	--
Halophila ovalis	--	--	12.0	--	60.7
Thalassia hemprichii	--	7.4	15.8	2.9	--
Potamogetonaceae					
Cymodocea rotundata	--	--	41.8	--	--
Cymodocea serrulata	17.2	6.4	8.5	72.9	15.6
Halodule pinifolia	--	30.5	4.3	17.8	23.6
Halodule univervis	--	37.1	1.2	4.5	--
Syringodium isoetifolium	--	--	12.5	0.5	--
Species Richness	2	5	9	7	4
Evenness index (Shannon J')	0.54	0.93	0.83	0.45	0.95
Diversity Index (Shannon H')	0.16	0.64	0.79	0.35	0.45

Note: -- no species observed

Recent seagrass assessment conducted in various sites of Bataraza including Rio Tuba (Sariego and Montaño, 2016; Haribon Environmental Services Palawan Community-Based Fisherfolk Alliance, 2020) had documented only eight species. The occurrence of *Halophila minor* in monitoring sites of CBNC is first reported in this report. This species which is closely similar to *H. ovalis,* was observed in two monitoring stations namely, Small Sandbar and Rio Tuba MPA. These stations were not assessed during the previous monitoring activities.

The highest seagrass evenness index of Shannon J was recorded in Ursula Island (0.946), while the least was recorded at Rio Tuba MPA (0.455). The highest diversity index or Shannon H was recorded in Small Sandbar (0.79), while the least was recorded at Ocayan River (0.16) (Figure 10). These data implied that seagrass species diversity in Tagdalungon, which is considered as a highly impact-prone area due to coastal inhabitants and a primary impact area of CBNC operations, is relatively higher compared to other stations, except for the Small Sandbar which obtained the highest index value. The Tagdalungon area has also a high evenness index, which is indicative of a healthy ecosystem wherein no certain species is dominating.

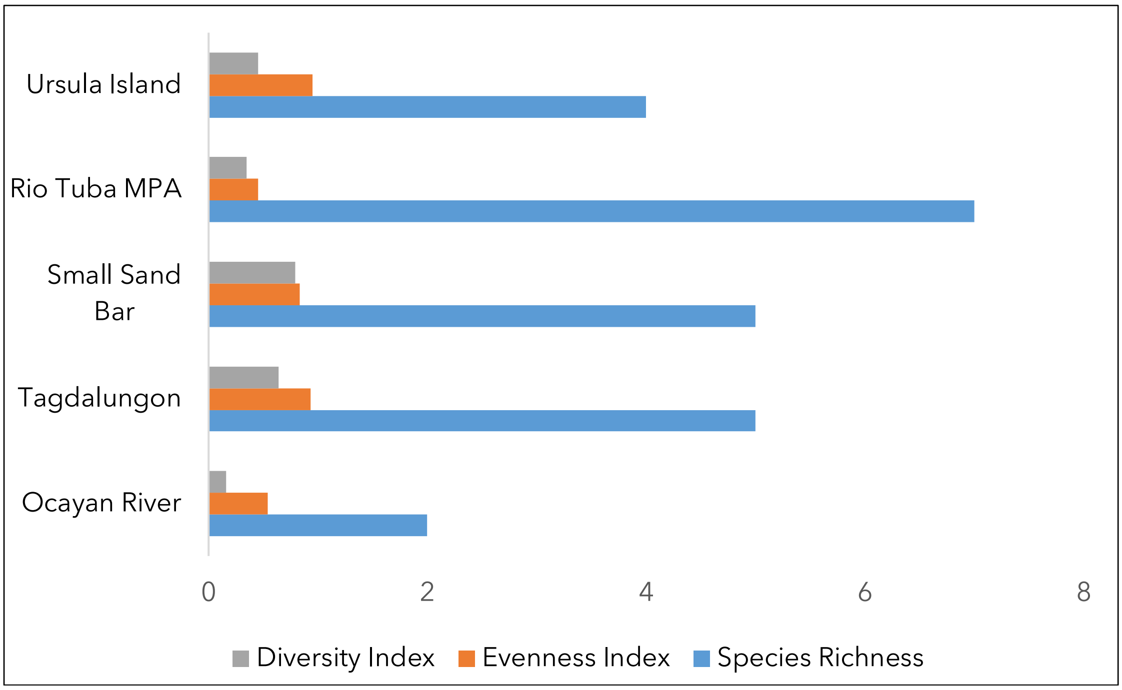


Figure 10. Comparison of seagrass bed's diversity and evenness indices and species richness in the monitoring stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

3.1.3 Seagrass density and cover

Seagrass shoot density differs among species and sampling stations. Among the nine seagrass species recorded, *H. uninervis* had the highest shoot density, ranging from 200 shoots/m^2 to 866 shoots/m^2 with an average of 316 shoots/m^2. The highest density was recorded in Rio Tuba MPA, while the lowest was in Tagdalungon. The shoot density of other species in decreasing order are *H. pinifolia* (127 shoots/m^2), *E. acoroides* (33 shoots/m^2), *H. ovalis* (30 shoots/m^2), and *S. isoetifolium* (29 shoots/m^2).

Among the five monitoring sites, Rio Tuba MPA had the highest seagrass density (1,252 shoots/m^2), followed by Small Sandbar with 978 shoots/m^2 and Tagdalungon with 600 shoots/m^2. Ursula Island harbored the least seagrass density with only 65 shoots/m^2, while the station in Ocayan River has total seagrass density of 100 shoots/m^2.

In general, Rio Tuba MPA and Small Sandbar were densely populated with seagrass as compared to other three monitoring sites. It was apparent also that *H. uninervis* and *H. pinifolia* were the most abundant species in seagrass beds of monitoring stations of CBNC, Rio Tuba, Bataraza, Palawan (Figure 11).

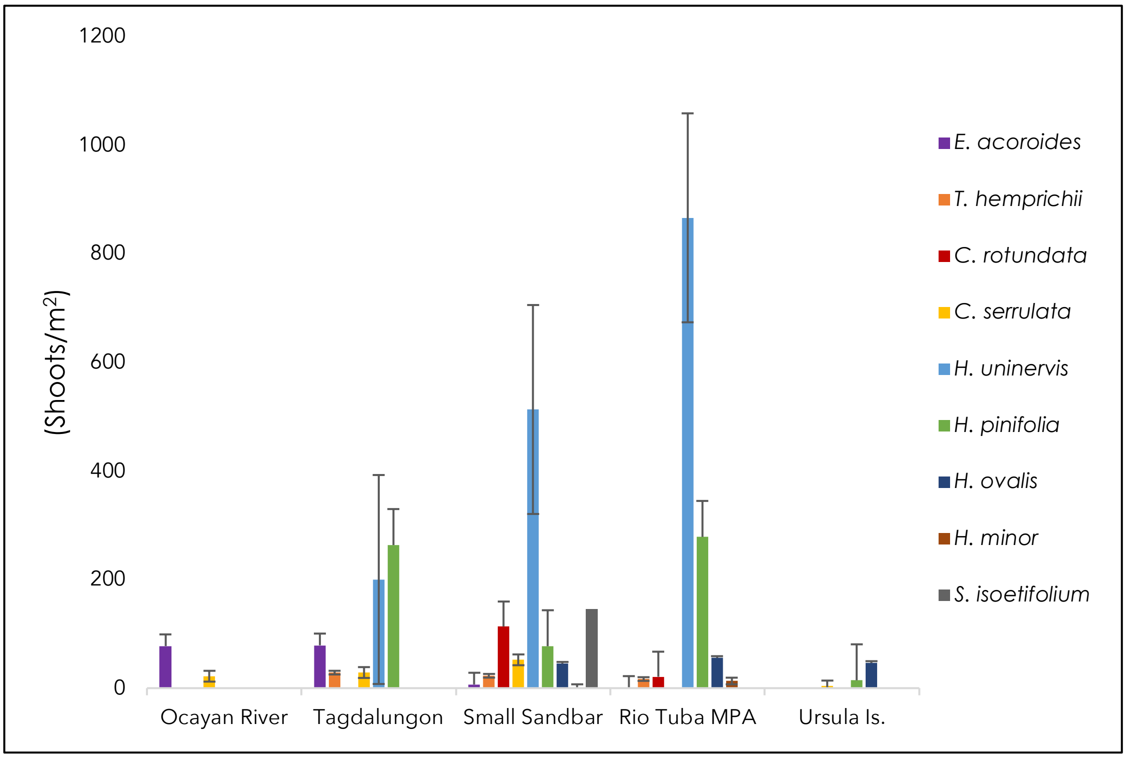


Figure 11. Seagrass shoot densities in the monitoring stations of CBNC, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Seagrass cover varies among species and sampling stations. A relatively higher cover was recorded for *H. uninervis* in Rio Tuba MPA (26%) and in Small Sandbar (13%). The cover of *C. serrulata* was also high in Small Sandbar (11%) and that of *E. acoroides* (12%) at station near the Ocayan River (Figure 12).

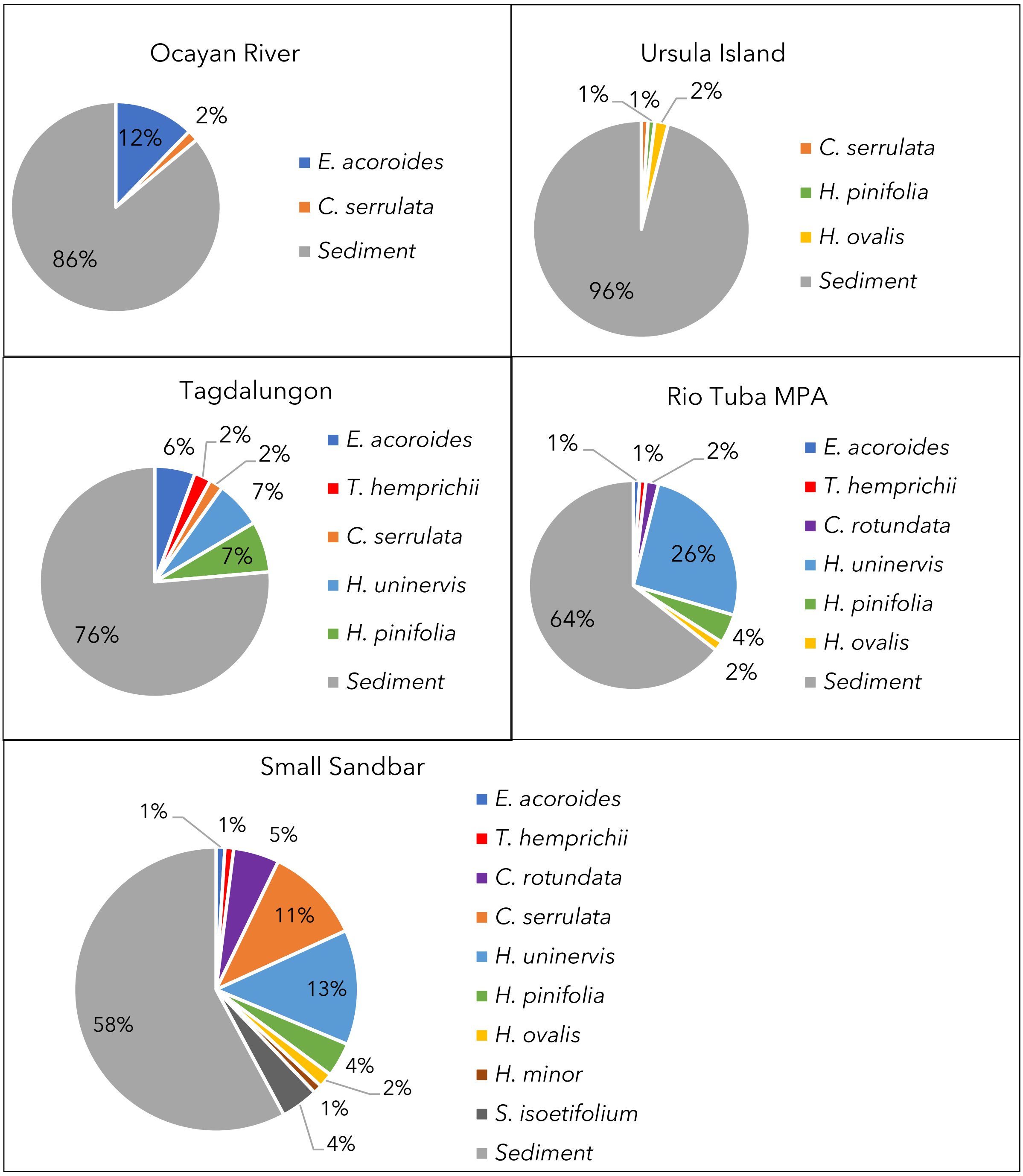


Figure 12. Seagrass cover (%) in monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

The total seagrass cover was relatively higher in Small Sandbar (42%, "fair" condition) and Rio Tuba MPA (34%, "fair" condition) as shown in Table

4. The low seagrass covers in Tagdalungon and at a station near Ocayan River can be attributed to human activities observed during the field survey, such as gleaning, fishing, and boat anchorage. In Ursula Island, the seasonal variation in seagrass cover can be assumed based on the interview with the island warden, wherein sea turtles periodically graze in the seagrass within its vicinity.

Table 4. Overall seagrass cover and condition in five sampling stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Sampling Station	Seagrass Cover (%)	Overall Condition	Estimated extend of Seagrass Bed, (ha)
Small Sandbar	42	Fair	5.7
Rio Tuba MPA	34	Fair	2.5
Tagdalungon	18	Poor	33.0
Ocayan River	14	Poor	25.0
Ursula Island	4	Poor	Sparse

3.1.4 Seagrass canopy height and surface area covered with epiphytes

Surface area of seagrass blade or canopy covered with epiphytes was quantified to indicate the comparative level of siltation in the monitoring stations. The average surface area covered with epiphytes ranged from 0.19% (Ursula Island) to 27.05% (Tagdalungon) as shown in Table 5.

Table 5. Average seagrass canopy height and surface area covered with epiphytes in seagrass monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Sampling Station	Average canopy height (cm)	Area covered with epiphytes (%)
Ocayan River	52.22	26.11
Tagdalungon	21.90	27.05
Small Sandbar	9.64	9.23
Rio Tuba MPA	7.78	8.83
Ursula Island	5.02	0.19

Among the seagrass species examined for epiphytic loads, the *E. acoroides* had the highest value (22.6%), while the *H. ovalis* had the lowest (0.24%). The *E. acoroides* being the tallest species among the seagrasses is expected to accumulate more amounts of epiphytes and other suspended particles in the water column (Figure 13).

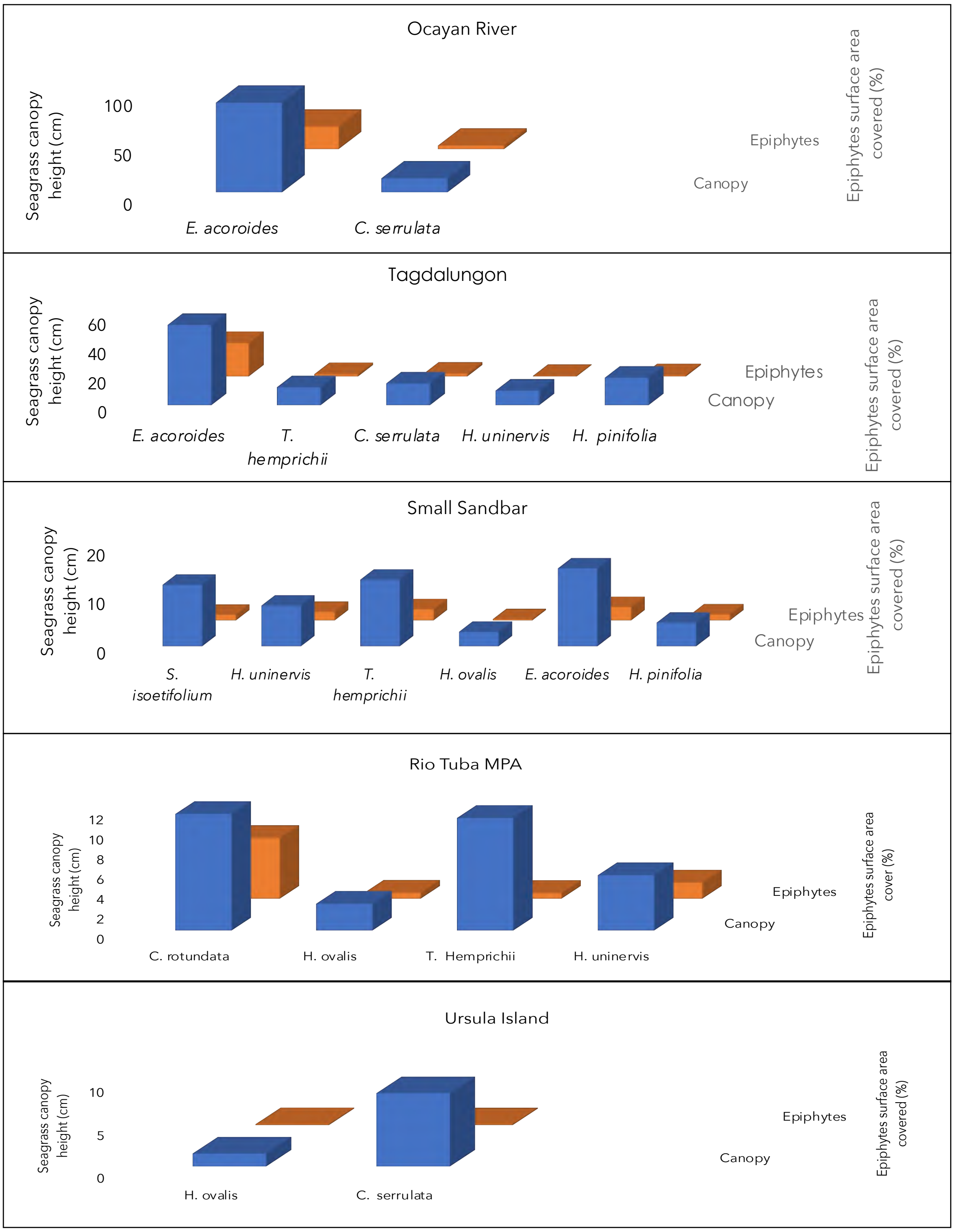


Figure 13. Seagrass canopy height and surface area covered with epiphytes in monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

3.1.5 Seagrass-associated seaweeds

There were 15 species of seaweeds found in the surveyed seagrass beds. Eight of these species are chlorophytes (green seaweeds), three phaeophytes/ochrophytes (brown seaweeds), and four rhodophytes (red seaweeds). Among the stations surveyed, Ursula Island had the highest number of seaweeds with 10 species, followed by Tagdalungon and Small Sandbar with six species each, and Rio Tuba MPA and the station near the Ocayan River with four and two species, respectively. Percent cover of these seaweeds in the area was relatively "low" (Table 6).

Table 6. Species composition and cover of seagrass-associated seaweeds at the surveyed stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Division/ Seaweed Species	**Sampling Station**					**Total cover per species**
	Ocayan River	*Tagda-lungon*	*Small sandbar*	*Rio Tuba MPA*	*Ursula Island*	
Chlorophyta						
Acetabularia sp.	--	0.16	--	--	--	0.16
Boergesenia forbessii	0.16	--	0.40	--	0.40	0.80
Caulerpa sertularioides	--	0.16	0.40	--	--	0.72
Dictyosphaeria cavernosa	2.40	--	0.80	--	--	0.80
Halimeda cylindracea	--	0.80	0.80	--	1.28	7.68
Halimeda macroloba	--	2.72	2.24	2.40	3.2	8.16
Halimeda opuntia	--	0.48	0.80	--	0.48	4.00
Udotea orientalis	--	0.40	--	2.24	--	0.40
Phaeophyta						
Dictyota cervicornis	--	0.48	--	--	4.0	0.84
Pidana sp.	--	0.40	--	0.96	1.44	2.80
Sargassum sp.	--	--	0.96	--	--	0.96
Rhodophyta						
Hypnea sp.	--	--	--	--	11.36	11.36
Laurencia sp.	--	--	--	1.44	0.32	1.76
Actinotrichia fragilis	--	--	--	--	0.32	0.32
Galaxuara rugosa	--	--	--	--	0.16	0.16
Total seaweed cover (%)	**2.56**	**5.6**	**6.4**	**7.04**	**22.96**	
Species Richness	**2**	**7**	**7**	**4**	**10**	

3.1.6 Seagrass-associated macro-invertebrates

There were 12 macroinvertebrate species found in seagrass beds of the sampling stations. These included seven species of Echinodermata (three species from Class Asteroidea; three species from Class Echinodea; and one species from Class Holothuroidea), three species of Mollusca (all from Class

Gastropoda), and two types of Porifera or the sponges. Species richness per station was relatively "low" with only 1-8 species (Table 7).

Table 7. Species composition and frequency of occurence of seagrass-associated macroinvertebrates in monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Macro-invertebrate Species	Frequency of Occurrence (No. of individual)					Total
	Ocayan River	*Tagda-lungon*	*Small Sandbar*	*Rio Tuba MPA*	*Ursula Island*	
Phylum: Echinodermata						
Class: Asteroidea						
Protoreaster nodosus	5	5	5	6	--	**21**
Linckia laevigata	--	3	2	--	--	**5**
Class: Echinoidea						
Archaster sp.	--	6	3	1	1	**11**
Diadema sp.	--	--	2	1	3	**6**
Salmaciella sp.	--	--	1	1	1	**3**
Clypeasteroida sp.	--	2	--	--	1	**3**
Class: Holothuroidea						
Synapta sp.	--	1	--	--	--	**1**
Phylum: Mollusca						
Conus leopardus	--	--	--	2	2	**4**
Cerithium sp.	--	--	--	--	1	**1**
Conus sp.	--	--	--	--	1	**1**
Porifera (Common Name)						
Orange aspicular sponges	--	4	8	--	--	**12**
Black tubular sponges	--	2	--	--	5	**7**
Total Frequency	**5**	**23**	**21**	**11**	**15**	
Species Richness	**1**	**6**	**5**	**5**	**8**	

3.1.7 Comparison of present findings with the previous data

The discussion in this section is focused only on the findings in Tagdalungon and Ocayan River, the only two surveyed seagrass stations under the CRA 2020 Report (Haribon Environmental Services Palawan Community-Based Fisherfolk Alliance, 2020). Results of the comparison indicated a greater number of seagrass species from Tagdalungon in the assessments conducted in 2020 (1st and 2nd semesters). Also, during that period, the seagrass covers in both stations (Tagdalungon and Ocayan River) were higher at 35.5%-57%. Apparently, species composition of seagrass-associated seaweeds and macroinvertbrates across the three sampling periods were nearly similar, except for the station near the Ocayan Rivers where no seagrass-associated seaweeds and macroinvertebrates were reported from the previous assessment (Table 8).

Table 8. Comparison on the results of seagrass assessments conducted in monitoring stations of CBNC, Bgy. Rio Tuba, Bataraza, Palawan (2020-2021).

Variables	**CRA 2020 (March 2019)**	**CRA 2020 (October 2020)**	**This Survey (June 2021)**
Seagrass species (Tagdalungon)	(8 species) *Enhlaus acoroides* *Syringodium isoetifolium* *Halophila ovalis* *Halodule uninervis* *Halodule pinifolia* *Thalassia hemprichii* *Cymodocea rotundata* *Cymodocea serrulata*	(8 species) *Enhlaus acoroides* *Syringodium isoetifolium* *Halophila ovalis* *Halodule uninervis* *Halodule pinifolia* *Thalassia hemprichii* *Cymodocea rotundata* *Cymodocea serrulata*	(5 species) *Enhalus acoroides* *Thalassia hemprichii* *Cymodocea serrulata* *Halodule pinifolia* *Halodule univervis*
Seagrass species (Ocayan River)	(2 species) *Enhalus acoroides* *Cymodocea rotundata*	(1 species) *Enhalus acoroides*	(2 species) *Enhalus acoroides* *Cymodocea serrulata*
% Seagrass bed (Tagdalungon)	38%	57%	18%
% Seagrass bed (Ocayan River)	35.5%	37.5%	14%
Associated seaweeds (Tagdalungon)	(10 species) *Galaxavena oblongata* *Acantophora spicifera* *Amphirea fragilis* *Halimeda macroloba* *Halimeda opuntia* *Udotea orientalis* *Acetabularia major* *Padina australis* *Padina minor* *Dictyota cavernosa*	(10 species) *Galaxavena oblongata* *Acantophora spicifera* *Amphirea fragilis* *Halimeda macroloba* *Halimeda opuntia* *Udotea orientalis* *Acetabularia major* *Padina australis* *Padina minor* *Dictyota cavernosa*	(7 species) *Acetabularia sp.,* *Caulerpa sertularioides* *Halimeda cylindraceae* *Halimeda macroloba* *Halimeda opuntia* *Dictyota cervicornis* *Pidana* sp.
Associated macro-invertebrates (Tagdalungon)	(5 species) Mantis shrimp Sponge *Linkia laevigata* *Protoreaster nodusos* *Linkia multifora*	(5 species) *P. nodusus* Sea Urchin *Conus sp.* Jelly Fish Sea Cucumber	(7 species) *Protoreaster nodosus* *Linckia laevigata* *Archaster* sp. *Clypeasteroida* sp. *Synapta sp.* Orange aspicular sponges Black tubular sponges
Associated seaweeds (Ocayan River)			*Caulerpa sertularioides* *Halimeda cylindracea*
Associated macro-invertebrates (Ocayan river)			*Protoreaster nodosus*

The decrease in seagrass species richness and cover should not be related solely to human perturbation in the area. The observed human activities in seagrass beds of Tagdalungon such as gleaning, fishing, and boat anchorage can impose only minimal damage to the ecosystem. The decrease in seagrass cover can also be related to the differing method used in calculating the seagrass cover. The previous surveys utilized the method of White et al. (2004) while the present survey used the method of Saito and Atobe (1970) as thoroughly discussed by Ganzon-Fortes (2011). Similarly, the decrease in species richness can also be associated to discrepancy in the location of assessed portion of seagrass bed or where transect lines were exactly established during surveys.

3.2 Mangrove Assessment

3.2.1 Species Composition

Five mangrove species were documented in all monitoring stations. Three of these species, the *Rhizophora apiculata*, *Rhizophora mucronata*, and *Sonneratia alba,* were observed inside the 10 m by 10 m plot, while the two other species, the *Brugueira gymnorrhiza* and *Ceriops tagal,* were found outside the established plot. Forest diversity and evenness were not computed due to very limited number of mangrove species within the plot; only three species were recorded and not all of these species were found in every plot. Nonetheless, species Importance Value or IV revealed that *S. alba* was the most dominant mangroves in the area with 53% and 76% IVs in Stations 1 and 2, respectively. The *R. mucronata* followed with IVs of 47% (Station 1) and 9% (Station 2), and *R. apiculata* had the lowest IV, only 15% at station 2. The average densities of mangrove seedlings and saplings were at 3,000 seedlings/ ha and 700 saplings/ ha. Most of these seedlings and saplings are non-natural recruits, instead planted in the area as part of the CBNC's tree planting initiatives (Table 9).

Table 9. Species composition and relative Importance Value (IV) of mangroves in the coast of Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Family	Mangrove Species	Importance Value (%)		
		Station 1 (Plots 1&2)	**Station 2** (Plots 3&4)	**Outside the Plot**
Rhizophoraceae	*Bruguiera gymnorrhiza*	--	--	--
	Ceriops tagal	--	--	--
	Rhizophora apiculata	--	15	--
	Rhizophora mucronata	47	9	--
	Sonneratia alba	53	76	--
	Species Richness	**2**	**2**	**2**
	Density of Seedlings (ind/ha)	**2,300**	**3,700**	
	Density of Saplings (ind/ha)	**300**	**1,100**	

3.1.2 Species average density, height, and basal area

Among the three mangrove species documented in the established plots, the *S. alba* had the highest mean density, 425 trees/ha (50 and 800 trees/ ha at Stations 1 and 2, respectively). This was followed by *A. mucronata* with 375 trees/ha (50-350 trees/ha at Stations 1 and 2, respectively) and *R. apiculata* with 75 trees/ha (Figure 14).

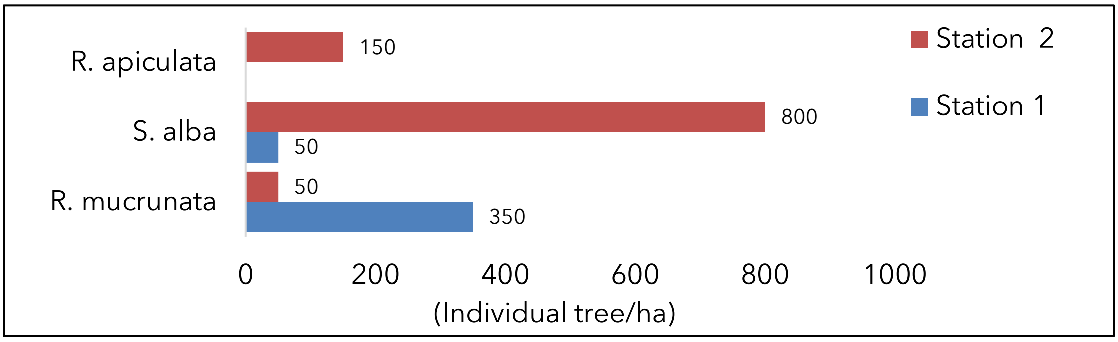


Figure 14. Average density of mangrove species in Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

The average mangrove canopy height ranged from 3 m to 11.3 m. The *S. alba* (10.9- 11.3 m high) represented the tallest mangrove species in Tagdalungon, followed by *A. apiculata* (6.7 m high) and *R. mucronata* (3-5 m high) (Figure 15). In terms of basal area, the *S. alba* had the highest coverage, up to 96.2 m^2/ha at station 2 and 17. 3 m^2/ha at station 1 or an average basal area of 56.8 m^2/ha. The *A. mucronata* and *A apiculata* had average basal areas of 4.1 m^2/ha and 0.66 m^2/ha, respectively (Figure 16).

Figure 15. Average canopy height of mangrove species in Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

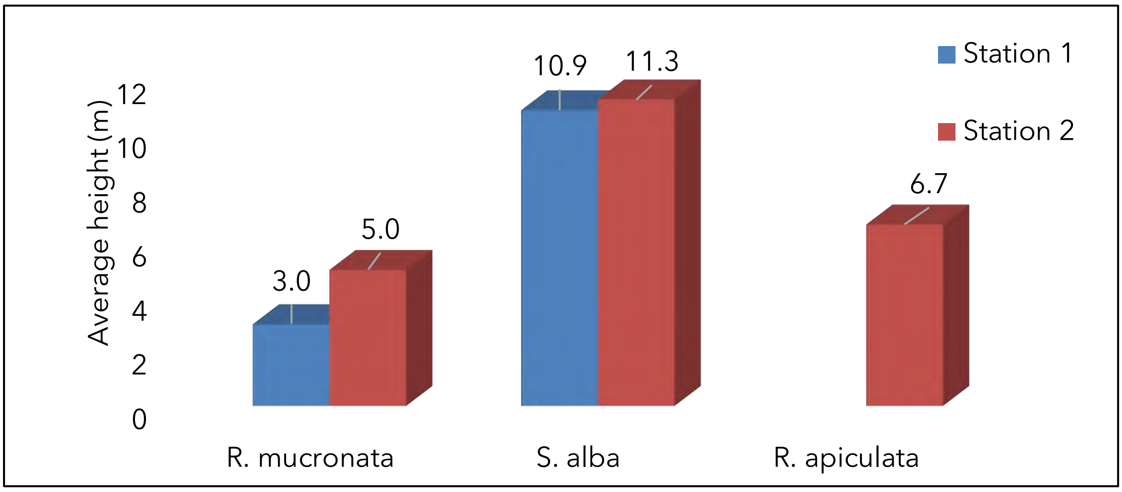


Figure 16. Average canopy height of mangrove species in Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

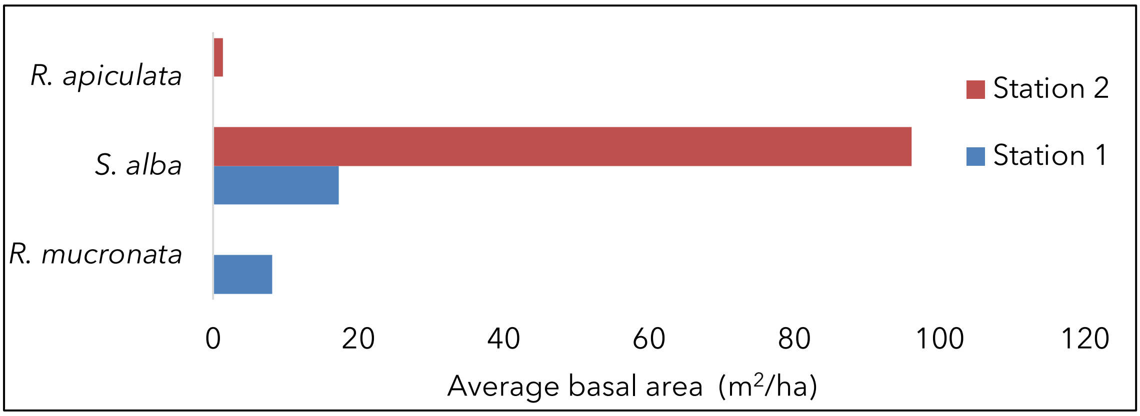


Figure 17. Average basal area of mangrove species in Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Generally, the surveyed mangrove forest had a low species richness, tree densities and basal area. A similar survey conducted in mangrove forest of Iwahig, Puerto Princesa City, Palawan, for instance, was able to record 28 mangrove species and the maximum tree density had reached to 8,100 trees/ha and the basal area was at 438 m^2/ha (Dangan-Galon et al., 2016). Nonetheless, data gathered from this survey shall serve as baseline information on the current state of mangrove forest in Tagdalungon, Rio Tuba, Bataraza, Palawan. This can likewise be used as basis for any management actions to be conducted in order to protect and conserve mangrove biodiversity in the area.

There was no trace of mangrove cutting in the surveyed area. However, solid wastes such as the used plastic bags, fragments of fishing nets, rubber strips were found entangled on prop roots and branches of some mangrove trees.

3.3. Plankton Assessment

A total of 33 species comprising 28 phytoplankton and five zooplankton species were recorded. This number of species is considered as low compared to 38 species recorded in 2020 monitoring. Plankton density was estimated to range from 252 to 325,796 cells/m^3 depending on species (Table 10). The estimated density from this report, however, is far denser comparative to the 2020 assessment. These differences in the densities of plankton communities maybe due to seasonality and the changes in physico-chemical properties of the area between the different sampling time (Lacuna et al., 2012; Galinato and Evangelio, 2016) which is still subject for verification.

There are slight differences in the species records and diversity from the previous reports in the area (Appendix 3). At least 30 species from previous reports were not recorded in this survey, while 11 new species were recorded in this report. The species variability between sampling period may indicate seasonality and changes of physico-chemical properties of the water and the depth of sampling collection. Such patterns of species and abundance differences had long been observed in Philippine seas. Taniguchi (1972) noted that large-size phytoplankton (e.g. diatoms) may dominate surface areas of water as they are uningestible by microzooplankton, while in the Philippine sea, the subsurface chlorophyll *a* maximum layer was formed and are most likely dominated by small phytoplankton. Moreover, Calumpong et al. (2013) also described patterns of species and dominance shifts from blue-green algae in wet and diatoms in dry seasons in the Ticao Pass, Masbate, Philippines.

Table 10. Overall list of plankters species and corresponding estimated density in cells per cubic meter of water in monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Plankters	Species	Density, cells/m^3
Phytoplankton	*Rhizosolenia setigera*	325,796.38
	Thalassionema sp.	171,690.65
	Chaetoceros sp.	159,546.33
	Thalassionema nitzschioides	107,016.88
	Ceratium trichoceros	46,255.90
	Thalassionema frauenfeldii	35,407.70
	Pseudo-nitzschia sp.	34,835.53
	Protoperidinium oceanicum	18,071.56
	Chaetoceros peruvianus	14,093.15
	Ditylum brightwellii	12,568.76
	Odontella mobiliensis	10,802.76
	Coscinodiscus granii	9,697.86
	Ceratium tripos	9,490.28
	Ceratium dens	7,783.34

Plankters	Species	Density, cells/m^3
	Odontella sinensis	4,156.86
	Chaetoceros decipiens	3,666.67
	Chaetoceros affinis	2,674.93
	Leptocylindricus sp.	2,446.58
	Dinophysis caudata	1,830.69
	Lauderia annulata	1,788.25
	Guinardia sp.	1,777.78
	Chaetoceros danicus	1,335.47
	Chaetoceros simplex	1,333.33
	Rhizosolenia crassispina	888.89
	Ceratium humile	504.13
	Ceratium furca	252.07
	Euterpina sp.	252.07
	Bacteriastrum sp.	0
Zooplankton	*Acanthocyclops* sp.	187,471.24
	Cyclops spp.	163,411.23
	Mesocyclops sp.	110,777.78
	Tropocyclops sp.	38,222.22
	Acartia sp.	6,996.53

Only one station is significantly comparable to the rest of the stations sampled in terms of dominance and diversity (Figure 17). Lower Kinurong is comparably less diverse with all other stations with only 2 species recorded, but with very high abundance/density (Table 11). Again, this is lower compared to previous reports, however, the abundance appears to have similar patterns.

Generally, diversity and distribution patterns (evenness index) are "high" in four stations (Mooring Dolphin, Discharge Point, Causeway and Ocayan River). Moreover, abundance of all the species identified are "high". It is important to note that phytoplankton are nearly absent in the Lower Kinurong Siltation Pond. The CBNC staff reported that the Lower Kinurong Siltation Pond was drained before the field assessment, thus, the observed abscense of phytoplankton. The high abundance of phytoplankton suggests a more frequent sampling of changes in planktons' abundance, physico-chemical properties of water (e.g. water salinity, nutrients and temperature, among others) to monitor the possibility of early detection of algal blooms that may cause red tide in the area, as well as potential climate change effects specifically on plankton community.

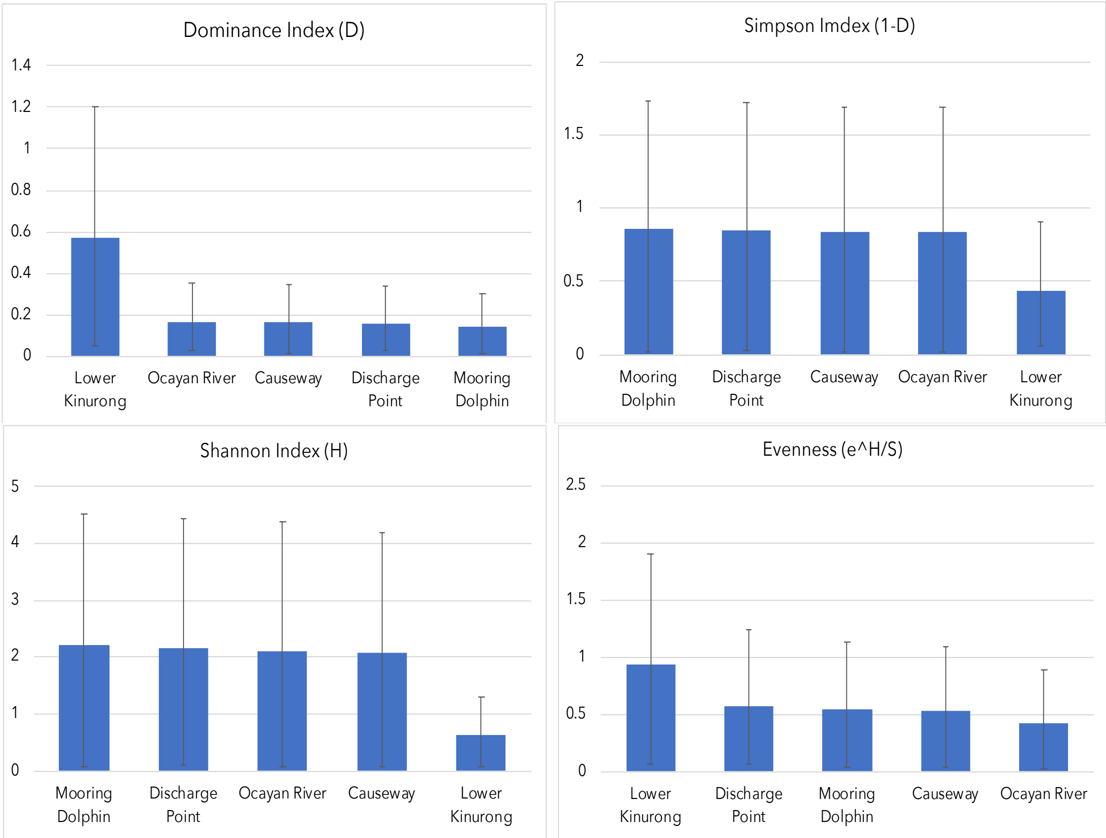


Figure 18. Dominance, diversity and evenness indices calculated based on the plankton population (cells/m^3) in monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Table 11. Species records of planktons and corresponding cell counts per monitoring stations of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Species	Lower Kinurong	Ocayan River	Cause-way	Mooring Dolphin	Discharge Point
Phytoplankton					
Bacteriastrum sp.	-	-	-	-	-
Ceratium dens	-	-	7	-	0
Ceratium furca	-	-	-	-	0
Ceratium humile	-	-	-	-	1
Ceratium trichoceros	-	-	27	15	5
Ceratium tripos	-	-	5	4	-
Chaetoceros affinis	-	2	-	-	1
Chaetoceros danicus	-	-	-	1	-
Chaetoceros decipiens	-	4	-	-	-
Chaetoceros peruvianus	-	3	4	6	1
Chaetoceros simplex	-	1	-	-	-
Chaetoceros sp.	-	39	55	52	13
Coscinodiscus granii	-	-	4	2	4
Dinophysis caudata	-	1	1	-	0
Ditylum brightwellii	-	7	-	2	3

Species	Lower Kinurong	Ocayan River	Cause-way	Mooring Dolphin	Discharge Point
Euterpina sp.	-	-	-	-	0
Guinardia sp.	-	2	-	-	-
Lauderia annulata	-	-	-	2	-
Leptocylindricus sp.	-	1	-	1	-
Odontella mobiliensis	-	1	-	5	5
Odontella sinensis	-	1	3	-	-
Protoperidinium oceanicum	-	-	17	-	1
Pseudo-nitzschia sp.	-	1	23	11	-
Rhizosolenia crassispina	-	1	-	-	-
Rhizosolenia setigera	-	33	162	98	33
Thalassionema frauenfeldii	-	2	-	32	1
Thalassionema nitzschioides	-	12	74	19	2
Thalassionema sp.	-	29	81	48	15
Zooplankton					
Acanthocyclops sp.	49	-	96	27	15
Acartia sp.	-	-	7	-	-
Cyclops spp.	-	78	-	63	22
Mesocyclops sp.	107	4	-		-
Tropocyclops sp.	-	38	-	-	-

There are few differences in the species records from recent reports. Several species reported in 2020 were not recorded in this survey and vice versa, suggesting further monitoring to identify seasonal variations between plankton community. Moreover, water quality and environmental factors (e.g. climate related variables) must be regularly monitored to determine the potential effects of pollution and climate change to plankton community and productivity.

3.4 Coral Reef Assessment

3.4.1 Coral genera composition/ categories

There were 38 coral genera belonging to 15 families encountered in monitored sites in Coral Bay and Ursula Island in Bgy. Rio Tuba, Bataraza. Among these families, only Acroporidae, Merulinidae, Pocilloporidae and Poritidae were noted across all stations. The recorded number of families per station in decreasing order is Ursula Is. 1 with 13 families, Maranto Pt. (11), Mooring dolphin (9), Ameril Is. (8), Causeway (8), Small sandbar (8), Ursula Is. 2 (8) and Rio Tuba MPA (7).

In terms of genera, only *Acropora* was encountered in all stations, while *Ctenactis* and *Porites* were noted in 7 out of 8 stations. *Diploastrea,* *Goniopora* and *Seriatopora* were recorded in 6 of 8 stations, while *Coeloseris, Cycloseris, Echinophyllia, Echinopora, Heliofungia, Lobophyllia, Millepora, Oxypora, Polyphyllia* and *Sandalolitha* were only encountered in one station.

Among these stations, only Ursula Is. 1 is categorized under Diversity Category B with 24 genera. Mooring Dolphin (20) and Ameril Is. (17) are categorized as Diversity Category C while Maranto Pt. (14), Small sandbar (14), Causeway (13), Rio Tuba MPA (13) and Ursula Is. 2 (10) are under Diversity Category D (Figure 18).

The Diversity Category must be monitored since it's the downgrade in present category coupled with changes in coral species composition are indication of the degradation of the reefs' ability to sustain their vital ecosystem services (Wilson et al. 2012; Licuanan 2020). The characterization of the coral reefs monitoring sites of CBNC allows the monitoring and comparison of overall quality of the coral reefs per sites and tracking of the populations of coral species.

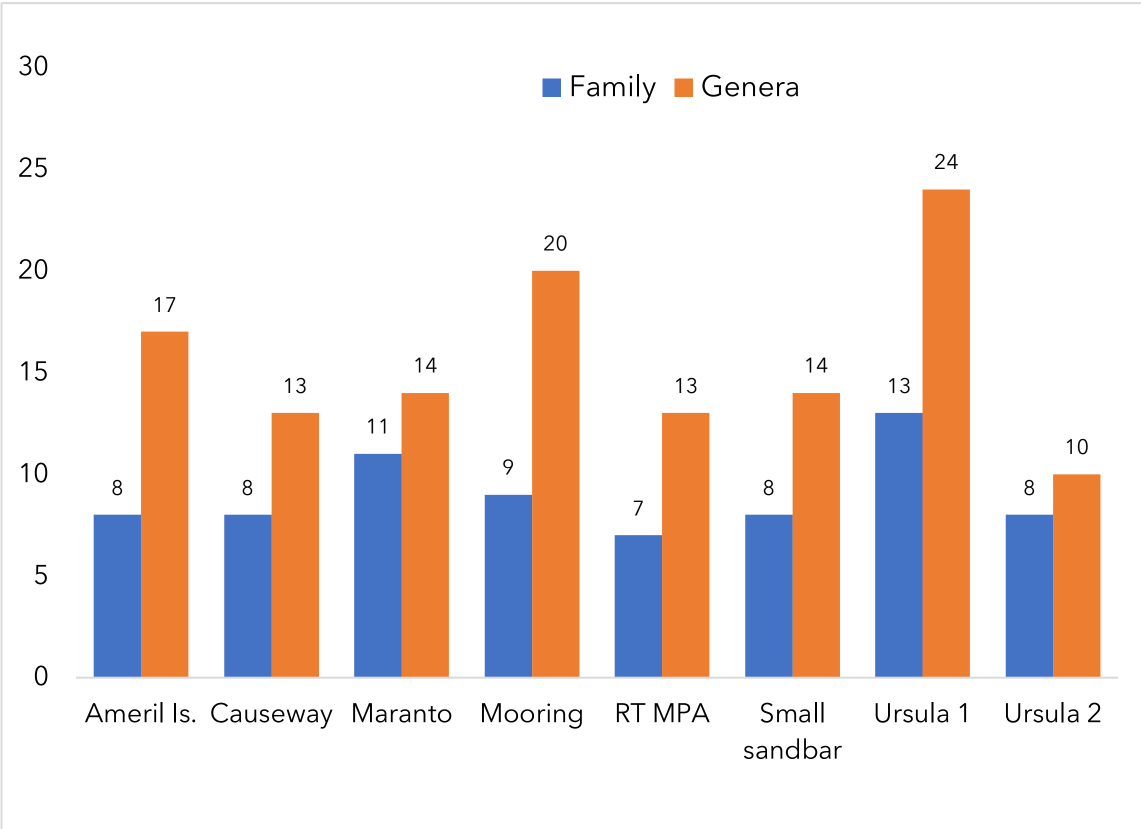


Figure 19. Number of coral families and genera encountered in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

For the complete list of coral genera encountered in each monitoring station, please refer to Appendix 4. Some of the examples of coral genera are also shown in Figures 19 and 20.

Figure 20. Some of the common coral genera encountered in monitored reefs in Coral Bay and Ursula Is., Bgy. Rio Tuba, Bataraza, Palawan (June 2021): Acropora (upper left), Ctenactis (upper right), branching Porites (lower left) and massive Porites (lower right).

Figure 21. Some of the rare coral genera encountered in monitored reefs in Coral Bay and Ursula Is., Bgy. Rio Tuba, Bataraza, Palawan (June 2021): Coeloseris (upper left), Echinophyllia (upper right), Echinopora (lower left) and Sandalolitha (lower right).

3.4.2 Overall substrate cover/ benthic life forms

The substrates in surveyed stations are categorized into biotic and abiotic components. Biotic substrates are living components of the reefs primarily composed of hard coral (HC), soft coral (SC), macroalgae (MA), sponge (SP) and others (OT). On the other hand, abiotic substrates are the non-living components composed of dead coral (DC), rubble (RB), sand (SD) and silt (SI). The average biotic component of the reef was computed at 85.59% of the substrate, while the abiotic component is 14.41%.

Among the biotic components, the highest mean substrate cover was macroalgae with 49.34%, followed by hard coral (34.21%), others (0.77%), sponge (0.62%) and soft coral (0.47%). In terms of abiotic components, these are composed of sand (5.89%), rubble (5.16%), dead coral (2.74%) and silt (0.87%).

The substrate macroalgae has the highest cover in all surveyed reefs ranging from 10.6% to 75.0% (mean = 49.34%). High macroalgae cover was recorded in Mooring Dolphin (75.00%), followed by Ursula Is. 1 (69.13%), Maranto Pt. (55.35%), Rio Tuba MPA (55.35%), Causeway (54.00%), Small Sandbar (44.42%), Ursula Is. 2 (30.74%) and Ameril Is. (10.6%).

The mean sand cover is computed at 5.89% (range: 2.5% - 11.23%): Mooring Dolphin (11.23%), Ursula Is. 2 (10.5%), Ameril Is. (8.88%), Small Sandbar (5.01%), Maranto Pt. (4.52%), Rio Tuba MPA (4.5%) and Ursula Is. 1 (2.5%).

The mean rubble (RB) cover is estimated at 5.16%, ranging 0.63% - 21.00%. Ameril Is. had the highest RB cover at 21.00%, Ursula Is. 2 had 5.38%, Causeway (5.14%), Rio Tuba MPA (4.38%), Small sandbar (3.00%), Ursula Is. 1 (1.13%), Maranto Pt. (0.64% and Mooring Dolphin (0.63%). The mean dead coral (DC) covers is computed at 2.74% (range: 0.13% - 10.75%). Ameril Is. had the highest DC (10.75%), followed by Small Sand bar (3.01%), Rio Tuba MPA (2.63%), Maranto Pt. (2.29%), Ursula Is. 1 (0.38%) and Mooring dolphin (0.13%) (Figure 21). For complete account of substrate cover, please refer to Appendix 5.

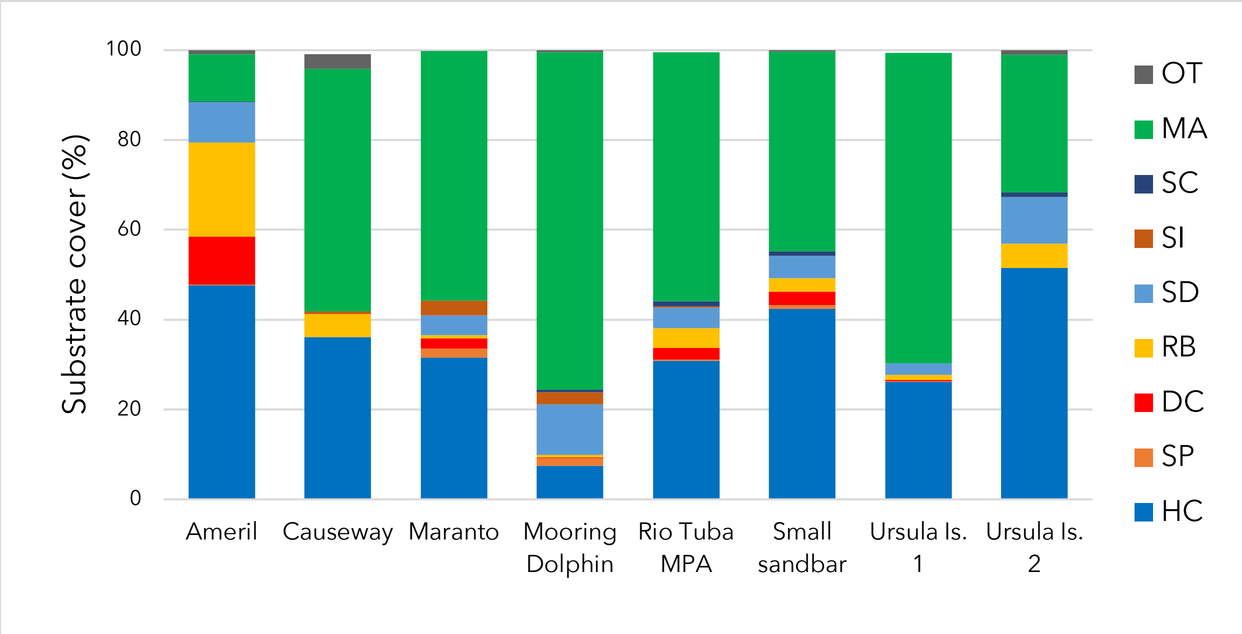


Figure 22. Mean substrate covers of monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021). *(Abbreviations: others (OT), macroalgae (MA), soft corals (SC), silt (SI), sand (SD), rubble (RB), dead coral (DC), sponge (SP), and hard coral (HC)).*

The HC cover of surveyed stations ranged at 7.5% – 51.5%, with mean at 34.21%, categorized as "good" by Licuanan et al. (2017). The stations with "excellent" conditions include Ursula Island 2 (51.5%) and Ameril Is. (47.63%), while the stations with "good" conditions are Small Sandbar (42.33%) and Causeway (36.16%). Maranto Pt. (31.57%), Rio Tuba MPA (30.88%) and Ursula Is. 2 (26.13%) have "fair" coral condition, while Mooring Dolphin has "poor" coral condition (7.5%) (Table 12).

Table 12. Hard coral (HC) cover and HC diversity conditions of monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021) based on Licuanan et al. (2017)[1] and Licuanan (2020)[2] categories (June 2021).

	Hard coral cover (HCC)[1]		Hard Coral Diversity[2]	
Monitoring Sites	**%**	**Category**	**# of TAUs**	**Category**
Ameril Is.	47.63	Excellent	17	Diversity Category C
Causeway	36.16	Good	13	Diversity Category D
Maranto Pt.	31.57	Fair	14	Diversity Category D
Mooring dolphin	7.50	Poor	20	Diversity Category C
Rio tuba MPA	30.88	Fair	13	Diversity Category D
Small sandbar	42.33	Good	14	Diversity Category D
Ursula Is. 1	26.13	Fair	24	Diversity Category B
Ursula Is. 2	51.50	Excellent	10	Diversity Category D
Mean	**34.21**	**Good**	**15.63**	**Diversity Category D**

Abbreviations: TAU – taxonomic amalgamation units; Is. – Island; Pt. – Point; MPA – Marine Protected Area

Among the HC, coral branching (CB) dominated (10.87%), followed by encrusting coral (CE) (9.40%), mushroom coral (CM) (8.49%) and *Acropora* branching (ACB) (2.85%). CB dominated the HC cover in Ameril, Maranto Pt., Rio Tuba MPA and Small Sandbar. On the other hand, CM are also abundant in Causeway and Maranto Pt., while CE dominates in Ameril Is. and Ursula Is. 2. The ACB are the dominant HC in Ursula Is. 1 (Figure 22). The full data of HC subcategories per stations is shown in Appendix 6.

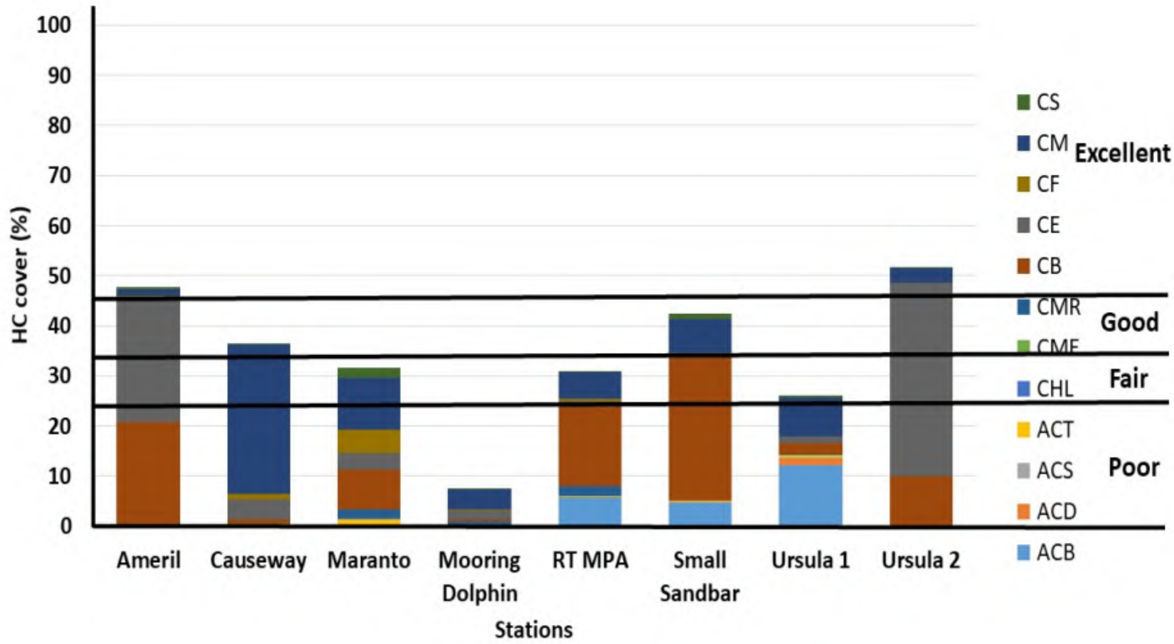


Figure 23. Subcategories of hard coral (HC) cover in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021). (*Abbreviation: Mushroom Coral (CM), Non-Acropora Submassive (CS), Non-acropora Branching (CB), Non-Acropora Foliose (CF), Non-Acropora encrusting (CE), Mushroom (CMR), Millepora (CME), Heliopora (CHL), Acropora Tabulate (ACT), Acropora Submassive (ACS), Acropora branching (ACB)).*

3.4.3 Substrate cover per station

In Ameril Is., the substrate is dominated by HC (47.63%) and RB (21.00%). Some substrates are DC (10.75%), MA (10.6%), SD (8.88%), OT (0.88%) and SP and SC at 0.13% each. In Causeway, MA and HC dominated the substrates with 54.00% and 36.16%, respectively. Other substrates include RB (5.14%), OT (3.36%) and SI (0.5%) (Figure 23).

In Maranto Pt., macroalgae (MA) dominated the substrates with 55.49%, followed by hard corals (HC) (31.57%), SD (4.52%), SI (3.29%), DC (2.29%), SP (2.00%) and RB (0.64%). In Mooring dolphin, about three-quarters (75%) of the substrates are composed of MA, with some SD (11.23%),

HC (7.50%), SI (2.75%), SP (1.64%), RB (0.63%), SC (0.63%), OT (0.50%) and DC (0.13%) (Figure 24).

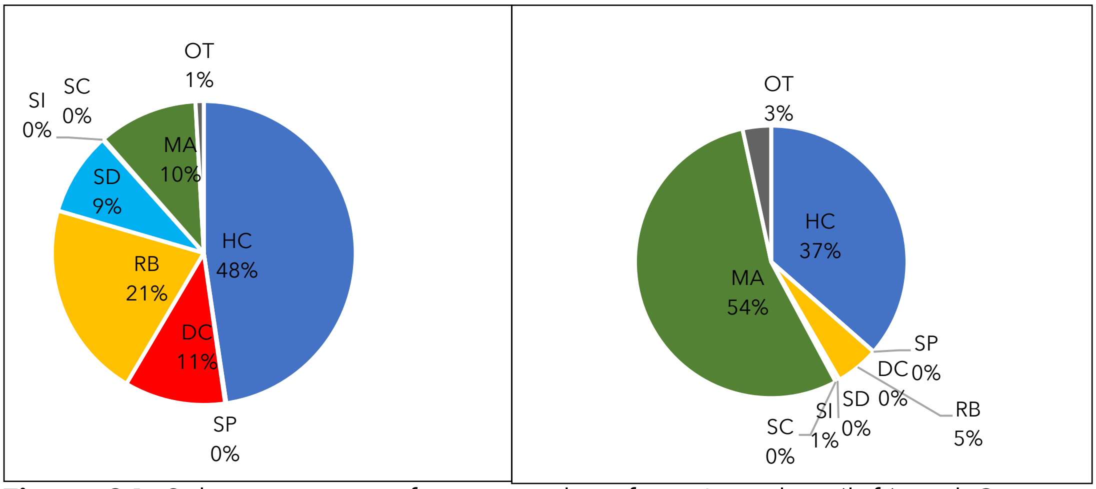


Figure 24. Substrate cover of monitored reefs in Ameril Is. (left) and Causeway (right), Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan, (June 2021). *(Abbreviations: others (OT), macroalgae (MA), soft corals (SC), silt (SI), sand (SD), rubble (RB), dead coral (DC), sponge (SP), and hard coral (HC)).*

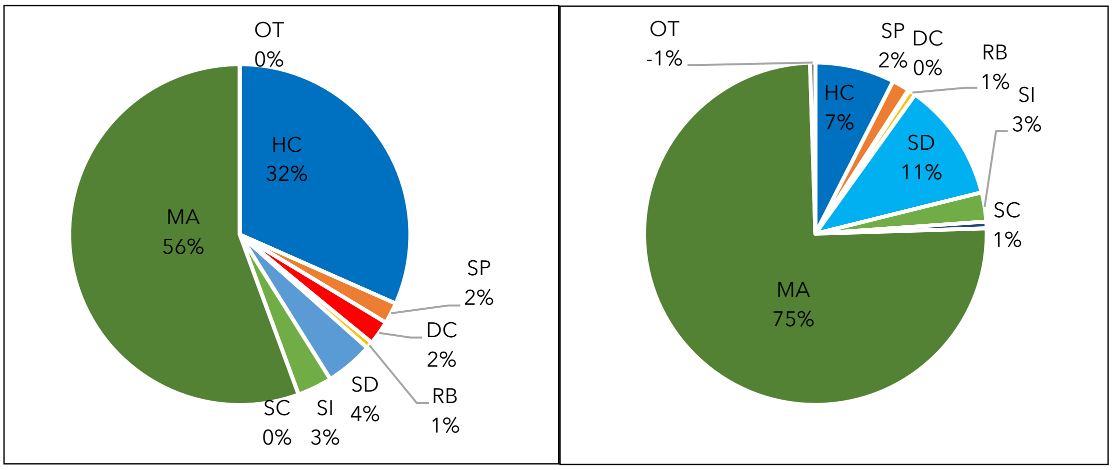


Figure 25. Substrate cover of monitored reefs in Maranto Pt. (left) and Mooring Dolphin (right), Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021). (*Abbreviations: others (OT), macroalgae (MA), soft corals (SC), silt (SI), sand (SD), rubble (RB), dead coral (DC), sponge (SP), and hard coral (HC)*).

Similar with other stations, MA and HC dominated the substrates of Rio Tuba MPA at 55.35% and 30.88% respectively. The rest are comprised of SD (4.50%), RB (4.38%), DC (2.63%), SC (1.13%), SI (0.38%) and SP (0.25%). The substrates of Small sandbar is composed of MA (44.42%) and HC (42.33%). Other substrates are SD (5.01%), DC (3.01%), RB (3.00%), SC (1.00%), SP (0.85%) and OT (0.38%) (Figure 25).

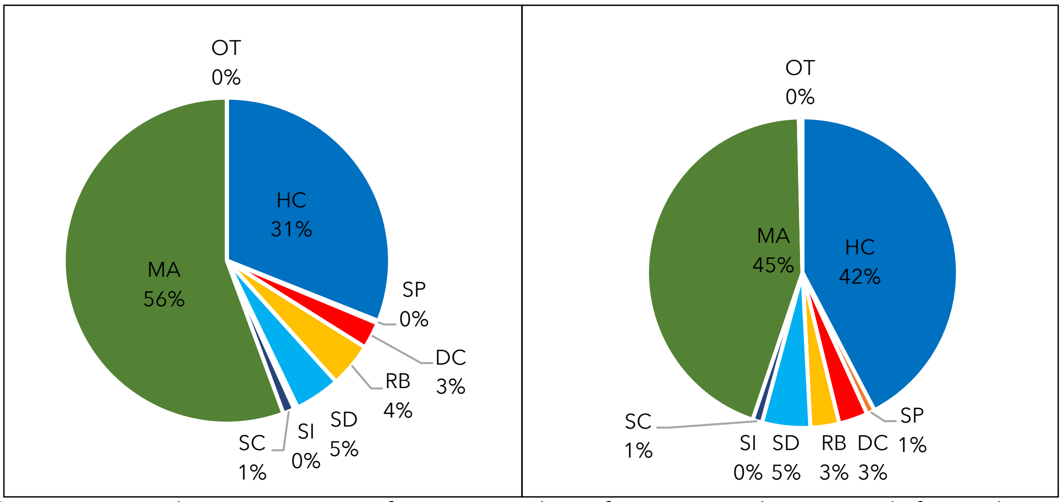


Figure 26. Substrate cover of monitored reefs in Rio Tuba MPA (left) and Small Sandbar (right), Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021). (Abbreviations: others (OT), macroalgae (MA), soft corals (SC), silt (SI), sand (SD), rubble (RB), dead coral (DC), sponge (SP), and hard coral (HC).

In Ursula Is. 1, the substrates is dominated by MA (69.13%), followed by HC (26.13%), SD (2.50%), RB (1.13%), DC (0.38%) and SP (0.13%). Contrary to Ursula Is. 1, more than half (51.%) of the substrates in Ursula Is. 2 is HC,. Other substrates include MA (30.74%), SD (10.50%), RB (5.38%), OT (1.00%) and SC (0.88%) (Figure 26).

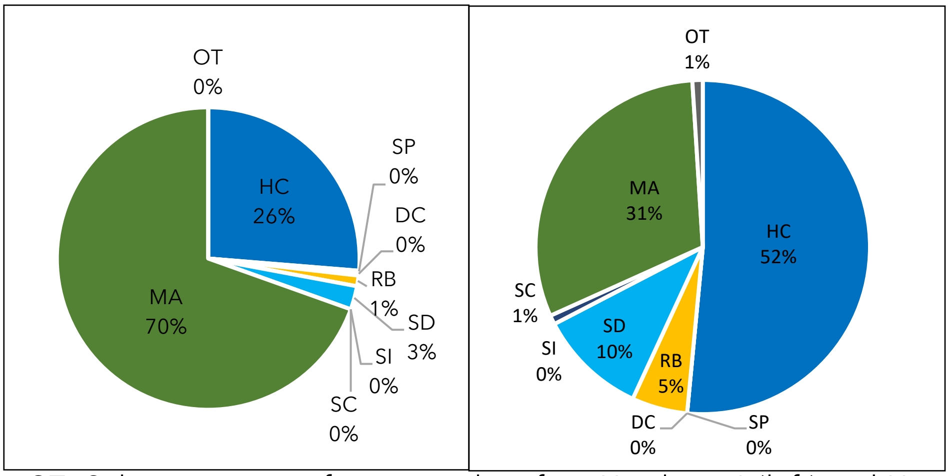


Figure 27. Substrate cover of monitored reefs in Ursula Is. 1 (left) and Ursula Is. 2 (right), Bgy. Rio Tuba, Bataraza, Palawan (June 2021). *(Abbreviations: others (OT), macroalgae (MA), soft corals (SC), silt (SI), sand (SD), rubble (RB), dead coral (DC), sponge (SP), and hard coral (HC).*

No coral substrates were encountered in Discharge Point station. This station is characterized by having a muddy substrate, low visibility (about 5-10 m) and water depth of 10-12 m. During the time of sampling, a moderate water current was observed in the station. A limited area of abiotic substrate was observed for the coral polyps to settle on. Most of biotic components were noted in the post of the Discharge Point point, which include the gorgonians or sea fans, tunicates, sea squirts, and sponges. For the list and photos of other biotic components encountered in this station, please refer to Appendix 7.

3.4.4 Coral families/genera composition

The number of coral families and genera varied with monitored reefs. Except for Ursula Is. 1, there was no correlation between the number of families and genera to the proximity of the monitored reefs to the mainland. It means that some "far" reefs have relatively fewer number of family and genera, while some "near" reefs have relatively higher number. Although Ursula Is. 2 and Ameril Is. are far from mainland Palawan, they only have eight families each while having 17 and 10 genera, respectively.

It is also interesting to note that in Ursula Is. 1, although has the greatest number of families and genera, its HC cover is one of the lowest. In the other side of Ursula Island (i.e. Ursula Is. 2), a relatively few families and genera were recorded, but it has the highest HC cover among the monitored reefs. Mooring Dolphin have the second highest number of coral genera, but recorded the lowest HC cover among the monitored reefs.

3.4.5 Comparison on the HC cover (2019-2021)

Comparing the data from previous monitoring, the HC cover in Causeway did not change significantly from 2019 to 2021. A significant reduction on the HC cover was observed in Small Sandbar and Mooring Dolphin, especially between the 2nd half of 2020 and the first half of 2021 (Figure 27). The difference could be attributed to the methods used during the monitoring. Coral monitoring activities from 1st half (2019) to 2nd half (2020) used the line intercept transect (LIT) method (English et al., 1997), while the 2021 monitoring used the modified photo-quadrat method (Luzon et al., 2019). The LIT method is conducted to estimate the substrate cover on site, while the photo-quadrat (PQ) method used computer program in scoring collected photos to estimate the substrate cover. One of the advantages of the PQ method is that you can visually compare the previous and current assessments using photos and decide intervention measures based on the estimated substrate cover.

Aside from the difference in the method used, it is also worth to note that among the monitored reefs, marine debris are noticeable in Mooring Dolphin and Causeway and may have caused the reduction in HC cover. The water visibility in these stations was also low (<7 m), owing to the siltation by nearby tributaries. This might have caused the mortality of some corals since they are sensitive to turbidity and sedimentation, and coral polyps may have been suffocated by the sediments (Erftemeijer et al., 2012). Note that water flushing and turnover rate in the area is very low.

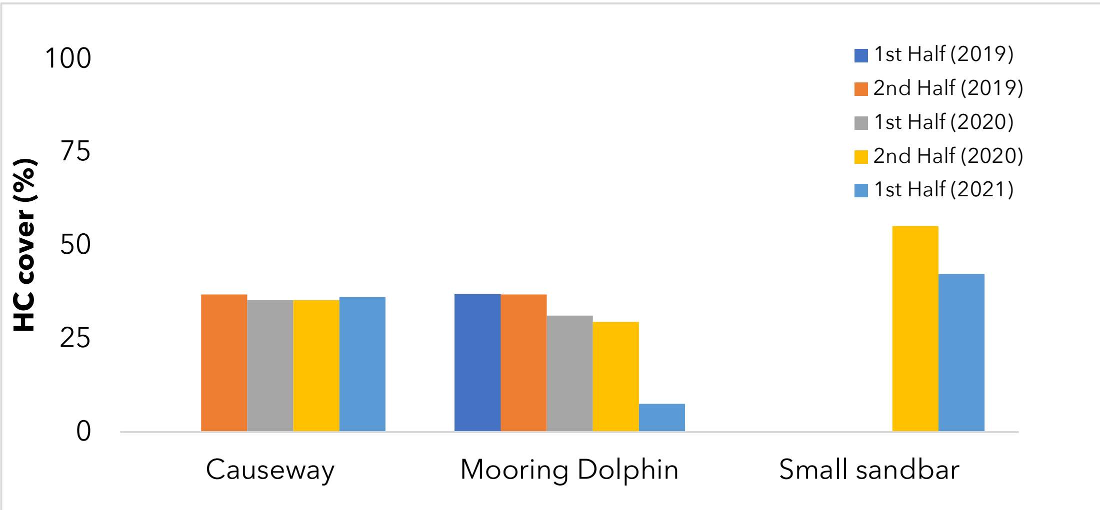


Figure 28. Comparison of hard coral (HC) cover on Causeway, Mooring Dolphin and Small Sandbar, Bgy. Rio Tuba, Bataraza, Palawan (2019-2021).

The municipality of Bataraza is surrounded by several freshwater tributaries and sediment sources. "Excellent" HC cover were observed only in reefs that are far from these sources (like the case of Ameril Is. and Ursula Is. 2, except for Ursula Is. 1). The reefs in Ursula Is. 1 are exposed to wave action, while Ursula Is. 2 are located on the other side of the island, thus, protected from wave action. This might be the reason why the two stations have relatively contrasted HC cover, wherein reefs that are exposed to frequent wave action have low HC cover than those that are protected. Reefs that are neither near nor far from the mainland also have "good" HC cover, while those that are near the "impact" zone have "poor" to "fair" HC category. This shows that reefs that are exposed to less stressors will have better HC cover than those that are more exposed.

Similarly, most of the HC encountered (e.g. Non-Acropora Branching (CB), Non-Acropora Massive (CM), Non-Acropora Encrusting (CE)) are massive in nature and more resilient to several environmental stressors, such as sedimentation, wave action, eutrophication and elevated sea surface temperature (Schloder and D'Croz, 2004; Baldock et al., 2015; Ferreira et al., 2021). Thus, reefs that are dominated by these coral types are more likely to adapt and survive the changing environmental conditions, compared to branching type and other *Acropora* species that are usually found in less cover.

3.4.6 Occurrence of high macrophyte cover

It is important also to note that macroalgae (MA) dominated in 6 out of 8 monitored stations. In this monitoring, MA are abundant in reefs near mainland (e.g. Causeway, Maranto Pt., Mooring Dolphin, Rio Tuba MPA and Small Sandbar) than in far reefs (e.g. Ameril Is., Ursula Is.).

There is a substantial increase in the MA cover in Mooring Dolphin and Causeway in this monitoring (Figure 28) as compared with the monitoring conducted in 2020. However, we noted that the increase in MA cover in the said monitoring stations coincide with the reduction of substrate covered by dead corals (DC) (Figure 29). One of the reasons might be that the DC in previous monitoring were already covered by MA when the environment was favorable for their growth.

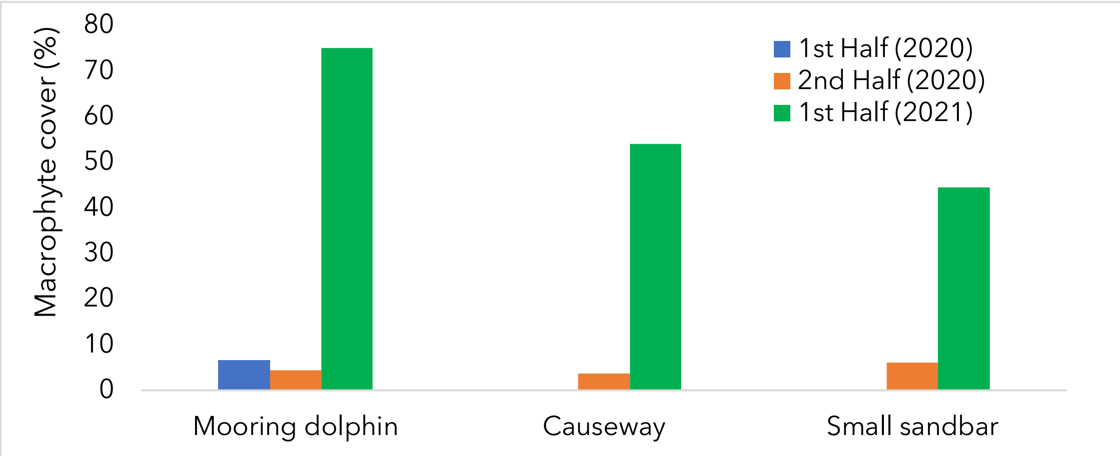


Figure 29. Comparison of macrophyte (MA) cover on Causeway, Mooring Dolphin and Small Sandbar in Bgy. Rio Tuba, Bataraza, Palawan (2020-2021).

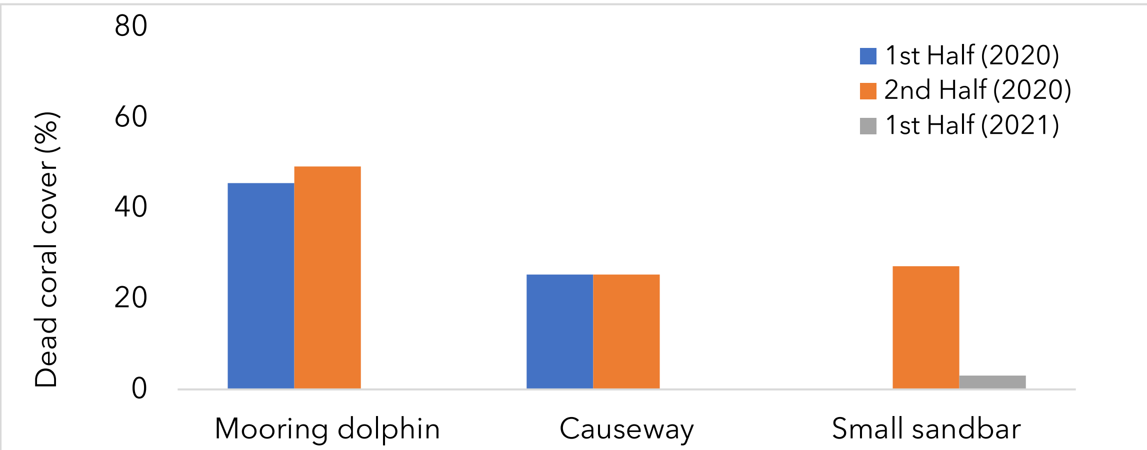


Figure 30. Comparison of the dead coral (DC) cover on Causeway, Mooring Dolphin and Small Sandbar, Bgy. Rio Tuba, Bataraza, Palawan (2020-2021).

There are several factors affecting the growth of macrophytes/macroalgae, which include herbivory and nutrient-loading. Herbivory is the key process that controls macrophyte abundance in coral reefs, wherein herbivorous species (e.g. sea urchins and herbivorous fish) fed on macroalgae that are present on coral reefs, thus reducing macrophyte abundance. Based on the results of fish visual census survey, herbivorous fish dominated in the coral reefs both in population density and biomass. However, territorial herbivores (e.g. damselfishes) are more abundant in the monitored reefs than roving herbivores (e.g. surgeonfishes). Territorial herbivores (although small in size) maintain a certain territory where they can "farm" macrophytes for own consumption and protect it from roaming herbivores, while roving herbivores look for areas with macrophytes (Hoey and Bellwood, 2010; Eurich et al., 2018). Reef herbivory (particularly roving herbivory) play a vital role in determining the structure of benthic community and resilience of coral reefs from shift to algal-dominated reef, by reducing the abundance of macroalgae. However, when the herbivorous fish are excessively taken from coral reefs through fishing, macrophytes tend to dominate the reefs and affect the survival and integrity of coral reefs (Burkepile and Hay 2009; Sotka and Hay 2009; Hoey and Bellwood 2010).

On the other hand, macrophytes are also expected to abound in areas with high nutrient input (i.e. eutrophic water) from agricultural areas which are brought about by rivers and runoff waters during heavy rain (Sharip et al., 2011; Rao et al., 2020). Except for Ursula Is. 1 (it has high MA cover even far from mainland), both Ursula Is. 2 and Ameril Is. have low MA at 10.60% and 30.74%, respectively, suggesting the two are less influenced by high nutrient loading because of their proximity from the source. This factor is seen to be the main driver of high MA cover in the monitored reefs near mainland, because they are located with nearby tributaries which is affected by the nutrient dynamics.

3.5. Reef Fish Communities

3.5.1 Species diversity

A total of 188 fish species belonging 34 families were identified in nine monitoring stations within the shallow reefs in identified primary impact areas of the CBNC operations. Mean species diversity of reef fishes was estimated at 66 species/1,000 m^2, which falls under "moderate" based on categories for species richness established by Hilomen et al. (2000).

Among the stations surveyed, highest number of fish species encountered was recorded in Ursula Island 2 with 73 species and Ursula Is. 1 (69 species), followed by Small Sandbar (68 species), Ameril Island (58 species), Rio Tuba MPA (58 species) and Maranto Point (55 species). Meanwhile, low number of fish species encountered was recorded in Causeway, Mooring Dolphin and Discharge Point with 48 species, 43 species and 19 species, respectively. Highest number of targeted fish species were encountered in Ursula Is. 2 with 29 species, followed by Rio Tuba MPA (27 species), Small Sandbar (24 species), Ursula Island 1 (22 species), Mooring Dolphin (20 species), Discharge Point (19 species), and Causeway (18 species). Ameril Island and Maranto Point observed to have a low targeted fish species with 16 and 14 species, respectively.

Fish communities in monitored reefs of CBNC operations impact areas is largely represented by major group (95 species), followed in importance by targeted species (80 species) and indicator group (13 species) (Table 13).

Table 13. Summary of the species composition and categories of reef fishes encountered in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Site	Number of fish families	Number of species	Target species	Indicator species	Major species
Ameril Island	19	58	16	4	38
Causeway	17	48	18	3	27
Maranto Point	19	55	14	7	34
Mooring Dolphin	16	43	20	2	21
Rio Tuba MPA	18	58	27	3	28
Small Sandbar	16	68	24	7	37
Ursula Island 1	21	69	29	7	33
Ursula Island 2	16	73	22	7	39
Discharge Point	16	26	19	0	7
Total	**34**	**188**	**80**	**13**	**95**

Note: *Target fish species indicated includes the following fish families: Acanthuridae, Caesionidae, Carangidae, Haemulidae, Labridae (subfamily Cheilininae), Lethrinidae, Lutjanidae, Mullidae, Nemipteridae, Scaridae, Serranidae (subfamily Epinephelinae), and Siganidae.*

Result of this study recorded relatively higher number of fish species and families encountered compared to reef areas monitored from 2018 to 2020. Increased in fish abundance and diversity in this monitoring may be attributed to the additional stations in this years' survey. The same trend was also observed for the Target, Major and Indicator species which recorded a relatively higher number of fish species observed (Figures 30-31, Table 14).

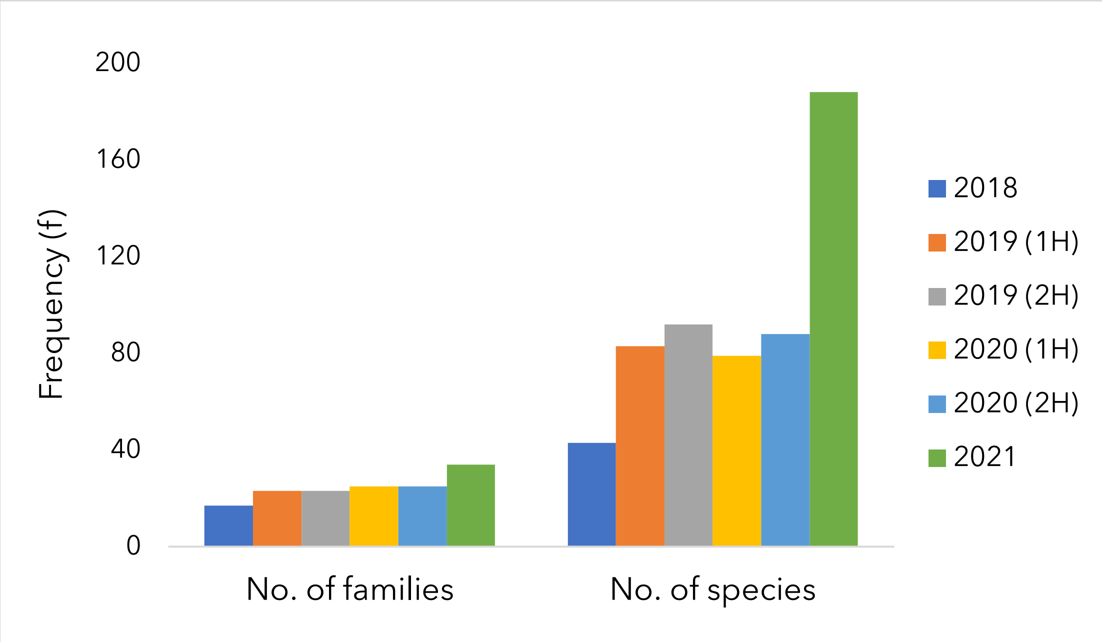


Figure 31. Total number of fish families and species in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan from 2018-2021.

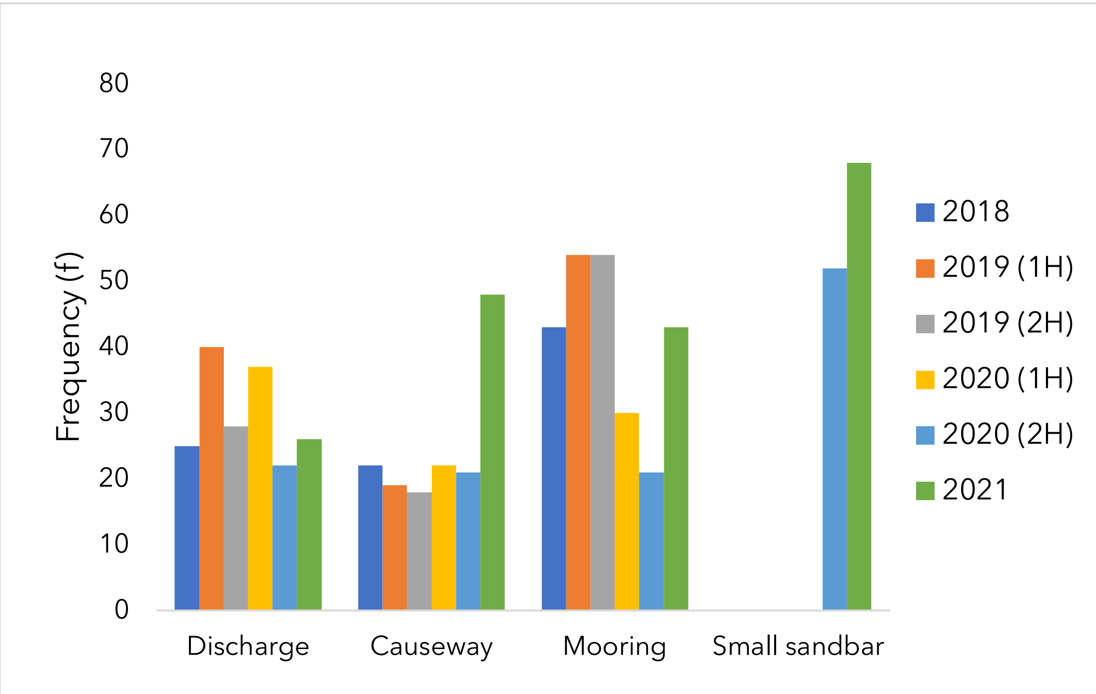


Figure 32. Total number of fish species in per monitoring stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan from 2018 to 2021.

Table 14. Summary of the species composition and categories of reef fishes encountered from 2018 to 2021 in monitoring stations of CBNC, Bgy. Rio Tuba, Bataraza, Palawan.

Year	Stations	Fish families	Species	Target species	Indicator species	Major species	Data Source
2018	Mooring Dolphin Causeway Discharge Point	17	43	18	2	28	2018 Report*
2019 (1st Half)	Mooring Dolphin Causeway Discharge Point	23	43	51	1	43	2019 Report*
2019 (2nd Half)	Mooring Dolphin Causeway Discharge Point	23	92	39	1	51	2019 Report*
2020 (1st Half)	Mooring Dolphin Causeway Discharge Point	25	79	39	3	37	2020 Report*
2020 (2nd Half)	Mooring Dolphin Causeway Discharge Point	25	88	31	2	55	2020 Report*
CBNC Impact Areas	Several Reefs	**34**	**185**	**77**	**13**	**95**	**This Report**

* Biodiversity Assessment Report conducted every semester.

3.5.2 Population Density

Results of the fish community assessment showed an overall mean density of fish communities observed in monitored reefs was estimated at 1,699.25 individual/1,000 m^2 which falls under "moderate" category based on categories for mean densities of coral reef fishes suggested by Naῆola et al. (2004). This showed that small sized reef fishes belong to the family Pomacentridae (damselfishes) are the most abundant with an estimated mean density of 1,166 individuals/1,000 m^2, followed in importance by the fish belonging to the family Labridae (wrasses) with 560 individuals/1,000 m^2, Chaetodontidae (162 individuals/1,000 m^2), Labridae Sub-family Scarinae (146 individuals/1,000 m^2), Serranidae (114 individuals/1,000 m^2) and Nemipteridae (100 individuals/1,000 m^2). Other fish families recorded substantially low mean densities (<100 individuals/1,000 m^2).

The surveyed reefs in discharge point with 4,158 individuals/1,000m^2 recorded highest mean density of reef fish, these reefs, and reefs surrounding Ursula Island with 2,906 individuals /1,000 m^2 in Ursula Is. 2 and 2,712 individuals /1,000 m^2 in Ursula Is. 1, classified under "high" category. All other reefs surveyed in Coral Bay areas falls under "moderate" category (Table 15).

Table 15. Fish densities and biomass of reef fishes encountered in monitored reefs in Coral Bay, Rio Tuba, Bataraza, Palawan (June 2021).

Stations	Individuals per 1,000 m²	Category (Nañola et al., 2004)
Ameril Island	1,332	Moderate
Causeway	1,444	Moderate
Maranto Point	1,392	Moderate
Mooring Dolphin	710	Moderate
Rio Tuba MPA	1,184	Moderate
Small Sandbar	1,914	Moderate
Ursula Island 1	2,712	High
Discharge Point	4,158	High
Total	**17,752.00**	
Mean	**1,972.44**	**Moderate**

Mean density of fish recorded in this study is higher compare to previous monitoring (2018-2020) in Coral Bay (Figure 32, Table 16). Increased in mean density of reef fish in Causeway and Mooring Dolphin may be attributed to the cryptic and diurnally active reef fish belong to the family Apogonidae (cardinalfishes) and herbivorous reef fish belong to family Pomacentridae (damselfishes) that settle in reef areas and fiercely defend defined areas of reef substratum. Furthermore, the increase in MA cover in these reef areas attracts herbivorous fish as key components in designing coral-algal dynamics in reef areas. It is also noteworthy to mention the presence of schools of nemipterids (coral breams) that frequently visit the area to feed and seek refuge from potential predators.

Table 16. Comparison of result from the previous studies in CBNC impact areas.

CBNC Impact Areas	Monitoring Period	Individuals per 1000m²	Source
Discharge Station	2020	3182	2020 (2H) Biodiversity Assessment
CBNC Causeway	2020	340	2020 (2H) Biodiversity Assessment
	2021	***1,444.0***	***This Study***
Moorning Dolphin	2020	687	2020 (2H) Biodiversity Assessment
	2021	***710***	***This Study***

Source of 2020 data: Haribon Environmental Services and the Palawan Community-Based Fisherfolk Alliance (2020)

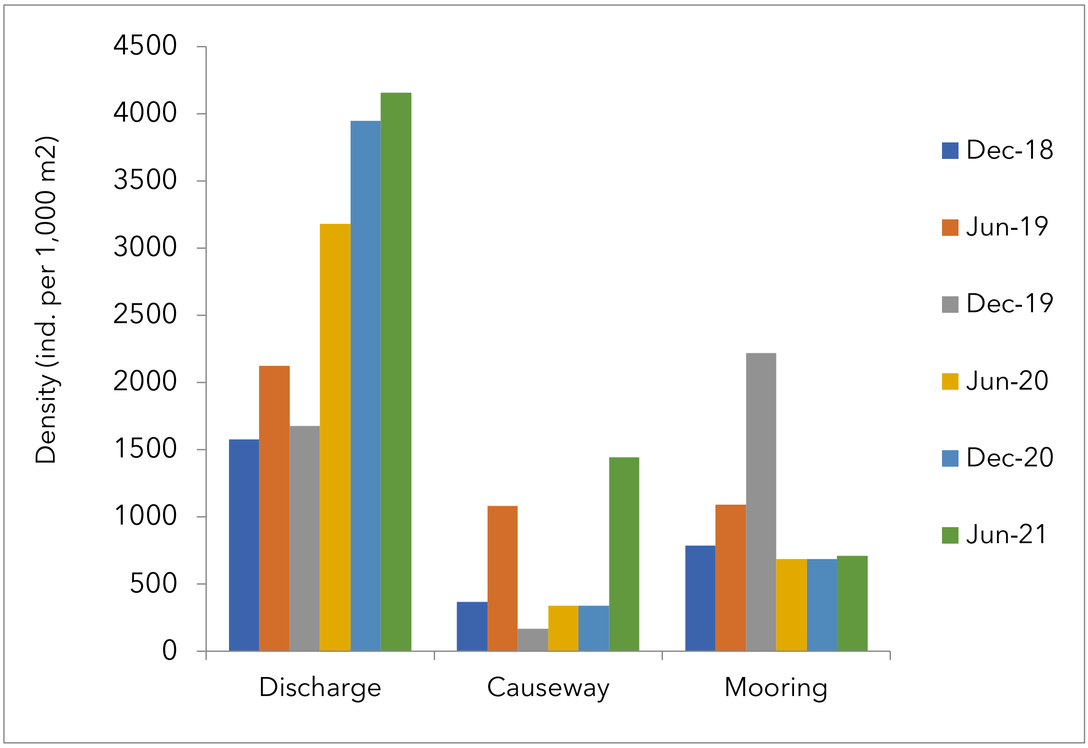


Figure 33. Density of reef fishes encountered in monitoring stations of CBNC in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan from 2018-2021 (June 2021).

Meanwhile, underwater structures in discharge stations mimics' role of artificial reffs providing hard surfaces where invertebrates such as corals, barnacles and other marine lifeforms attach. In addition, absence of fishing activity and favorable environmental conditions might significantly contribute in large aggregation of some fish species that seeks shelter, mating, and feeding ground from nearby reef areas.

3.5.3 Fish biomass

Results of reef fish communities survey revealed that mean biomass in all monitoring stations was estimated at 8.9 MT/km^2 as potential harvestable fish biomass. The estimated mean biomass of reef fishes falls under "low" level (0-10 MT/km^2) based on categories for ecological health conditions of reef fish suggested by Nañola et al. (2004). Monitored reefs in Ursula Island and Small Sandbar falls under "Moderate" category with more than 10.0 MT/km^2. Meanwhile, monitored reefs with "low" category includes Rio Tuba MPA (8.7 MT/km^2), Maranto Point (7.9 MT/km^2), Mooring Dolphin (6.9 MT/km^2), Causeway (6.6 MT/km^2) and Ameril Island (5.8 MT/km^2) (Table 17).

Table 17. Fish biomass (MT/km^2) in monitored reefs in Coral Bay, Rio Tuba, Bataraza, Palawan (June 2021).

Monitoring Stations	**Biomass** (MT/km^2)	**Category** (Naŋola et al. 2004)
Ameril Is.	5.8	Low
Causeway	6.6	Low
Maranto Point	7.9	Low
Mooring Dolphin	6.9	Low
Rio Tuba MPA	8.7	Low
Small Sandbar	10.6	Moderate
Ursula Island 1	13.0	Moderate
Ursula Island 2	12.1	Moderate
Total	**71.5**	
Average	**8.9**	**Low**

Monitored reefs in Coral Bay area composed mainly of fish species classified under Major category represented in group by the fish families belong to Pomacentridae (damselfishes), Labridae (wrasses), Pomacanthidae (angelfishes), Apogonidae (cardinalfishes) and Acanthuridae (surgeonfishes).

Potential harvestable fish biomass on the other hand, is composed primarily of fish species belong to the families Labridae sub-family Scarinae (parrotfishes), Caesionidae (fusiliers), Lutjanidae (snappers), Nemipteridae (coral breams) and Acanthuridae (surgeonfishes). Relatively high estimates of mean biomass of targeted fish species observed in Rio Tuba MPA is represented by the schools of large bodied parrot fishes and schools of fusiliers which frequently visit the reefs seeking to feed, refuge and protection from large predators.

Monitored reefs in Ursula Island, Small Sandbar and Causeway came in second in terms of mean biomass. Meanwhile, indicator group which is largely represented by the butterflyfishes (Chaetodontidae) and wrasses (Labridae) observed to be the lowest in abundance compare to the other groups (Figure 33, Table 18). These group of reef fish species have been used as indicator of reef health since they are highly associated with coral reefs; low abundance of indicator fish groups may presume that reef areas are in poor conditions.

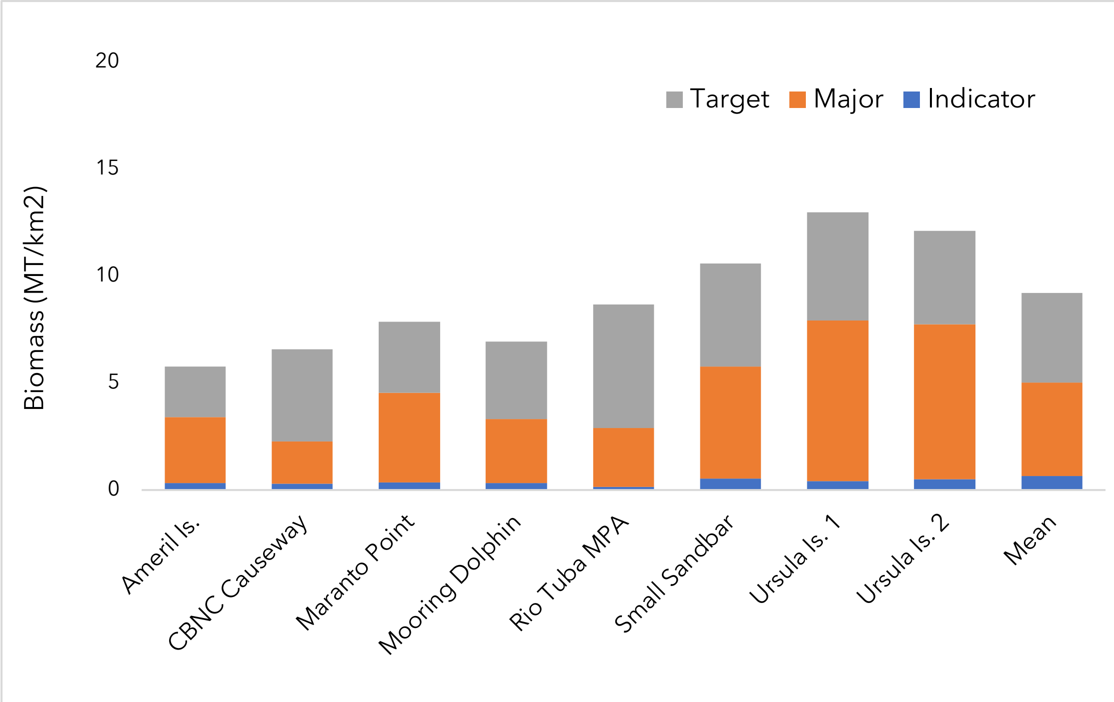


Figure 34. Biomass of target, major and indicator fish groups in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Table 18. Biomass of target, major and indicator fish groups in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Sites	Indicator	Major	Target	Total Biomass
Ameril Island	0.32	3.08	2.36	5.76
Causeway	0.31	1.95	4.33	6.59
Maranto Point	0.35	4.19	3.31	7.85
Mooring Dolphin	0.33	3.00	3.60	6.93
Rio Tuba MPA	0.16	2.75	5.77	8.67
Small Sandbar	0.55	5.23	4.81	10.60
Ursula Island 1	0.43	7.48	5.06	12.97
Ursula Island 2	0.50	7.25	4.37	12.12
Total	**2.94**	**34.95**	**33.61**	**71.50**
Average	**0.65**	**4.37**	**4.20**	**8.94**

Mean biomass for the target, major and indicator fish groups recorded in this study is relatively higher compared to the previous monitoring conducted in CBNC primary impact areas, except in Mooring Dolphin (Table 19) where significant decline in fish biomass is recorded (Haribon Environmental Services and the Palawan Community-Based Fisherfolk

Alliance 2020a, 2020b). Increase in fish biomass in most of the stations is largely attributed to the minimal fishing activity in the area, allowing the fish to recover quickly and grow to their optimal sizes to reproduce. Furthermore, substantial increased in biomass (MT/km^2) recorded in Small Sandbar may be attributed to the success of coral gardening in the area. Structural complexity of branching corals in coral platform may greatly influence functional richness, divergence and fish assemblages of reef fish in these parts of the reefs (Richardson et al., 2016).

Table 19. Comparison of biomass of target, major and indicator fish groups in monitoring stations in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan from 2020-2021.

Station	Monitoring Period	Target Biomass (MT km^{-2})	Major Biomass (MT km^{-2})	Indicator Biomass (MT km^{-2})	Average Biomass (MT km^{-2})
CBNC Causeway	2020*				2.13
	2021	***4.33***	***1.95***	***0.31***	***6.59***
Mooring Dolphin	2020				127.55
	2021	***3.60***	***3.00***	***0.33***	***6.93***
Small Sandbar	2020				5.53
	2021	***4.81***	***5.23***	***0.55***	***10.6***

Source of 2020 data: Haribon Environmental Services and the Palawan Community-Based Fisherfolk Alliance (2020)

3.5.4 Trophic Group

The trophic structure of reef fishes based on population densities is largely represented by herbivores (45%) and planktivores (32%) (Figure 34). Herbivore reef fishes exhibit wide range of feeding modes and ingest a variety of plant materials (e.g. macroalgae, epilithic algal turf, detrital materials and algal mats). Herbivores have various functional groups such as scrappers, excavators, grazers and browsers that promotes resiliency of the coral reef habitat (Green and Bellwood, 2009). Planktivores, however, usually appears in large groups feeding on macroplankton in mid-water this was largely represented by the reef fishes belong to families Pomacentridae, Caesionidae and Labridae. Benthic invertivores are reef fishes that feeds primarily in benthic invertebrates, which usually feed in groups scouring invertebrates hiding under coral rubbles and sandy substrates. This was largely represented by the reef fishes belonging to the families Labridae, Nemipteridae, Mullidae (goatfishes) and Chaetodontidae.

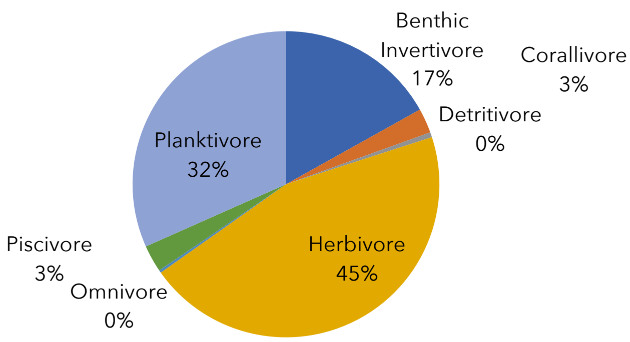


Figure 35. Trophic structure of reef fishes (based on population density) in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

Trophic structure of reef fish community in terms of biomass is largely represented by hervibores, followed by benthic invertivores and planktivores. Herbivores includes damselfishes (Pomacentridae), parrotfishes (Labridae sub-family Scarinae) and surgeonfishes (Acanthuridae) (Figure 35).

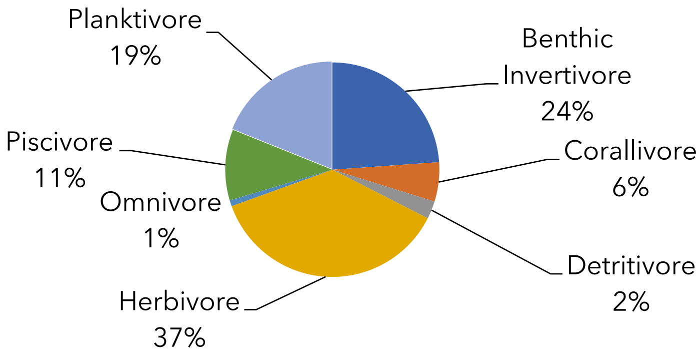


Figure 36. Trophic structure of reef fishes (based on biomass) in monitored reefs in Coral Bay, Bgy. Rio Tuba, Bataraza, Palawan (June 2021).

3.5.5 Primary Impact Areas

Discharge Point is considered as one of the primary impact areas in CBNC operations since this is where the effluent discharge from the processing plant is released. Thus, it is crucial to regularly conduct monitoring activities of fish populations and other marine organisms in the area as they can be a good indicator of the ecological status of the marine environment. Discharge Point is composed of three structures, two of which serves as mooring platform for docking, and the other one supports the pipeline where mixture of rainwater and neutralized tailings supernatant is being discharged.

Discharge Point harbors schools of large sized commercially important fish species belong to the families Carangidae, Monodactylidae, Caesionidae, Serranidae, Lutjanidae, Haemullidae, Scaridae, Acanthuridae and Siganidae. It is also worth mentioning that Mooring Dolphin and Causeway harbors almost similar fish species with Discharge Point, which substantiates connectivity among the three stations. Moreover, frequency of large sized and highly fecund individuals in large numbers increase chances of finding mate without considering risk of predations, highlighting its function as nursery and spawning areas and must be consider these areas for protection and conservation.

3.6 Freshwater Fishes

This study recorded only one species of fish catch which is similar to the fish catch reported during the first half survey of 2020 and lower to the number of fish recorded during the 2nd half of the survey in 2020 as shown in Table 20 (Haribon Environmental Services and the Palawan Community-Based Fisherfolk Alliance, 2020).

Similar with the previous monitoring, Nile tilapia dominated the fish caught in Lower Kinurong Siltation Pond. During this monitoring period, the number of tilapia individuals caught using gill net was higher than the previous monitoring periods. Ten samples were collected during the 1st half and seven were collected in the 2nd half of 2020, compared to 15 samples in this monitoring.

Table 20. List of fish species caught in Lower Kinurong Siltation Pond, CBNC, Bgy. Rio Tuba, Bataraza, Palawan (2020-2021).

Station	Methodology	*Scientific Name*	Local Name	No. of Samples	Weight (Kg)
Lower Kinurong (this study)	Bottom-set gillnet	*Oreochromis niloticus*	Tilapia	15 pcs	5.0
Lower Kinurong (2020 1st half)	Drift gillnet	*Oreochromis niloticus*	Tilapia	10 pcs	--
Lower Kinurong (2020 2nd half)	Drift gillnet	*O. niloticus*	Tilapia	7 pcs	--
		Megalops cyprinoides	Bulan Bulan	1 pcs	--
		Opicephalus striatus	Dalag	2 pcs	--

The CBNC reported that the siltation pond was drained before the conduct of field activity, thus affected the number of species in the pond. Moreover, anecdotal reports mentioned that changes in weather patterns and shift in tide level might be the reason in the variations in volume of fish catch as well as presence of other fish species in the pond. The variation in the number of species also depends on the moon phase, as more fishes appear during the new moon than other moon phases.

4. CONCLUSIONS AND RECOMMENDATIONS

Mangroves

Mangrove forest along the coast of Tagdalungon harbors a few numbers of species and stands and should be protected from foreseen degradation due to its proximity to human settlement. Coastal clean-up to include collection of trapped garbage within the mangrove forest should be initiated on regular basis. Information, and Education Campaign (IEC) on the ecological importance of mangroves should be continued and expanded in ter]ms of scope. Succeeding mangrove tree planting activities in the area should consider the most appropriate planting site, seedlings to be planted, and method of planting to attain a much higher survival rates of seedlings.

Seagrass

Based on the findings of this survey and the comparison made with the previous seagrass assessments conducted in the area, there was a decrease in seagrass species richness and cover particularly in Tagdalungon and species richness that can be attributed to the utilized method and location of the monitoring sites. This report, therefore, provided the GPS coordinate readings for all transect lines established in each sampling station. For the succeeding assessment, mapping of entire seagrass bed in all sampling stations is recommended. This will provide additional information on changes in seagrass cover over time, may it be due to human activities or environmental.

The information derived from estimating the seagrass canopy surface area covered with epiphytes would suggest that among the surveyed stations in the Coral Bay, the seagrass bed of Tagdalungon is more prone to degradation due to heavy siltation in the area. Siltation is an indicator of increased nutrient input to the sea, which subsequently promote the growth of epiphytes. This calls for an urgent management intervention. For one, Education, Information Campaign or IEC on proper waste disposal to protect the integrity of seagrass beds in the area should be intensified. Seagrass restoration options should be explored as early as possible. Such can be used as one of the mitigating measures to conserve seagrass diversity in the area.

Planktons

There are few differences in the species records from recent reports. Several species reported in 2020 was not recorded in this survey and vice versa. This can be attributed to the drying of Lower Kinurong Siltation Pond prior to the collection of samples. The results also suggest further monitoring to identify seasonality variations between plankters community. Moreover, water quality and environmental factors (e.g. climate related variables) to determine the potential effects of pollution and climate change to plankters community and productivity should likewise be monitored regularly.

Coral Reefs

This is the first time that coral genera composition in the monitored reefs were identified which showed that there is a high diversity of corals in Coral Bay. However, this high number of coral genera is at risk due to threats of sedimentation and climate change. Reefs that are "far" from mainland have higher HC cover than those "near" which can be caused by several factors, including sedimentation from nearby river tributaries. The high MA cover in some monitored reefs is quiet alarming since it is an indicative of low presence of roving herbivores and reduction in coral cover due to space competition of MA with coral colonies. The temporal reduction in HC cover in some monitored reefs should not be of high concern as of this moment since the decreasing trend can be attributed to the difference on methods used between monitoring methods. We recommend the consistent use of photo-quadrat method in the succeeding monitoring periods to ensure accurate data collection. Photos collected can also be used to visually determine the status of the reefs and if operations in CBNC impact areas really affects nearby reefs. The establishment of a 75 m x 25 m permanent monitoring station is recommended to which the monitoring activities should be conducted to determine the changes within the area.

Reef Fish Communities

This study shows that fish species observed within the Coral Bay are composed mainly of small sized fish population, and frequency of large-sized fish are "low". It should be noted, however, that the locations of the monitoring stations are within the shallow reefs' habitats and extensive back reef lagoon area, wherein small-sized fish species use as refuge/feeding site to maximize growth while minimizing the risk of predation, and as part of ontogenetic habitat shift as a function of food choices, size and development. These shallow reef habitats that mostly harbor small-sized reef fish, played crucial role in life stages of the fish as nursery ground and must be prioritized as areas for protection and conservation.

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APPENDICES

Appendix 1. The mangrove species in Tagdalungon, Bgy. Rio Tuba, Bataraza, Palawan.

Rhizophora mucronata

Rhizophora apiculata

Sonneratia alba

Bruguiera gymnorrhiza

Ceriops tagal

Recruits of mangrove saplings, resulted from tree planting initiatives of CBNC

Recruits of mangrove seedlings, resulted from tree planting initiatives of CBNC

Appendix 2. Coordinates of monitoring stations per component of Coral Bay Nickel Corporation, Bgy. Rio Tuba, Bataraza, Palawan, Philippines (June 2021).

Name	North (Lat)	East (Long)	Notes
1. Fish and Coral Reefs			
Riotuba MPA	08.47737	117.44054	
Maranto	08.49409	117.42923	Near Community
Small Sandbar	08.48710	117.44297	
Ameril Island	08.45089	117.43657	
Ursula Island 1	08.33554	117.51715	
Ursula Island 2	08.34646	117.52048	
Causeway	08.50117	117.45119	Along CBNC Tresle
Mooring Dolphin	08.49454	117.44635	Near CBNC Tresle
Discharge Point	08.49382	117.44706	Discharge point of CBNC Tresle
Lower Kinurong siltation pond	08.55460	117.41705	Freshwater fish
2. Seagrass Stations			
Rio Tuba MPA	8.47895	117.44061	
Small Sandbar	8.48951	117.44106	
Tagdalungon	8.50116	117.44394	
Ocayan River	8.51807	11746027	
Ursula Island	8.34320	117.51969	
3. Mangrove Stations - Tagdalungon			
Plot 1	8.50280	117.44596	
Plot 2	8.50264	117.44599	
Plot 3	8.50272	117.44699	
Plot 4	8.50329	117.44719	
4. Planktons			
Ocayan River	8.52618	117.46124	
Causeway	8.50114	117.45120	
Mooring Dolphin	8.49472	117.44648	
Lower Kinurong siltation pond	08.55460	117.41705	
Discharge Point	08.49382	117.44706	

Appendix 3. Comparative record of species of phytoplankton and zooplankton from this survey and the 2020 2nd quarter report in the area.

June 2021 Assessment (This report)	*CI 2020 (2nd quarter report)*
Phytoplankton	
--	*Bacillaria paradoxa*
--	*Bacillaria sp*
--	*Bacteria strumhyalinum*
--	*Biddulphiaceae B. Sinensis*
--	*Calanoides cf. carinatus*
Ceratium dens	*Ceratium dens*
Ceratium furca	--
Ceratium humile	--
Ceratium trichoceros	--
Ceratium tripos	--
Chaetoceros affinis	*Chaetoceros affinis*
Chaetoceros danicus	--
Chaetoceros decipiens	--
Chaetoceros peruvianus	--
Chaetoceros simplex	--
Chaetoceros sp.	--
--	*Chaetocerotaceae C. Didymus*
--	*Chaetocerotaceae C. Socialis*
--	*Closterium sp*
--	*Corethron sp.*
--	*C. Granii*
Coscinodiscus granii	--
Dinophysis caudata	--
Ditylum brightwellii	--
Euterpina sp.	--
--	*Cytotella eccentricus*
--	*Ditylum brightwelli*
--	*Epithemiaventricosan*
--	*Eucampia zodiacus*
Guinardia sp.	*Guinardia sp.*
Lauderia annulata	*Lauderiaceae L. Annulata*
Leptocylindricus sp.	--
--	*Leptocylindraceae L. Danicus*
--	--
--	*Melosira sp.*
--	*Microspora Naviculaceae*
--	*Microsporasp*
--	*N. Sigma*
--	*Naviculaceae N. Longa*
--	*Navicula sp.*
Odontella sinensis	*Odentella sinensis*
Odontella mobiliensis	--
Protoperidinium oceanicum	*Prorocentumsp*

June 2021 Assessment (This report)	*CI 2020 (2nd quarter report)*
Phytoplankton	
Pseudo-nitzschia sp.	*Protoperidinium sp.*
--	*Protoperidinium sp.*
--	*Pseudo-nitzchia Australis*
--	*Pseudo-nitzchia sp.*
--	*R. delicatula*
--	*Rhizosoleniaceae Probosciaalata*
Rhizosolenia crassispina	--
Rhizosolenia setigera	--
--	*T. Nitzchioides*
--	*Tabellaria sp.*
Thalassionema frauenfeldii	*Thalassionema frauenfeldii*
Thalassionema nitzschioides	--
Thalassionema sp.	*Thalassiosira sp.*
--	*Thalassiosira pacifica*
--	*Tripos karstenii*
--	*Volvox sp*
Zooplankton	
Acanthocyclops sp.	--
Acartia sp.	--
Cyclops spp.	--
Mesocyclops sp.	--
Tropocyclops sp.	--
--	*Keratella tropica*
--	*Calanoides sp.*
--	*Calanus sp.*
--	*Calocalanus pavo*
--	*Centropages brachiatus*
--	*Centropages sp.*
--	*Daphnia sp*
--	*Euterpinaacutifrons*
--	*Fritillaris sp*
--	*Oithonidae Dioithonarigida*
--	*Paracalanus parvus*
--	*Undinula vulgaris*

Appendix 4. Occurrence of coral genera encountered in monitored reefs in Coral Bay and Ursula Island, Bgy. Rio Tuba, Bataraza, Palawan, Philippines.
Note: Positive (+) sign means presence.

Family	Genus	Ameril Is.	Cause-way	Maranto	Mooring Dolphin	RT MPA	Small Sandbar	Ursula 1	Ursula 2
Acroporidae	*Acropora*	+	+	+	+	+	+	+	+
	Astreopora	+					+	+	+
	Isopora	+				+	+	+	
Agariciidae	*Coeloseris*						+		
Dendrophylliidae	*Turbinaria*		+	+				+	+
Diploastraeidae	*Diploastrea*			+	+	+	+	+	+
Euphylliidae	*Fimbriaphyllia*			+	+				+
	Galaxea	+			+	+	+	+	
Faviidae	*Favia*		+	+	+			+	
Fungiidae	*Ctenactis*	+	+	+	+	+		+	+
	Cycloseris				+				
	Fungia	+	+		+	+		+	
	Heliofungia			+					
	Herpolitha	+	+		+				
	Polyphyllia	+							
	Sandalolitha							+	
Helioporidae	*Heliopora*	+						+	
Lobophylliidae	*Acanthastrea*				+	+			
	Echinophyllia	+							
	Lobophyllia				+				
	Oxypora				+				
	Symphyllia	+	+	+	+			+	
Merulinidae	*Caulastraea*		+		+				
	Echinopora						+		
	Favites		+		+	+	+	+	
	Goniastrea	+	+				+	+	
	Merulina				+		+	+	
	Mycedium				+	+	+	+	
	Oulophyllia							+	+
	Pectinia		+	+	+			+	
	Platygyra	+				+			
Milleporidae	*Millepora*								+
Montastraeidae	*Montastrea*	+					+	+	
Plerogyridae	*Plerogyra*			+	+		+	+	

Family	Genus	Ameril Is.	Cause-way	Maranto	Mooring Dolphin	RT MPA	Small Sandbar	Ursula 1	Ursula 2
Pocilloporidae	*Pocillopora*	+		+		+		+	+
	Seriatopora	+	+	+		+	+	+	
Poritidae	*Goniopora*	+		+	+	+		+	+
	Porites	+	+	+		+	+	+	+
Scleractinia incertae sedis	*Pachyseris*		+	+	+			+	
	Total	**17**	**13**	**14**	**20**	**13**	**14**	**24**	**10**

Appendix 5. Percentage (%) of substrate cover of surveyed reefs in Coral Bay and Ursula Island, Bgy. Rio Tuba, Bataraza, Palawan, Philippines (June 2021).

Stations	Hard Coral (HC)	Sponge (SP)	DeadCoral (DC)	Rubble (RB)	Sand (SD)	Silt (SI)	Soft Corals (SC)	Macroalgae (MA)	Others (OT)
Ameril Is.	47.63	0.13	10.75	21.00	8.88	-	0.13	10.60	0.88
Causeway	36.16	-	-	5.14	-	0.50	-	54.00	3.36
Maranto Pt.	31.57	2.00	2.29	0.64	4.52	3.29	-	55.49	-
Mooring Dolphin	7.50	1.63	0.13	0.63	11.23	2.75	0.63	75.00	0.50
Rio Tuba MPA	30.88	0.25	2.63	4.38	4.50	0.38	1.13	55.35	-
Small sandbar	42.33	0.85	3.01	3.00	5.01	-	1.00	44.42	0.38
Ursula Is. 1	26.13	0.13	0.38	1.13	2.50	-	-	69.13	-
Ursula Is. 2	51.50	-	-	5.38	10.50	-	0.88	30.74	1.00
Average	**34.21**	**0.62**	**2.74**	**5.16**	**5.89**	**0.87**	**0.47**	**49.34**	**0.77**

Appendix 6.Percentage (%) of subcategories of hard coral (HC) cover in surveyed reefs in Coral Bay and Ursula Island, Bgy. Rio Tuba, Bataraza, Palawan, Philippines (June 2021).

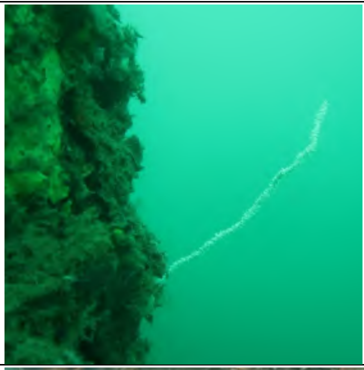
Hard coral subcategories	Ameril	Cause-way	Maranto	Mooring Dolphin	RT MPA	Small Sandbar	Ursula Is. 1	Ursula Is. 2
ACB	-	-	0.13	-	5.75	4.65	12.25	-
ACD	-	-	-	-	-	-	1.25	-
ACS	-	-	-	0.13	-	0.13	0.13	-
ACT	0.25	-	1.22	-	0.13	0.38	0.63	-
CHL	-	-	0.13	-	-	-	-	0.13
CME	-	0.38	0.13	-	-	-	-	-
CMR	-	0.13	1.66	0.75	2.13	-	0.13	-
CB	20.50	0.88	7.92	0.50	16.63	28.53	2.25	9.75
CE	24.50	3.90	3.50	1.75	0.38	1.00	1.38	38.75
CF	0.63	1.13	4.50	0.25	0.50	-	-	-
CM	1.38	29.73	10.51	4.00	5.25	6.63	7.63	2.75
CS	0.38	0.13	1.87	0.13	0.13	1.13	0.50	0.13
Total	**47.64**	**36.28**	**31.57**	**7.51**	**30.9**	**42.45**	**26.15**	**51.51**

Appendix 7. Listing of substrates at CBNC Discharge Point, Bgy. Rio Tuba, Bataraza, Palawan, Philippines (June 2021).

Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	

Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Melithaeidea Genus *Melithae* sp.	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Genus	

Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Genus	
Phylum Cnidaria Class Anthozoa Sub-class Octocorallia (Octocorals) Order Alcyonacea (Soft corals/Gorgonians) Family Genus	
Phylum Chordata Class Ascidiacea Order Enterogona (Tunicates) Family Cionidae Genus *Ciona* sp.	
Phylum Chordata Class Ascidiacea Order Stolidobranchia Family Styelidae Genus *Polycarpa* sp. (Gold mouth sea squirt)	

Phylum Porifera Class Anthozoa Order Antipatharia/ Black or thorny corals Family Antipathidae Genus *Stichopathes* sp. (Whip corals)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Clionaidae Genus Cliona sp (Coral encrusting sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Cliona sp. (Coral encrusting sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus	

Phylum Porifera (Sponges) Class Demospongia Order Haplosclerida Family Chalinidae Genus Haliclona sp.	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus	
Phylum Porifera (Sponges) Class Demospongiae Order Family Chalinidae Genus Chalinula sp.	
Phylum Porifera (Sponges) Class Demospongiae Order Haplosclerida Family Genus Callyspongia sp.	
Phylum Porifera (Sponges) Class Demospongiae Order Haplosclerida Family Genus Callyspongia sp.	

Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Phyllospongia sp. (Fan sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Cliona sp. (Coral encrusting sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Cliona sp. (Coral encrusting sponge)	
Phylum Porifera Class Demospongiae Order Poecilosclerida Family Microcionidae Genus *Clathria* sp. (Orange-veined encrusting sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus	

Phylum Porifera (Sponges) Class Demospongiae Order Haplosclerida Family Genus Callyspongia sp.	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Cliona sp. (Coral encrusting sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Cliona sp. (Coral encrusting sponge)	
Phylum Porifera (Sponges) Class Demospongiae Order Family Genus Cliona sp. (Coral encrusting sponge)	

There are 4 different classes of sponges; Calcarea (calcareous- has spicules*), Hexactinellida (horn sponges), Demospongiae (coralline), and Sclerospongiae (glass sponges).

Appendix 8. Categories for evaluating ecological health of coral reef fish communities according to Hilomen et al.(2000)) and Nañola et al. (2004).

Parameter	**Measure**	**Category**
Species Richness	Number of species per 1,000 m^2)	
	<26	Very poor
	27-47	Poor
	48-74	Moderate
	75-100	High
	>100	Very High
Abundance	Number of fish per 1,000 m^2)	
	< 201 fish	Very Poor
	202-676	Low
	677-2267	Moderate
	2268-7592	High
	> 7592	Very High
Biomass	mt/km^2	
	0-10	Very Low to Low
	11-20	Moderate
	21-40	High
	>40	Very High

Appendix 9. Occurrence of reef fishes in surveyed impact areas of CBNC operations, Bataraza, Palawan, Philippines (June 2021).

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Acanthuridae	*Acanthurus auranticavus*					1				
Acanthuridae	*Acanthurus japonicus*								1	
Acanthuridae	*Acanthurus nigrofuscus*							1		
Acanthuridae	*Acanthurus thompsoni*				1					1
Acanthuridae	*Ctenochaetus binotatus*	1	1					1	1	
Acanthuridae	*Ctenochaetus striatus*								1	
Acanthuridae	*Naso lituratus*								1	
Acanthuridae	*Zebrasoma scopas*							1	1	
Apogonidae	*Apogon chrysopomus*		1							
Apogonidae	*Apogon sealei*		1	1			1			
Apogonidae	*Apogon trimaculatus*						1			
Apogonidae	*Archamia zosterophora*						1			
Apogonidae	*Cheilodipterus macrodon*		1							
Apogonidae	*Cheilodipterusquinquelineatus*	1	1	1			1	1		
Apogonidae	*Ostorhinchus compressus*			1			1			
Apogonidae	*Sphaeramia nematoptera*			1						
Aulostomidae	*Aulostomus chinensis*							1	1	
Balistidae	*Odonus niger*									1
Balistidae	*Sufflamen bursa*	1							1	
Bleniidae	*Meiacanthus grammistes*	1								
Bleniidae	*Plagiotremus rhinorhynchos*	1								
Caesionidae	*Caesio caerulaureus*									1

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Caesionidae	*Caesio teres*	1	1	1		1	1		1	1
Caesionidae	*Pterocaesio tile*								1	
Carangidae	*Atule mate*									1
Carangidae	*Caranx melampygus*					1				1
Centriscidae	*Aeoliscus strigatus*			1			1			
Chaetodontidae	*Chaetodon adiergastos*		1							
Chaetodontidae	*Chaetodon auriga*						1	1		
Chaetodontidae	*Chaetodon baronessa*						1	1		
Chaetodontidae	*Chaetodon kleinii*								1	
Chaetodontidae	*Chaetodon lineolatus*	1						1	1	
Chaetodontidae	*Chaetodon lunulatus*			1						
Chaetodontidae	*Chaetodon melannotus*						1			
Chaetodontidae	*Chaetodon octofasciatus*	1	1	1	1	1	1			
Chaetodontidae	*Chaetodon vagabundus*			1			1			
Chaetodontidae	*Chelmon rostratus*	1	1	1	1	1	1			
Chaetodontidae	*Heniochus pleurotaenia*			1			1		1	
Chaetodontidae	*Heniochus singularis*		1	1						
Chaetodontidae	*Heniochus varius*	1		1				1	1	
Ephippidae	*Platax teira*			1	1	1				1
Gerreidae	*Gerres argyreus*		1							
Gobiidae	*Amblygobius hectori*				1					
Gobiidae	*Ptereleotris evides*								1	
Haemulidae	*Plectorhinchus chaetodonoides*	1	1			1	1			1
Haemulidae	*Plectorhinchus lessonii*						1			

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Haemulidae	*Plectorhinchus lineatus*					1				
Holocentridae	*Myripristis chryseres*								1	
Holocentridae	*Myripristis murdjan*								1	
Holocentridae	*Sargocentron rubrum*					1				
Kyphosidae	*Kyphosus cinerascens*				1					
Labridae	*Bodianus mesothorax*					1			1	
Labridae	*Cetoscarus bicolor*					1	1			
Labridae	*Cheilinus chlorourus*	1	1		1	1	1		1	
Labridae	*Cheilinus fasciatus*	1		1	1	1	1		1	
Labridae	*Cheilinus undulatus*							1		
Labridae	*Chlorurus bleekeri*					1	1	1	1	
Labridae	*Chlorurus microrhinos*						1			
Labridae	*Chlorurus sordidus*	1				1	1	1	1	
Labridae	*Choerodon anchorago*		1				1			
Labridae	*Cirrhilabrus cyanopleura*	1					1	1	1	
Labridae	*Coris batuensis*	1								
Labridae	*Diagramma melanacrum*				1					
Labridae	*Diagramma pictum*				1					1
Labridae	*Diproctacanthus xanthurus*		1	1		1	1	1	1	
Labridae	*Epibulus brevis*	1			1		1	1	1	
Labridae	*Epibulus insidiator*						1			
Labridae	*Halichoeres chloropterus*	1		1			1			
Labridae	*Halichoeres hartzfeldii*		1							
Labridae	*Halichoeres hortulanus*							1	1	

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Labridae	*Halichoeres leucurus*			1	1		1			
Labridae	*Halichoeres melanurus*	1		1	1	1	1	1	1	
Labridae	*Halichoeres prosopeion*	1								
Labridae	*Hemigymnus melapterus*						1			
Labridae	*Hologymnosus doliatus*							1	1	
Labridae	*Labrichthys unilineatus*							1	1	
Labridae	*Labroides bicolor*					1		1		
Labridae	*Labroides dimidiatus*	1	1	1	1	1	1	1	1	1
Labridae	*Labropsis manabei*		1					1	1	
Labridae	*Macropharyngodon meleagris*							1	1	
Labridae	*Oxycheilinus digramma*				1		1	1		
Labridae	*Oxycheilinus rhodochrous*	1				1				
Labridae	*Oxycheilinus unifasciatus*		1				1			
Labridae	*Pseudocheilinus hexataenia*	1		1		1			1	
Labridae	*Scarus dimidiatus*					1	1	1	1	
Labridae	*Scarus flavipectoralis*		1					1		
Labridae	*Scarus forsteni*							1		
Labridae	*Scarus ghobban*				1					1
Labridae	*Scarus hypselopterus*			1			1	1	1	
Labridae	*Scarus* sp.	1	1	1		1	1		1	
Labridae	*Stethojulis bandanensis*	1	1		1		1			
Labridae	*Thalassoma hardwicke*							1	1	
Labridae	*Thalassoma lunare*		1	1	1	1	1	1	1	1
Labridae	*Wetmorella albofasciata*			1						

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Lethrinidae	*Gnathodentex aureolineatus*					1				
Lethrinidae	*Monotaxis grandoculis*					1			1	
Lutjanidae	*Lutjanus argentimaculatus*		1	1	1					1
Lutjanidae	*Lutjanus biguttatus*		1							
Lutjanidae	*Lutjanus carponotatus*			1	1	1				
Lutjanidae	*Lutjanus decussatus*			1	1		1	1		1
Lutjanidae	*Lutjanus ehrenbergii*		1	1						
Lutjanidae	*Lutjanus lutjanus*	1								1
Lutjanidae	*Lutjanus quinquelineatus*				1					
Monodactylidae	*Monodactylus argenteus*		1							1
Mullidae	*Parupeneus barberinus*			1	1				1	
Mullidae	*Parupeneus bifasciatus*					1	1	1	1	
Mullidae	*Parupeneus cyclostomus*							1	1	
Mullidae	*Parupeneus multifasciatus*	1				1	1	1		
Mullidae	*Upeneus tragula*		1							
Nemipteridae	*Pentapodus bifasciatus*				1	1			1	
Nemipteridae	*Pentapodus caninus*				1					
Nemipteridae	*Scolopsis bilineata*							1	1	
Nemipteridae	*Scolopsis ciliatus*		1		1					
Nemipteridae	*Scolopsis margaritifer*	1	1	1	1		1	1	1	
Pinguipididae	*Parapercis cylindrica*								1	
Pinguipididae	*Parapercis hexophthalma*							1		
Plotosidae	*Plotosus lineatus*			1	1					
Pomacanthidae	*Centropyge vrolikii*							1	1	

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Pomacanthidae	*Chaetodontoplus mesoleucus*	1		1	1	1	1	1		
Pomacanthidae	*Pomacanthus sexstriatus*			1						1
Pomacentridae	*Abudefduf bengalensis*		1							
Pomacentridae	*Abudefduf sexfasciatus*		1							
Pomacentridae	*Abudefduf sordidus*		1							
Pomacentridae	*Abudefduf vaigiensis*			1		1			1	1
Pomacentridae	*Acanthochromis polyacanthus*	1		1	1	1	1	1	1	1
Pomacentridae	*Amblyglyphidodon curacao*	1		1	1	1	1	1	1	
Pomacentridae	*Amblyglyphidodon leucogaster*								1	
Pomacentridae	*Amphiprion sandaracinos*					1				
Pomacentridae	*Chromis amboinensis*								1	
Pomacentridae	*Chromis atripectoralis*			1				1		
Pomacentridae	*Chromis margaritifer*							1	1	
Pomacentridae	*Chromis* sp.			1	1			1	1	
Pomacentridae	*Chromis ternatensis*	1		1			1			
Pomacentridae	*Chromis viridis*			1			1	1	1	
Pomacentridae	*Chromis weberi*			1				1		
Pomacentridae	*Chrysiptera hemicyanea*	1	1				1			
Pomacentridae	*Chrysiptera oxycephala*					1				
Pomacentridae	*Chrysiptera parasema*	1		1		1	1			
Pomacentridae	*Chrysiptera rex*		1		1			1	1	
Pomacentridae	*Chrysiptera rollandi*	1					1	1	1	
Pomacentridae	*Chrysiptera springeri*	1		1			1			
Pomacentridae	*Chrysiptera talboti*	1						1	1	

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Pomacentridae	*Dascyllus aruanus*					1				
Pomacentridae	*Dascyllus trimaculatus*					1		1	1	
Pomacentridae	*Dischistodus melanotus*	1	1	1	1	1	1		1	
Pomacentridae	*Dischistodus perspicillatus*					1				
Pomacentridae	*Dischistodus prosopotaenia*	1		1	1	1	1			
Pomacentridae	*Neoglyphidodon melas*			1		1	1			
Pomacentridae	*Neoglyphidodon nigroris*	1	1	1	1	1	1	1	1	
Pomacentridae	*Neoglyphidodon oxyodon*		1	1	1	1				
Pomacentridae	*Neopomacentrus nemurus*							1		1
Pomacentridae	*Neopomacentrus taeniurus*		1							
Pomacentridae	*Plectroglyphidodon lacrymatus*	1					1	1	1	
Pomacentridae	*Pomacentrus adelus*	1	1	1	1	1	1	1		
Pomacentridae	*Pomacentrus alexanderae*	1			1	1	1	1		1
Pomacentridae	*Pomacentrus amboinensis*	1						1		
Pomacentridae	*Pomacentrus auriventris*	1								
Pomacentridae	*Pomacentrus bankanensis*								1	
Pomacentridae	*Pomacentrus brachialis*	1				1	1	1		
Pomacentridae	*Pomacentrus burroughi*	1	1	1	1	1	1			
Pomacentridae	*Pomacentrus chrysurus*	1	1							
Pomacentridae	*Pomacentrus lepidogenys*	1					1	1		
Pomacentridae	*Pomacentrus moluccensis*	1				1	1	1		
Pomacentridae	*Pomacentrus philippinus*	1					1	1		
Pomacentridae	*Pomacentrus stigma*	1				1	1			1
Pomacentridae	*Pomacentrus tripunctatus*		1							

Family Name	Scientific Name	Ameril Island	CBNC Causeway	Maranto Point	Mooring Dolphin	Rio Tuba MPA	Small Sandbar	Ursula Island 1	Ursula Island 2	Discharge Point
Pomacentridae	*Pomacentrus vaiuli*		1		1			1		
Pseudochromidae	*Labracinus cyclophthalmus*	1							1	
Serranidae	*Cephalopholis argus*			1		1				
Serranidae	*Cephalopholis boenak*					1				1
Serranidae	*Cephalopholis microprion*	1	1	1	1	1	1		1	1
Serranidae	*Epinephelus fasciatus*							1		
Serranidae	*Epinephelus merra*							1	1	
Serranidae	*Epinephelus ongus*	1						1	1	
Serranidae	*Epinephelus quoyanus*							1	1	
Serranidae	*Epinephelus sexfasciatus*		1							
Serranidae	*Plectropomus leopardus*								1	
Serranidae	*Plectropomus oligacanthus*		1							
Serranidae	*Pseudanthias huchtii*							1	1	
Siganidae	*Siganus guttatus*					1				
Siganidae	*Siganus puellus*					1				
Siganidae	*Siganus vermiculatus*									1
Siganidae	*Siganus virgatus*							1	1	
Siganidae	*Siganus vulpinus*	1		1		1				
Synodontidae	*Saurida gracilis*	1					1			
Tetraodontidae	*Arothron nigropunctatus*								1	
Tetraodontidae	*Canthigaster papua*	1	1					1	1	
Zanclidae	*Zanclus cornutus*			1	1	1	1	1	1	1
	Total	**58**	**48**	**55**	**43**	**58**	**68**	**69**	**73**	**26**

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