Republic of the Philippines
Department of Environment and Natural Resources
MIMAROPA Region 644

OUTGOING
Received by:
Date: JUN 07 2023

06 June 2023

MEMORANDUM

FOR : **The Regional Executive Director**
1515 DENR by the Bay Building, Roxas Blvd
Brgy. 668, Ermita, Manila

FROM : **The OIC, PENR Officer**
PENRO-Romblon

SUBJECT : **FOLLOW-UP ON ACTIONS TAKEN BY THE MGB, EMB AND THE DENR AS TO THE JOINT ORDER DATED 06 FEBRUARY 2023**

This pertains to the report and/or update on compliance to an order as regards Items No. 5 and 6 of the Joint Order dated February 06, 2023 issued by your office, the Mines and Geosciences Bureau-MIMAROPA Region and the Environmental Management Bureau-MIMAROPA Region, respectively, concerning the illegal construction of causeway and other relative activities of ALTAI Philippine Mining Corporation (APMC) in Sitio Bato, Barangay España, San Fernando, Romblon, *to wit*:

"5. PENRO Romblon to FILE appropriate legal actions, if warranted, on the reported cutting of trees without permit, and

6. "PENRO Romblon to conduct investigation on the alleged damage/destruction of sea grass and marine resources."

We would like to respectfully inform your good office that a criminal complaint for violating Section 77 of Presidential Decree No. 705 also known as the "Revised Forestry Code of the Philippines" has already been filed against APMC before the Office of the Provincial Prosecutor in Romblon, Romblon on 24 May 2023. Attached are the Investigation Data Form and the Complaint-Affidavit marked as Annex "**A**" to "**B**", respectively.

Moreover, please be informed that the PENRO-Romblon Inspectorate Team (the team for brevity) has made a rapid assessment of corals/sea grass in the above-stated address on February 7, 2023 in order to assess the possible damages surrounding the causeway constructed by APMC. Findings of the investigation revealed that sand, rocks, and rocks with algae were the only visible on site. Thus, the team requested for assistance of expert divers to conduct a thorough and further investigation.

Subsequently, the team together with the Ecosystems Research and Development Bureau personnel conducted a thorough investigation in the aforesaid site on May 17-19, 2023. The result of the investigation and assessment was submitted by ERDB through memorandum dated June 5, 2023. (Annex **"C"**).

For your information, reference and further instruction, please.

"For and in the absence of OIC PENRO"

MALVIN R. ROCERO
Chief, TSD

Copy furnished:

Regional Director
EMB IV-B MIMAROPA

Regional Director
MGB IV-B MIMAROPA

DENR-Romblon
Odiongan, Romblon
Tel # 567-2199
Email Address: penroromblon@denr.gov.ph

ANNEX A

NPS Investigation Form No. 01, s. 2008

Republic of the Philippines
Department of Justice
National Prosecution Service

INVESTIGATION DATA FORM

To be accomplished by the Office

DATE RECEIVED:

(stamped and initiate) :
Time Received :
Receiving Staff :

OFFICE OF THE PROVINCIAL PROSECUTOR PROVINCE OF ROMBLON RECEIVED BY: DATE: MAY 2 4 2023 TIME:

NPS DOCKET NO. NPS-IV-10B-INV 23E-031

Assigned to :
Date Assigned:

To be accomplished by complainant/counsel/law enforcer
(Use back portion if space is not sufficient)

COMPLAINANT/S: Name, Sex, Age & Address

DENR Represented by: Arnoldo A. Blaza Jr. et al; Male,61 yrs. old, Tabing-Dagat, Odiongan, Romblon

RESPONDENT/S: Name, Sex, Age & Address

ALTAI PHILIPPINES MINING CORPORATION Represented by its President Hanniel T. Ngo 1901 Tycoon Center, Pearl Drive, San Antonio, Ortigas Center, Pasig City

LAW/VIOLATED:

Sec. 77 of P.D. 705 as amended by RA 7161

WITNESS/ES: Name & Address

Rolando Y. Galicia, Tampayan, Magdiwang, Romblon
Ludwin M. Ruado, Tampayan, Magdiwang, Romblon
James M. Mendoza, Odiongan, Romblon

DATE & TIME OF COMMISSION:
January 18, 2023 to March 15, 2023

PLACE OF COMMISSION:
Sitio Bato, Brgy. España, San Fernando, Romblon

1. Has a similar complaint been filed before any other office?* YES__ NO__ If yes, indicate details below
2. Is this complaint in the nature of a counter-affidavit?* YES__ NO__ If yes, indicate details below
3. Is this complaint related to another case before this office?* YES__ NO__ If yes, indicate details below

I.S No. :
Handling Prosecutor:

CERTIFICATION*

I CERTIFY, under oath, that all the information on this sheet are true and correct to the best of my knowledge and belief, that I have not commenced any action or filed any claim involving the same issues I any court, tribunal, or quasi judicial agency, and that if I should thereafter learn that a similar action has been filed and/or is pending, I shall report that fact to this Honorable Office within five (5) days from knowledge thereof.

MALVIN R. ROCERO ARNOLDO A. BLAZA JR.
(Signature over printed name)
Complainant

SUBSCRIBED AND SWORN TO before me this _____ day of MAY 2 4 2023, 2023.
In ________.

NERISSA G. GUIRAO
Prosecutor II
OIC - Provincial Prosecutor
As per Department Order No. 217, dated April 17, 2023
Prosecutor Administering Oath

*1,2,3 and Certification need not be accomplished for inquest cases.

ANNEX A-2

WITNESS/ES: Name & Address

Sheilla Jane M. Forlales, Odiongan, Romblon
Ernie L. Forcadas, Tampayan, Magdiwang, Romblon
Marielle V. Magallanes, Odiongan, Romblon
Ramer F. Manalon, Tampayan, Magdiwang, Romblon
Henry L. Carbonilla II, Tampayan, Magdiwang, Romblon
Rolly F. Morales, Tampayan, Magdiwang, Romblon

ANNEX B

FEB. 07 2023

PENRO Special Order
No. 23-20
Series of 2023

SUBJECT : RAPID ASSESSMENT OF POSSIBLE DAMAGES OF CORALS/SEA GRASS IN THE VICINITY OF THE DOCKING PORT BUILT BY ALTAI PHILIPPINES MINING CORPORATION (APMC) AT SITIO BATO, BRGY. ESPAÑA, SAN FERNANDO, ROMBLON

In the interest of the service and to facilitate the assessment of possible damages incurred during the construction of the docking port by APMC pursuant to Joint Order signed by DENR MIMAROPA Regional Executive Director Lormelyn E. Claudio, Regional Director of Mines and Geosciences Bureau Engr, Glenn Marcelo C. Noble, and Regional Director of Environmental Management Bureau Joe Amil M. Salino dated February 6, 2023, hereunder is the composition of the assessment team:

Team Lead	-	Forester II James Mendoza
V. Team Lead	-	Forester II Sheilla Jane M. Forlales
Member	-	Forester I Rolly Morales
Member	-	Forest Technician I Ernie Forcadas

The team shall conduct investigation/assessment on the potentially damaged sea grass and other marine resources in the vicinity of the docking port constructed by APMC. Further, the team will submit report with categorical recommendation/s within twenty four (24) hours.

This order shall take effect immediately.

Approved by:

FOR. ARNOLDO A. BLAZA, JR.
OIC, PENR Officer

ANNEX C

Department of Environment and Natural Resources
Ecosystems Research and Development Bureau

June 5, 2023

MEMORANDUM

FOR	:	The Regional Executive Director DENR-MIMAROPA
ATTN.	:	The Assistant Regional Director Technical Services, DENR-MIMAROPA
FROM	:	The Director
SUBJECT	:	**TECHNICAL REPORT FOR THE COASTAL RESOURCES ASSESSMENT (CRA) AT THE CAUSEWAY PROJECT AND NEARBY REEF SITES IN SIBUYAN ISLAND, ROMBLON**

Anent the above subject, we are providing your good office the e-copy of the CRA technical report as a response to the request for technical assistance concerning the assessment of seagrasses and other marine resources allegedly affected by the causeway project in San Fernando, Sibuyan Island, Romblon. For queries and/or clarifications about the report, please contact our research center in Cebu through the Center Head at 09178806538, or email at joseisidromichael.padin@erdb.denr.gov.ph or crerdec@erdb.denr.gov.ph.

FOR INFORMATION AND RECORDS.

MARIA LOURDES G. FERRER, *CESO III*

ASSESSMENT REPORT

May 2023

Benthic Lifeforms, Marine Macrophytes, and Associated Fauna Adjacent to the Altai Mining Causeway in San Fernando, Sibuyan, Romblon

Ecosystems Research and Development Bureau (ERDB)
Coastal Resources and Ecotourism Research, Development and Extension Center (CRERDEC)
Greenplains Subdivision, Banilad, Mandaue City, Cebu | Telephone No. (063-32) 346-2209
E-mail Address: crerdec@erdb.denr.gov.ph

Table of Contents

List of Tables

List of Figures

Benthic Lifeforms, Marine Macrophytes, and Associated Fauna Adjacent to the Altai Mining Causeway in San Fernando, Sibuyan, Romblon

Executive Summary

Rapid assessment of benthic lifeforms, seagrass and macro-algae (marine macrophytes), and associated fauna (fish and macro-invertebrates) at the causeway project site and nearby areas in Sibuyan, Romblon with the PENRO Romblon technical staff from 16-19 May 2023. The purpose of the assessment was to determine if there are marine habitats directly impacted by the construction of the causeway by looking at the underwater physical profile, habitat conditions, and other discernable indicators proximate to the said structure.

The rapid assessment was carried out at the causeway projects site and adjacent areas in Barangay España, San Fernando in Sibuyan, Romblon. The causeway site is located at Sitio Bato. Based on the NAMRIA 2020 Coastal Resources Map (CRM), the coral reefs can be found 6.99 km southeast and 10-15 km northwest of the causeway site. In terms of marine plants and coastal vegetation, the seagrass or algal beds occurred 17.97 km northwest of the causeway, while the nearest mangroves were less than a kilometer southeast of the causeway. After the reconnaissance survey and review of the aerial photos compiled by PENRO Romblon, reef formations were observed proximate to the causeway. Five reef sites were marked, but only four were assessed, which represent two relatively contiguous reefs (RS1 and RS4) and two patch reefs (RS2 and RS3). RS1 and RS2 are situated in Sitio Bato, while the other stations (RS3 and RS4) are within Sitio Taclobo. The benthic lifeforms at the reef sites were assessed using the photo-quadrat method. The same transect was used to assess the associated fish assemblages following the underwater fish visual census (FVC) technique. Fish species observed within 2.5 meters on both sides and above the transect were identified and counted. For marine macrophytes (seagrass and macro-algae), three sites were identified for the quantitative assessment of seagrass and associated macroalgae proximate to the causeway project Seagrass and macroalgae assessment was done following the transect-quadrat method. Species richness and substrate cover were determined.

The boulders surrounding the causeway were devoid of coral colonies, but biofouling by barnacles was visible on the boulder surfaces. No reef formations were found a few meters from the sides and the seaward tip of the causeway. Sandy to rocky substrate separated the nearby patch reef formation (RS1) and the causeway. Turf algae with fine sediments were common on the surfaces of causeway rocks and boulders. The causeway boulders offered new habitats for fish species and macro-invertebrates, including sea urchin *Astropyga radiata*, sea slug *Chelidonura varians*, and crown-of-thorns *Acanthaster planci*. Nineteen species belonging to 12 families were recorded at the site. Eight of these are considered "target" species or those favored by fishermen due to their high market value. The target

species were represented by 36 individuals, followed by indicator species with 18 individuals. Indicator species are usually taxa under Chaetodontidae, which are known to be highly associated with the presence of live corals (Valavi et al. 2010). Nearly 200 individuals of juvenile coral reef catfish *Plotosus lineatus* were also recorded, contributing 70% to the total fish abundance. The occurrence of reef-associated fish species suggests the presence of coral reefs adjacent to the causeway. The movement of these species from the natural reefs to the causeway structures could be driven by the availability of habitat space or refuge and source of food. The temporal (if not gradual) increase in the population of small fish species at the artificial habitat may trigger the movement of larger species and top predators, thereby improving the fish biomass and diversity at the site over time if no fishing is imposed. On the contrary, the migration or immigration of fish assemblages to the artificial habitat may depopulate the natural reefs.

The reef sites were characterized by mostly encrusting, submassive, massive, and branching corals. The highest hard coral cover (HCC) was observed in RS3 (13%), followed by RS4 (11.3%). The patch reef in RS3 was dominated by *Sargassum* spp. (70.8%) as well as in RS2 (71.9%). Turf algae were common in RS4 (70.8%) and RS3 (81.5%). Several marine invertebrates were also observed such as species of sponges and crown-of-thorns seastar (*Acanthaster planci*) (0.4%). Both RS3 (81.5%) and RS1 (52.3%) were dominated by turf algae. The abiotic factor such as the presence of rubbles and rocks was also observed in all sampling sites, which are potential substrate for settlement for coral planulae and recruits to grow. The presence of herbivorous species of invertebrates such as the sea urchins *Salmacis sphaeroides*, *Diadema* sp. and *Echinothrix calamaris* and fish species *Abudefduf lorenzi*, *Abudefduf vaigiensis*, *Chaetodon kleinii*, *Dascyllus melanurus*, *Plotosus lineatus*, *Pomacentrus bankanensis*, *Siganus guttatus* and *Zebrasoma scopas* can be attributed to the dominance of algae. The following coral genera were observed in all sampling sites: *Coscinarea*, *Echinopora*, *Favia*, *Favites*, *Goniastrea*, *Heliopora*, *Leptoria*, *Montastrea*, *Montipora*, *Oxypora*, *Porites,* and *Pocillopora*. The latter was the most dominant taxa in RS3 with 9.5% cover. The most common coral TAUs across reef sites were *Porites* massive and encrusting and *Favia*. The highest number of taxa were recorded in contiguous reef sites (RS1 and RS4) with varied coral growth forms ranging from encrusting massive, submassive, and branching. For fish assemblages, a total of ten families with 26 species were observed at the reef or sampling sites. The highest number of families was recorded in RS1 with six families, while RS2 and RS3 had the lowest with only three (3) families apiece. The highest fish density was noted in RS1 (79). This was followed by RS2 (58), RS4 (59), and RS3 (49). Non-target species from the family Pomacentridae dominated all four (4) sampling sites. On the other hand, four target species (*Scarus* sp., *Ctenochaetus striatus*, *Scolopsis bilineata Parupeneus multifasciatus*) and one indicator species (*Chaetodon vagabundus*) were found across four sites. The diversity of fish assemblages ranged from 1.51 to 2.38, with the highest index in RS1 followed by RS4. Most of the reef sites had moderate fish diversity. In terms of marine macrophytes, patches of *Halophila ovalis* were observed 10-20 m from the shoreline. *H. ovalis* has an average percent cover of 5.96%. Phaeophyta (brown algae), particularly *Padina* sp. and *Sargassum* sp. were relatively common with 6.26% and 9.64% cover, respectively. The macroalgae occurred on the surfaces of rocks, dead corals, and pebbles. Site 2 was located at the reef flat in Sitio Bato. Patches of seagrass were 150 to 250 m away from the nearby river. Mixed growths of *Oceana serrulata, Halodule pinifolia,* and *Halophila ovalis* were spotted at 20-35 m perpendicular to the shoreline. *Oceana serrulata* contributed 7.06% of the total macrophyte cover in Site 2, while *Sargassum* sp. registered a cover of 7.92%. Site 3 was located on the left side of the causeway. Green algae (Chlorophyta) were dominant with a percent cover of 23.22%. The algae were attached to the pebbles and rocks, forming an algal mat. The mats can be visible on the surface. *Padina* was sighted 50-75 meters from the shoreline going seaward. The brown algae were found on the rocky substrate, with an average cover of 16.07%. All the seagrass species were sighted in Site 2. Macroalgal communities were represented by Rhodophyceae (red algae), Chlorophyceae (green algae), and Phaeophyceae (brown algae). Ten macroalgal taxa were recorded, which were mostly found in Site 1 (right side of the causeway). In Site 2 and Site 3, two to three macroalgal species were found. Most of the species were brown algae.

There were no indications of a contiguous reef directly affected or buried during the causeway development possibly because of its proximity to the river mouth. However, this report does not discount the possibility of reef formation or patch reefs at the current location of the causeway. If there were reef structures before the causeway was built, the conditions could be comparable to the assessed reef sites. In the absence of baseline data, anecdotal information from the nearby residents or fishing communities could be helpful. They might have a valuable understanding of the historical conditions of the marine environment before the intervention. It should be noted, however, that local knowledge may have its own biases and limitations. Moreover, causeway construction can impact the coastal area by altering the movement of water and sediments and the speed and direction of water currents. A thorough project evaluation must be considered before making a causeway to determine the potential impacts and identify adaptive strategies to mitigate the negative impacts. Impact evaluation should take into account the involvement of all stakeholders to ensure that project implementation strategies have considered environmental and natural resources protection, social benefits, and economic gains. Utilization of modern technologies such as water circulation modeling, remote sensing, and geographic information systems is also essential in coastal causeway construction. Water circulation modeling, for instance, may help in predicting the water and sediment movement, which can be used to identify the most effective and functional causeway design. Furthermore, a detailed survey of the physical profile and resources along the coastal area of Barangay Espańa and adjoining barangays should be considered to determine the changes as the causeway project and related project progresses over some time. Management interventions should be implemented on the adjacent contiguous reef sites to protect the young coral colonies or recruits, enhance coral settlement, reduce the population of COTs, increase the population of associated target and herbivorous fish species, and regulate fishing pressure. Considering the proximity of these reefs to river systems, regulatory and monitoring schemes for land-based activities that could induce sedimentation and nutrient loading, and inflict damage to natural buffers such as terrestrial, riverine, and coastal vegetation must also be in place and should adopt a landscape approach.

I. Background

On 06 February 2023, the Department of Environment and Natural Resources (DENR) through the Regional Offices of DENR, Mines and Geosciences Bureau, Environmental Management Bureau (EMB) in Region IV-B MIMAROPA issued a Joint Order (JO) to Altai Philippines Mining Corporation (APMC) in connection with the illegal construction of the causeway and other related activities. One of the directives in the Joint Order is for DENR-PENRO Romblon to investigate the alleged damage or destruction of seagrass and other marine resources as a result of the construction of the causeway project in Sitio Bato, Brgy. España, San Fernando, Romblon.

In compliance with the Joint Order, PENRO Romblon created a team via PENRO Special Order dated 07 February 2023. The following day, the said team carried out an ocular observation of the area surrounding the causeway. They observed rocks and gravel on the shoreline extending both the northwest and southeast of the causeway project. They also performed skin diving and reported the absence of seagrass and other marine resources in the vicinity of the causeway. For validation purposes, PENRO Romblon sought the technical assistance of ERDB to do a further assessment.

Through ERDB Special Order 120-2023, research personnel from the Coastal Resources and Ecotourism Research, Development and Extension Center (CRERDEC) were deployed to undertake a rapid assessment of benthic lifeforms, seagrass and macro-algae (marine macrophytes) and associated fauna (fish and macro-invertebrates). CRERDEC team assessed the causeway project site and nearby areas with the PENRO Romblon technical staff from 16-19 May 2023. The assessment intends to determine if there are marine habitats directly impacted by the construction of the causeway by looking at the underwater physical profile, habitat conditions, and other discernable indicators proximate to the said structure.

II. Methodology

a. Sampling Site

The rapid assessment was conducted at the causeway projects site and adjacent areas in Barangay España, San Fernando in Sibuya, Romblon. The causeway site is located at Sitio Bato (**Fig. 1**). Based on the NAMRIA 2020 Coastal Resources Map (CRM), the coral reefs can be found 6.99 km southeast and 10-15 km northwest of the causeway site. In terms of marine plants and coastal vegetation, the seagrass or algal beds occurred 17.97 km northwest of the causeway, while the nearest mangroves were less than a kilometer southeast of the causeway. After the reconnaissance survey and review of the aerial photos compiled by PENRO Romblon, reef formations were observed proximate to the causeway (**Fig. 2**). Five reef sites were marked, but only four were assessed, which represent two relatively contiguous reefs (RS1 and RS4) and two patch reefs (RS2 and RS3) (**Fig. 3**). RS1 and RS2 are situated in Sitio Bato, while the other stations (RS3 and RS4) are within Sitio Taclobo. The reef sites are approximately 25 to 478 m away from the causeway. RS1 is relatively the closest (25 m). Two rivers drain in Sitio Bato, which are potential sources of fine sediments. RS1 is about 1.54 to 2.14 km away from the river mouths. The distance of the river mouth near the causeway to RS3 and RS4 ranges from 108 to 344 meters. Sediment run-offs on these sites were expected. The reef sites were relatively shallow with depths ranging from 2.6 m to 6.9. The reef formation was of fringing type. Grooves can be observed at more contiguous reef sites, particularly in RS1 and RS4.

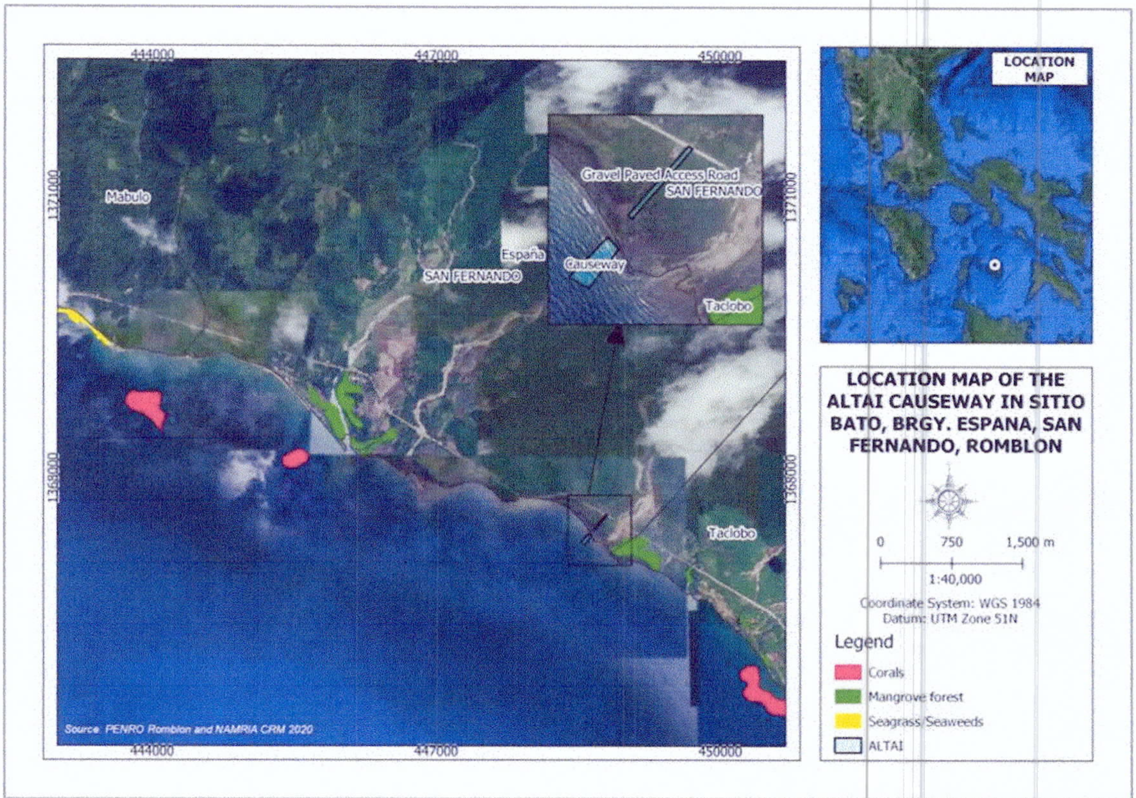


Fig. 1. Location of the APMC causeway project in San Fernando, Sibuyan, Romblon. The map was generated before ERDB assessed the area. PENRO Romblon provided the GPS coordinates of the causeway, while NAMRIA 2020 CRM was used in plotting the marine habitats. (Plotted by JR Manahan, ERDB-CZFERD)

The intertidal area near the causeway was characterized by rocks and pebbles. The same materials were visible in the subtidal area with surfaces covered with thin layers of fine sediments and algal assemblages (**Fig. 4**). Next to the rocky materials were sandy substrate, except for portions with patch reefs. The periphery of the causeway was mostly of rock and boulders (**Fig. 5**). Rock to sandy bottom from the shore to seaward was observed at least 5-10 m from both sides of the causeway. Lateritic particles at the bottom were not noticed at the time of the assessment. Seagrasses, particularly those species that inhabit subtidal areas, were absent at the sandy bottom next to the causeway boulders. Mixed assemblages of fish species occurred on the boulders. A few species of macro-invertebrates were also sighted.

Fig. 2. Location and configuration of the causeway. The closest reef formations or sites are situated on the right side of the causeway (seaward perspective) and marked with white arrows. The left side of the structure is about 70 to 120 m away from the river mouth (Photos by DENR-PENRO Romblon)

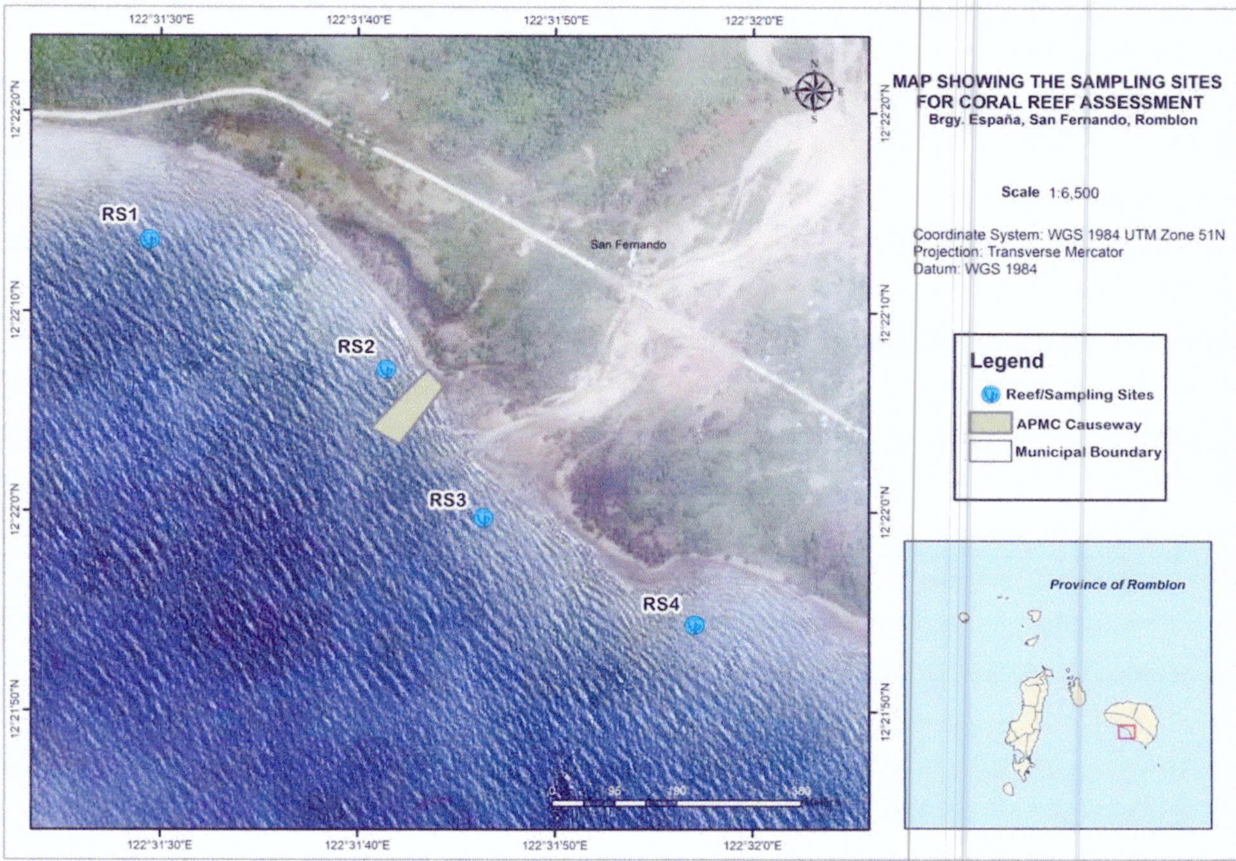


Fig. 3. Location of reef or sampling stations for benthic lifeforms and associated fauna. The patch reef in RS2 is closest to the causeway (25 m linear distance). The contiguous reef in RS4 is relatively the farthest (478 m) from the project site. (Plotted by SJM Forlales, PENRO Romblon)

Fig. 4. Features of the tidal flat close to the causeway. The intertidal area is mostly composed of rocks and pebbles (upper photos). These materials in the subtidal area are coated with a layer of fine sediments and algal assemblages (lower photo). (Photos by PENRO Romblon and JIM Padin)

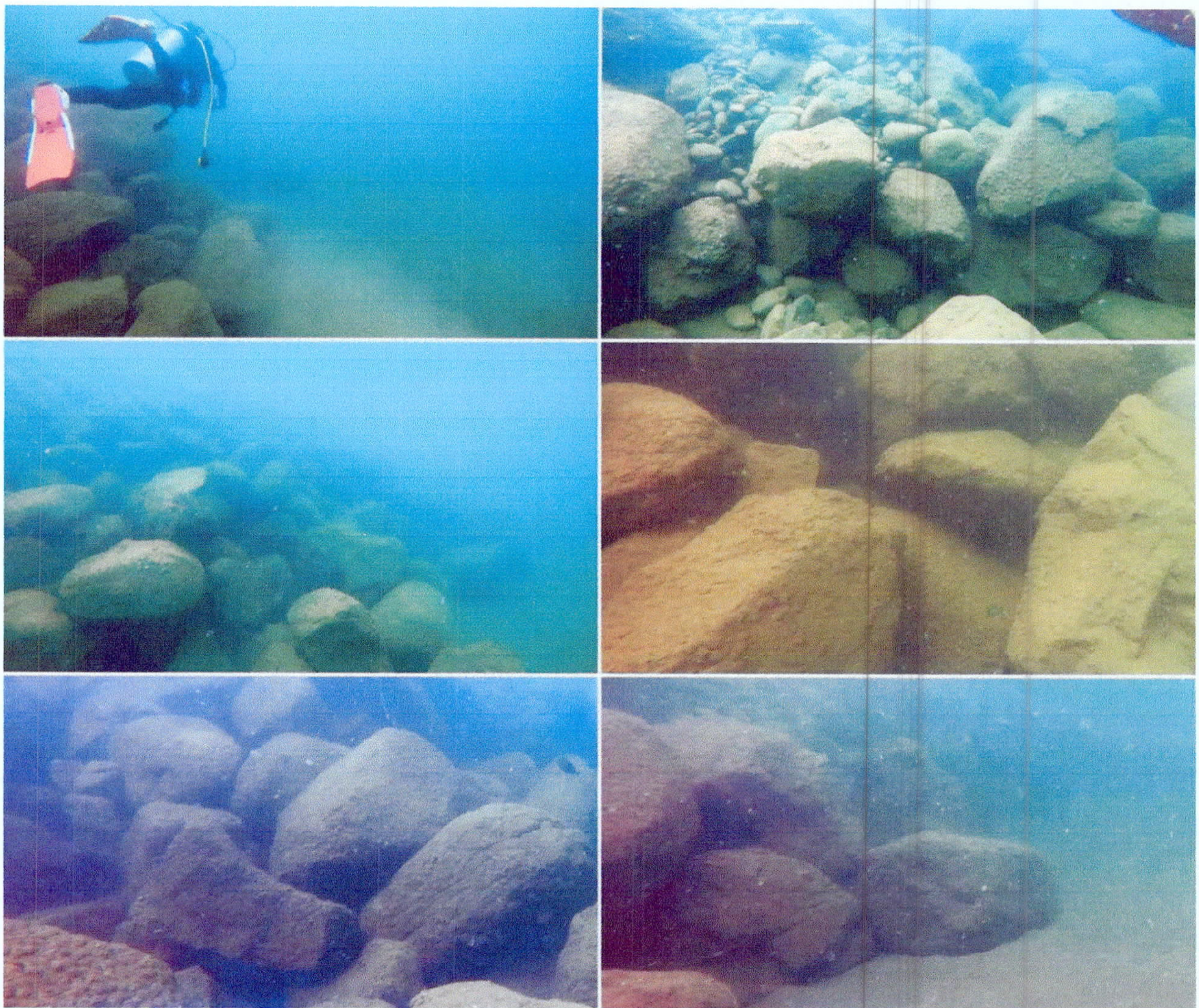


Fig. 5. Rocks and boulders at the periphery of the causeway. The deepest part (seaward tip) of the causeway is between 5.2 to 6 m with a sandy to silty substrate. Above the sandy bottom is a layer of fine sediments about 8-10 cm thick. Resuspension of the fine sediments by wave action caused low water clarity at the time of the assessment (Screengrab by JIM Padin).

b. Sampling Methods and Data Management

b.1. Benthic Lifeforms and Associated Fish Assemblages

The benthic lifeforms at the reef sites were assessed using the photo-quadrat method (**Fig. 6**). A 50-m transect was laid parallel to the shoreline at depths between 3-5 m. At the sites with patch reefs, only half of the entire transect was utilized. At every 1-m interval of the transect, a monopod with a camera was pressed on the substratum and photos were taken. A minimum of 20 sample frames were taken from each reef site. A 1 m x 1 m area from the phototransect frames was extracted to determine the lifeform structure and percent cover using an image editor. The frames were imported to CPCe 4.1 Software (Kohler and Gill 2006) and at least 10 random points were overlaid. Each benthic lifeform underneath each point was identified using the categories of English et al. (1997). The field guides of Veron (1993) and Kelley (2016) were used to identify the coral colonies within the frame. The CPC file was converted to an Excel file using the same software for further formatting and analysis.

The same transect was used for the underwater fish visual census (FVC). Fish species observed within 5 meters on both sides and above the transect were identified and counted. The total sampled area was standardized to 100 m^{-2}. The fish density was expressed as individuals 100 m^{-2}. The diversity of fish assemblages was determined using the Shannon index algorithm in PAST 4.11. Fish identification and authorities were confirmed using FishBase (https://fishbase.net.br/search.php).

The occurrence of corals, seagrasses, and other fauna at the periphery of the causeway was assessed through visual inspection. Organisms encountered were recorded on a plastic slate. For associated fish assemblages, the same parameters were taken. The assessment of marine organisms at the causeway was more of an enumeration. The underwater assessment was done with the aid of SCUBA (Self-contained Underwater Breathing Apparatus).

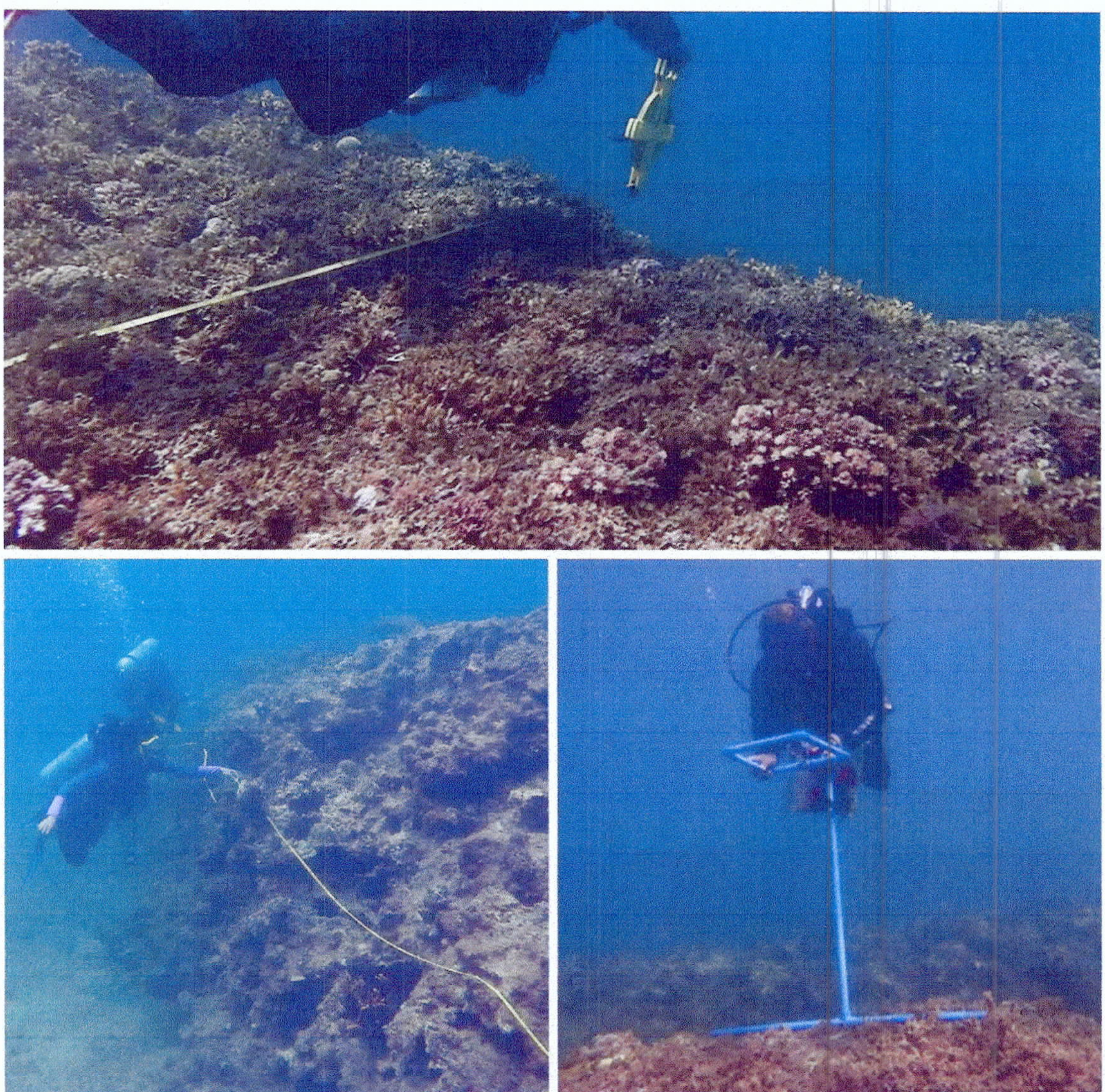


Fig. 6. Sampling of the benthic lifeforms using the photo-quadrat method. A monopod mounted with a Go-pro camera was used to obtain photo frames. The dimension of the frame was at least 1m x 1m. (Photos by CRA Bartonico and JIM Padin)

b.2. Marine Macrophytes

For marine macrophytes (seagrass and macro-algae), three sites were identified for the quantitative assessment of seagrass and associated macroalgae proximate to the causeway project Seagrass and macroalgae assessment was done following the methods described in English et.al (1997). The estimation of seagrass cover was adapted from Saito and Atobe (1970). Sampling points were established parallel to the shoreline at every 50-m interval. Skin diving was performed to observe or survey the presence of seagrass and macroalgae and determine their extent and coverage relative to the length of the causeway. A 50-m transect line was laid perpendicular to the shore from the low tide mark. A 0.5 x 0.5 m quadrat was laid starting from the 0-m mark of the transect line and recording was done at every 5-m distance interval.

III. Results and Discussion

a. Causeway Site

The boulders surrounding the causeway were devoid of coral colonies, but biofouling by barnacles was visible on the boulder surfaces. No reef formations were found a few meters from the sides and the seaward tip of the causeway. Sandy to rocky substrate separated the nearby patch reef formation (RS1) and the causeway. Turf algae with fine sediments were common on the surfaces of causeway rocks and boulders. The causeway boulders offered new habitats for fish species and macro-invertebrates, including sea urchin *Astropyga radiata*, sea slug *Chelidonura varians*, and crown-of-thorns *Acanthaster planci* (**Fig.7**). Nineteen species belonging to 12 families were recorded at the site (**Table 1**). Eight of these are considered "target" species or those favored by fishermen due to their high market value. The target species were represented by 36 individuals, followed by indicator species with 18 individuals. Indicator species are usually taxa under Chaetodontidae, which are known to be highly associated with the presence of live corals (Valavi et al. 2010). Nearly 200 individuals of juvenile coral reef catfish *Plotosus lineatus* were also recorded, contributing 70% to the total fish abundance.

The occurrence of reef-associated fish species suggests the presence of coral reefs adjacent to the causeway. The movement of these species from the natural reefs to the causeway structures could be driven by the availability of habitat space or refuge and source of food. The temporal (if not gradual) increase in the population of small fish species at the artificial habitat may trigger the movement of larger species and top predators, thereby improving the fish biomass and diversity at the site over time if no fishing is imposed. On the contrary, the migration or immigration of fish assemblages to the artificial habitat may depopulate the natural reefs. Reef-associated fish species are an essential component of many coral reef ecosystems and contribute to the overall function of the reef. The movement of the fish individuals to artificial habitat may alter trophic interactions (e.g. grazing and predation), bioerosion, sediment and transport, nutrient cycling in reef ecosystems, and reef complexity, among other processes in natural reef systems (reviewed by Perry et al. 2022). Thus, maintaining an adequate population of reef-associated fish species is important to the health and resilience of the natural reef ecosystems.

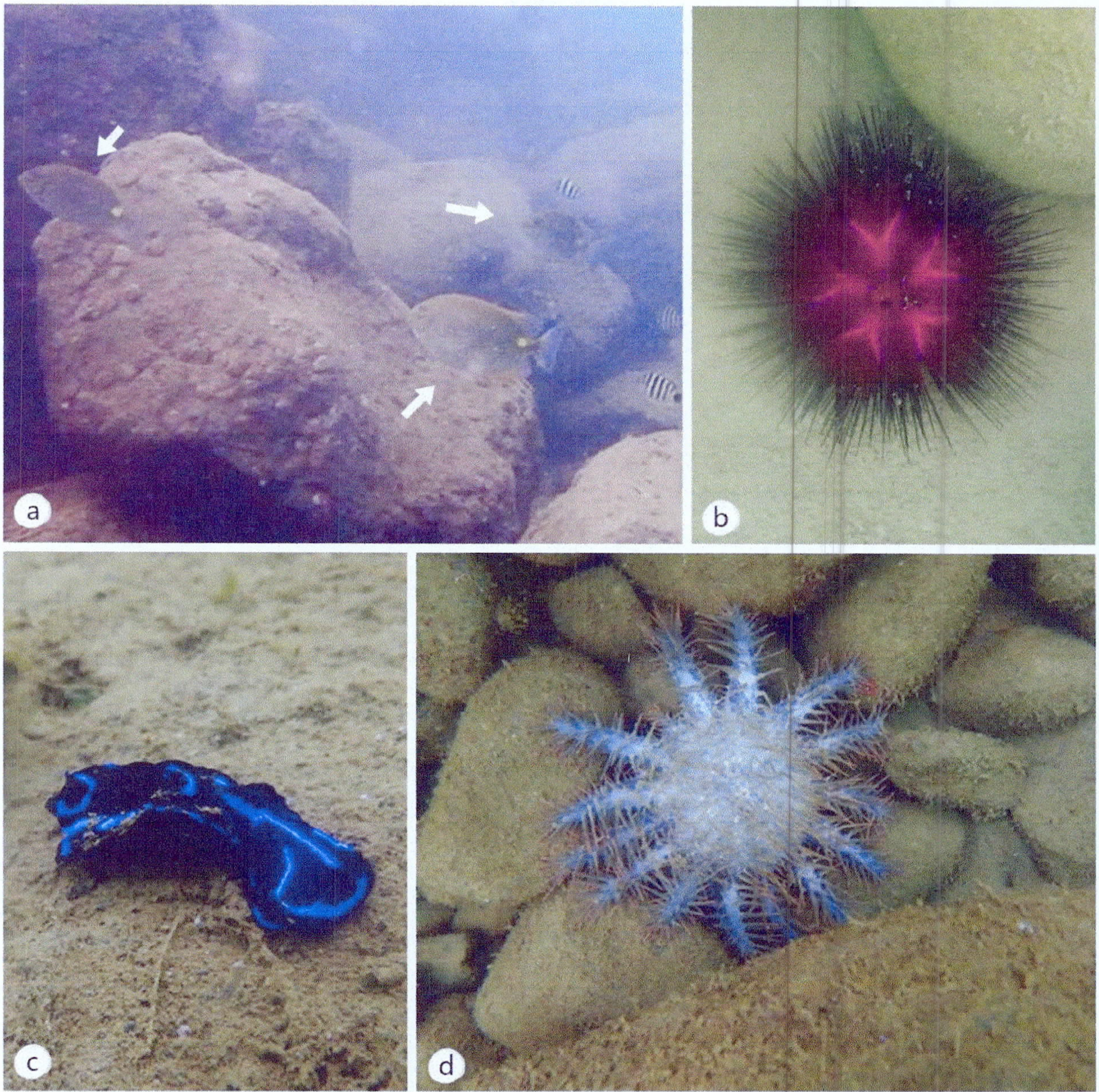


Fig. 7. Marine organisms sighted at the causeway structure: **a.** assemblage of target fish species *Siganus guttatus* (white arrows) mixed with pomacentrids *Abudefduf vaigensis*; **b.** sea urchin *Astropyga radiata* (Leske, 1778); **c.** sea slug *Chelidonura varians* Eliot, 1903; and **d.** crown-of-thorns *Acanthaster planci* (Linnaeus, 1758). (Photos by: CRA Bartonico)

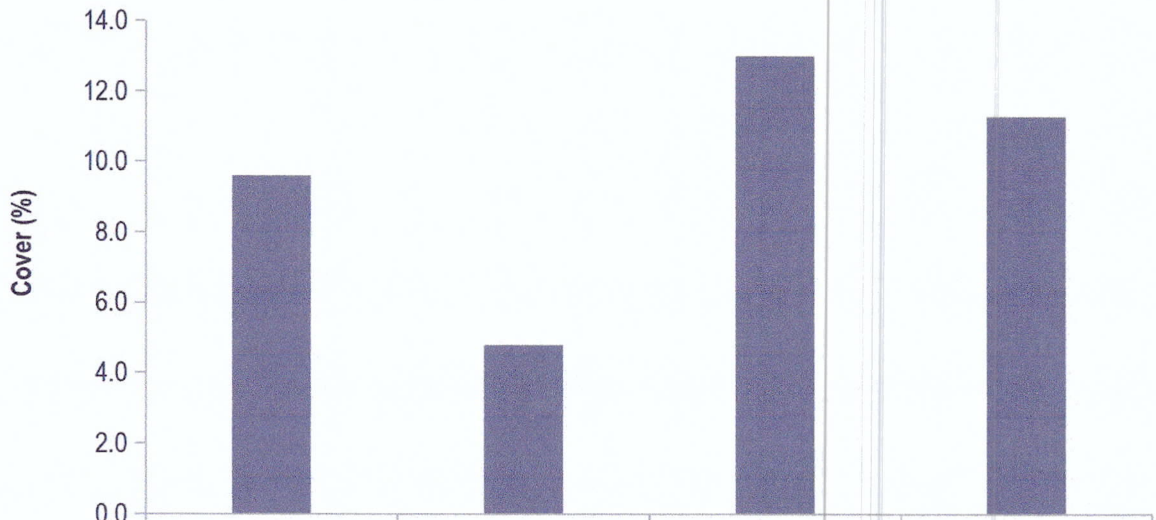
Table 1. Species composition and abundance of fish species associated with the causeway structures.

Category	Family	Species	Abundance
Indicator	Chaetodontidae	*Chaetodon kleinii* Bloch 1790	3
Indicator	Chaetodontidae	*Chaetodon mertensii* Cuvier, 1831	2
Indicator	Chaetodontidae	*Chaetodon vagabundus* Linnaeus, 1758	13
Non-Target	Pomacentridae	*Abudefduf lorenzi* Hensley & Allen, 1977	6
Non-Target	Pomacentridae	*Abudefduf sexfasciatus* Lacepede, 1801	1
Non-Target	Pomacentridae	*Abudefduf vaigiensis* (Quoy &Gaimard, 1825)	6
Non-Target	Plotosidae	*Plotosus lineatus* (Thunberg, 1787)	200
Non-Target	Pomacentridae	*Pomacentrus coelestis* Jordan & Starks, 1901	12
Non-Target	Pomacentridae	*Pomacentrus* sp.	1
Non-Target	Scorpaenidae	*Pterois volitans* (Linnaeus, 1758)	1
Non-Target	Synodontidae	*Synodus binotatus* Schultz, 1953	2
Target	Acanthuridae	*Acanthurus grammoptilus* Richardson, 1843	10
Target	Carangidae	*Caranx ignobilis* (Forsskål, 1775)	1
Target	Lutjanidae	*Lutjanus biguttatus* (Valenciennes, 1830)	5
Target	Lutjanidae	*Lutjanus fulvus* (Forster, 1801)	5
Target	Lutjanidae	*Lutjanus lutjanus* Bloch, 1790	3
Target	Mullidae	*Parupeneus barberinoides* (Bleeker, 1852)	3
Target	Scaridae	*Scarus* sp.	6
Target	Siganidae	*Siganus guttatus* (Bloch, 1787)	3
		Total Number of Individuals	**283**
		Total Number of Families	**12**

b. Benthic Lifeforms

The reef sites were characterized by mostly encrusting, submassive, massive, and branching corals. The highest hard coral cover (HCC) was observed in RS3 (13%), followed by RS4 (11.3%) (**Fig. 8**). The percent cover of benthic lifeforms is presented in **Fig. 9**. The patchy reef in RS3 was dominated by *Sargassum* spp. (70.8%) as well as in RS2 (71.9%). Turf algae were common in RS4 (70.8%) and RS3 (81.5%). Several marine invertebrates were also observed such as species of sponges and crown of thorn starfish (*Acanthaster plancii*) (0.4%). Both RS3 (81.5%) and RS1 (52.3%) were dominated by turf algae. The abiotic factor such as the presence of rubbles and rocks was also observed in all sampling sites, which are potential substrate for settlement for coral planulae and recruits to grow. The presence of herbivorous species of invertebrates such as the sea urchins *Salmacis sphaeroides*, *Diadema* sp. and *Echinothrix calamaris* and fish species *Abudefduf lorenzi*, *Abudefduf vaigiensis*, *Chaetodon kleinii*, *Dascyllus melanurus*, *Plotosus lineatus*, *Pomacentrus bankanensis*, *Siganus guttatus* and *Zebrasoma scopas* can be attributed to the dominance of algae.

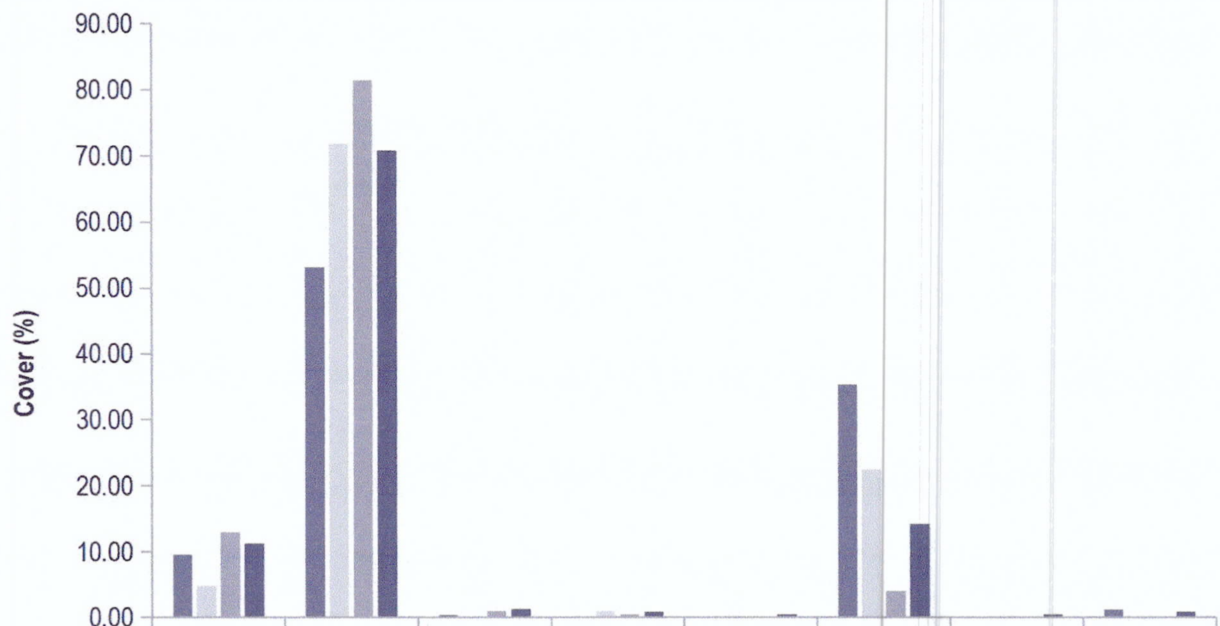
The following coral genera were observed in all sampling sites: *Coscinarea*, *Echinopora*, *Favia*, *Favites*, *Goniastrea*, *Heliopora*, *Leptoria*, *Montastrea*, *Montipora*, *Oxypora*, *Porites,* and *Pocillopora*. The latter was the most dominant taxa in RS3 with 9.5% cover (**Fig. 10**). The most common coral TAUs across reef sites were *Porites* massive and encrusting and *Favia*. The highest number of taxa were recorded in contiguous reef sites (RS1 and RS4) with varied coral growth forms ranging from encrusting massive, submassive, and branching.



	RS1	RS2	RS3	RS4
Cover (%)	9.6	4.8	13.0	11.3

Reef Sites

Fig. 8. Hard coral cover (HCC) at the four reef sites adjacent to the causeway.



	CORAL	ALGAE	DC	DCA	SC	ABIOTIC	OT	SPONGE
RS1	9.60	53.20	0.40	0.20	0.00	35.20	0.20	1.20
RS2	4.76	71.90	0.00	0.95	0.00	22.38	0.00	0.00
RS3	13.00	81.50	1.00	0.50	0.00	4.00	0.00	0.00
RS4	11.25	70.83	1.25	0.83	0.42	14.17	0.42	0.83

Fig. 9. Percent cover of benthic lifeforms at the reef sites adjacent to the causeway. (Legend: DC-Dead Coral, DCA-Dead Coral with Algae, SC-Soft Corals, OT-Other Fauna)

As pointed out earlier in the text, nearby river systems could transport riverine sediments to the reef sites. Sediment inputs might have influenced the low cover of HCC in the reef sites. Sedimentation affects corals by creating marine snow composed of silt, sand, mud, and mud bacterial complexes reducing coral proliferation and coral growth through light reduction. These mud-bacterial complexes also inhibit nutrients which results in plankton blooms limiting the light that would penetrate the corals (Wolanski et al. 2003). In addition, sediments prevent planulae from settling down since they cannot attach to fine particles (Harrigan1972). Several species of branching corals such as *Acropora*, *Pocillopora,* and *Porites* spp were resistant to smothering and able to tolerate extreme sediment deposition (Jones et al., 2019). Meanwhile, coral taxa such as *Echinopora*, *Favia*, and *Montipora* were found to be sediment-tolerant species. On the other hand, *Favites* have intermediate tolerance to sediments (McClanahan and Obura 1997). A study by Ismail and Tsuchiya (2005) showed that the coral *Goniastria aspera* has been observed to be tolerant to sediment stress from river input showing high respiration rates due to high densities of zooxanthellae in its tissues. The authors added that *Leptoria phrygia* rejects sediments with the presence of turbulence. It can also develop morphological features to survive areas with sediment inputs. Nonetheless, the species still appears to be sensitive in overlying sediments (Stafford-Smith 1990; Stafford-Smith 1992).

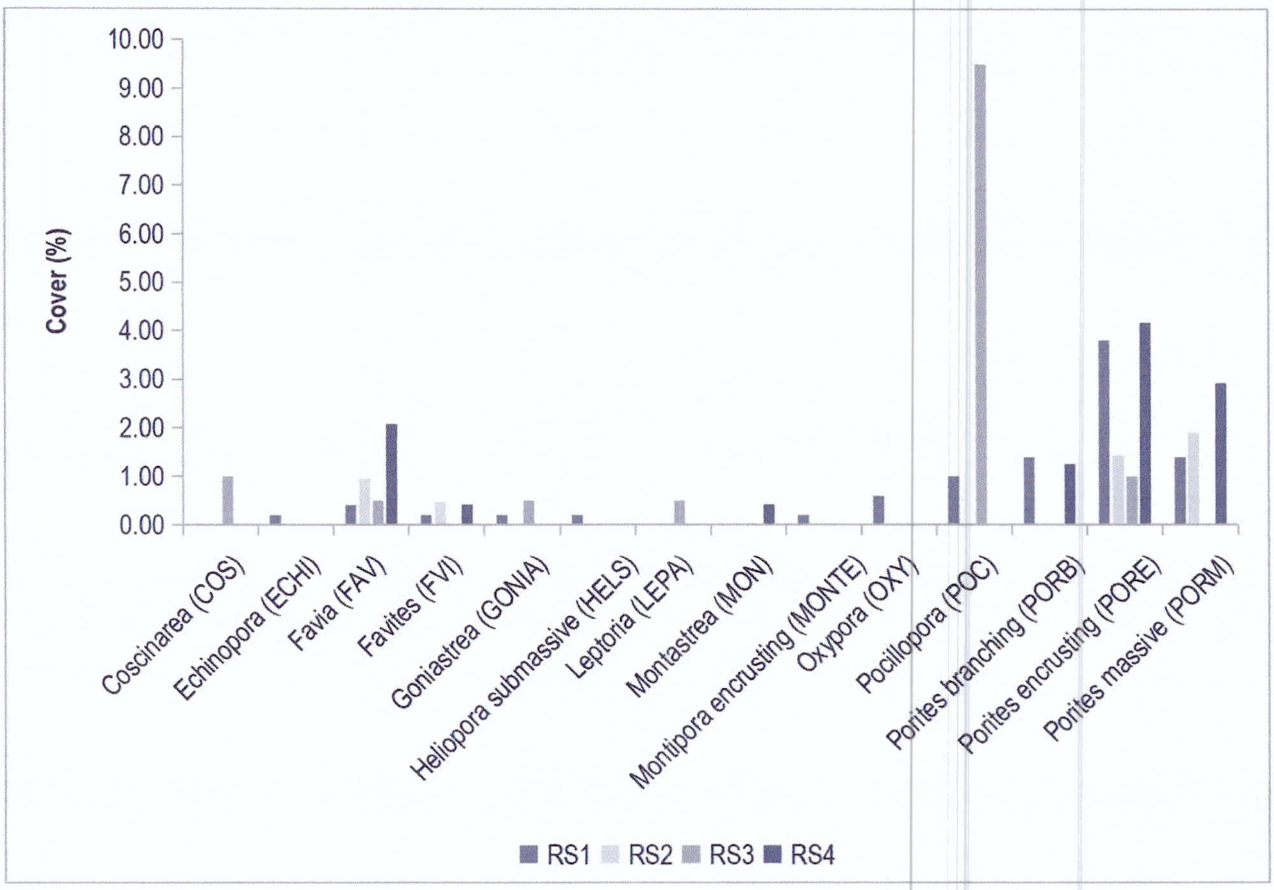


Fig. 10. Cover of coral Taxonomic Amalgamation Units (TAUs) at the reef sites.

Acevedo et al. (2013) observed the dominance of *Montastrea cavernosa* exposed to sediment stress. This could explain the presence of these taxa at the reef sites. In the substrate composition result, all the reef sites were dominated by algal aggregates, which are composed mainly of turf algae and macroalgae *Sargassum* spp. Results showed that turf algae dominate in areas with no *Sargassum* due to the ability of brown algae in reducing the availability of light suppressing the growth of turf-forming algae (Kim 2002; Connell 2005; Wernberg et al. 2005; Russell 2007). In addition, blast craters and rubbles at RS1 and RS4 may indicate previous blast fishing activity. According to McManus et al. (2004), algae such as turf, calcareous frondose macroalgae (CFM), or fleshy frondose macroalgae (FFM) cover dead coral pieces to large areas of the reef after a disturbance. This occurs when a dead coral creates a surface for attachment, which allows settlement for benthic organisms, corals, or algae. If the coral planulae are inhibited because of the opportunistic macroalgae after a few months, this would likely result in a phase shift called a coral-algal phase shift. Moreover, the removal of large-sized fish species, particularly herbivores could lead to algal dominance (Hughes 1994).

c. Associated Fish Assemblages and Other Fauna

A total of ten families with 26 species were observed at the reef or sampling sites (**Table 2**). The highest number of families was recorded in RS1 with six families, while RS2 and RS3 had the lowest with only three (3) families each. The highest fish density was noted in RS1 (79). This was followed by RS2 (58), RS4 (59), and RS3 (49). Non-target species from the family Pomacentridae dominated all four (4) sampling sites. On the other hand, four target species (*Scarus* sp., *Ctenochaetus striatus*, *Scolopsis bilineata Parupeneus multifasciatus*) and one indicator species (*Chaetodon vagabundus*) (**Fig. 12**) were found across four sites. The diversity of fish assemblages ranged from 1.51 to 2.38, with the highest index in RS1 followed by RS4. Most of the reef sites had moderate fish diversity, except at RS1 with relatively high diversity (**Fig. 11**).

The presence of other invertebrates was also documented. The corallivore crown-of-thorns *Acanthaster planci* was common across sites. If left unchecked, proliferation or population outbreak of this starfish could result in coral bleaching and mortality. *Tridacna* sp. or giant clams were recorded at RS1, while the rest of the documented invertebrates were observed in the causeway area.

Table 2. Species compositions and density (individuals 100 m^{-2}) of reef-associated fish assemblages at the reef stations

Category	Family	Species	Sampling Stations			
			RS1	RS2	RS3	RS4
Indicator	Chaetodontidae	*Chaetodon vagabundus*	0	0	7	0
Non-Target	Pomacentridae	*Abudefduf lorenzi*	0	0	12	0
Non-Target	Pomacentridae	*Abudefduf vaigiensis*	4	0	0	0
Non-Target	Pomacentridae	*Amphiprion clarkii*	4	2	0	0
Non-Target	Pomacanthidae	*Centropyge bicolor*	0	0	0	2
Non-Target	Pomacanthidae	*Centropyge vrolikii*	2	0	0	10
Non-Target	Pomacentridae	*Chromis ternatensis*	0	0	13	0
Non-Target	Pomacentridae	*Dascyllus melanurus*	0	0	0	6
Non-Target	Pomacentridae	*Dascyllus reticulatus*	0	0	0	13
Non-Target	Pomacentridae	*Dascyllus trimaculatus*	22	9	15	0
Non-Target	Labridae	*Halichoeres biocellatus*	1	0	0	0
Non-Target	Labridae	*Halichoeres scapularis*	5	0	0	0

Non-Target	Labridae	*Labroides dimidiatus*	1	0	2	0
Non-Target	Pomacentridae	*Neoglyphidodon nigroris*	1	0	0	0
Non-Target	Pomacentridae	*Pomacentrus bankanensis*	0	9	0	0
Non-Target	Pomacentridae	*Pomacentrus coelestis*	11	19	0	0
Non-Target	Pomacentridae	*Pomacentrus philippinus*	12	0	0	0
Non-Target	Pomacentridae	*Pomacentrus stigma*	0	0	0	10
Non-Target	Balistidae	*Sufflamen chrysopterum*	0	0	0	6
Non-Target	Labridae	*Thalassoma lunare*	1	13	0	8
Non-Target	Acanthuridae	*Zebrasoma scopas*	2	0	0	0
Non-Target	Fistulariidae	*Fistularia commersonii*	3	0	0	0
Target	Scaridae	*Scarus* sp.	5	0	0	0
Target	Acanthuridae	*Ctenochaetus striatus*	0	0	0	4
Target	Nemipteridae	*Scolopsis bilineata*	5	0	0	0
Target	Mullidae	*Parupeneus multifasciatus*	0	6	0	0
		Total Number of Families	**6**	**3**	**3**	**5**
		Total Number of Individuals	**79**	**58**	**49**	**59**

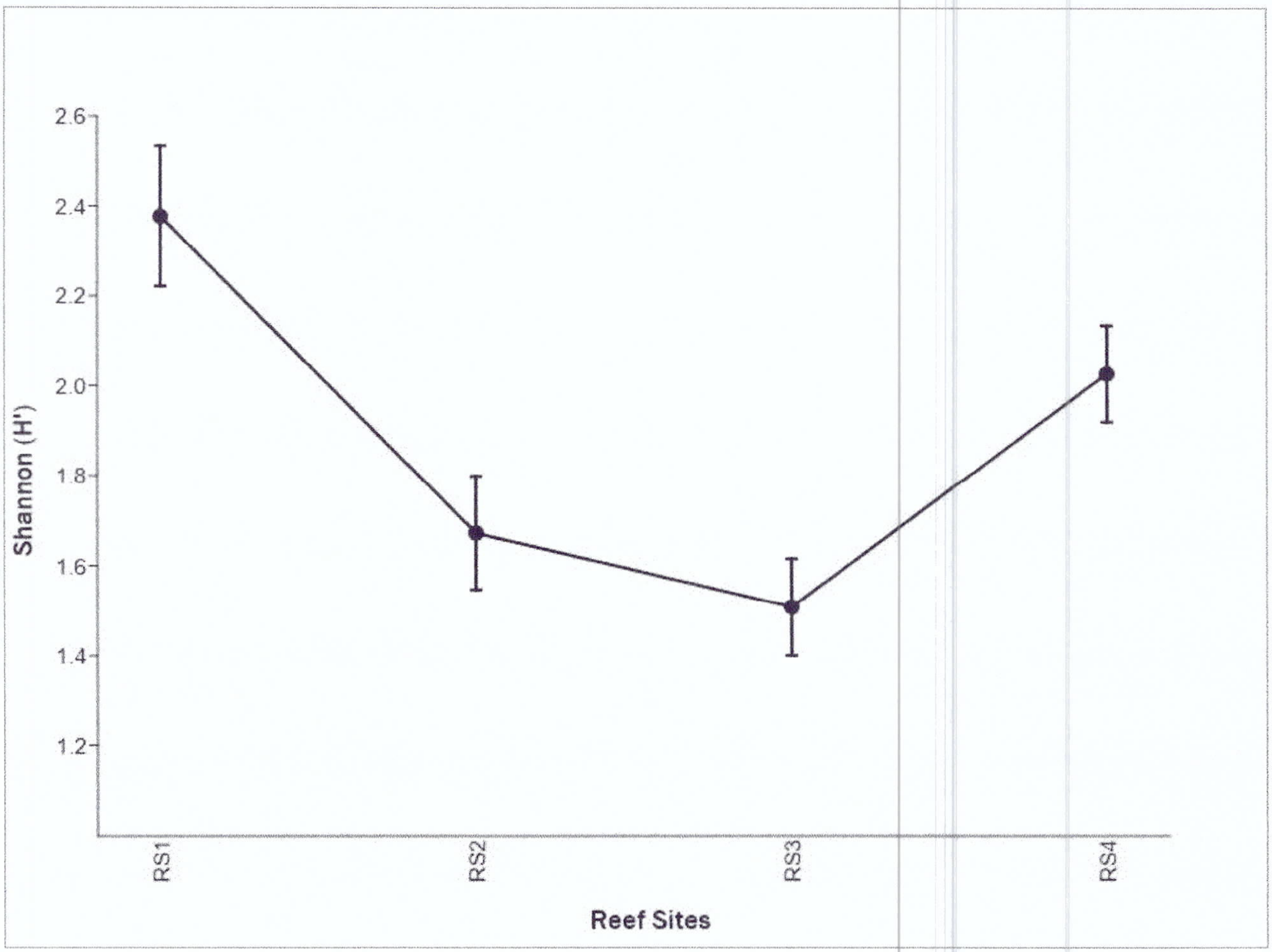


Fig. 11. Diversity of fish assemblages at the reef sites based on Shannon (H') index.

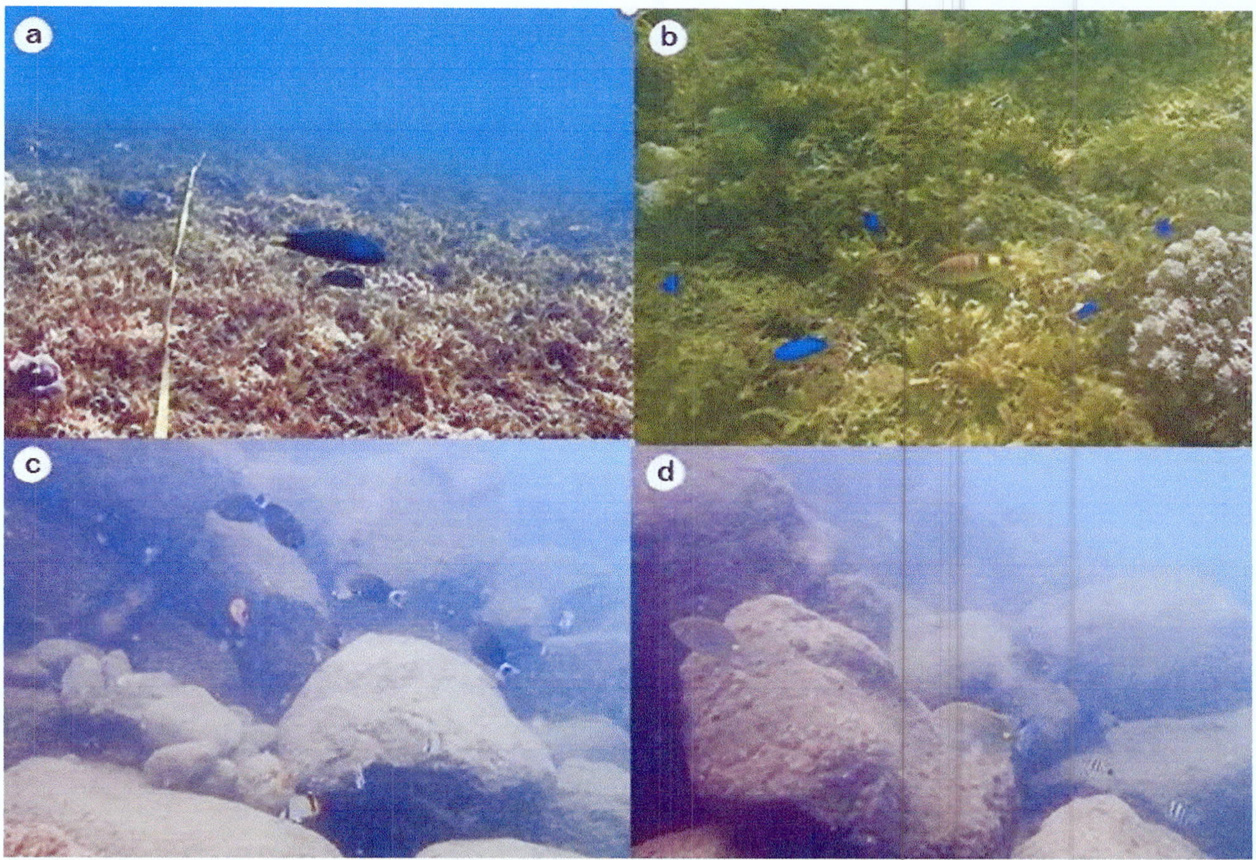


Fig. 12. Fish assemblages in the sampling sites: **a.** crescent wrasse *Thalassoma lunare*; **b.** manybargoatfish *Parupeneus multifasciatus* with neon damselfish *Pomacentrus coelestis*; **c.** Mixed assemblage of finelined surgeonfish *Acanthurus grammoptilus*, vagabond butterflyfish *Chaetodon vagabundus*, and Klein's butterflyfish *Chaetodon kleinii*; **d.** Orange-spotted spinefoot *Siganus guttatus* with black-tail sergeant *Abudefduf lorenzi*, and Indo-Pacific sergeant *Abudefduf vaigiensis.* (Screengrab by CRA Bartonico)

The density and diversity of fish assemblages at the reef sites might be affected by several factors, including habitat conditions. A study by Jones et al. (2004) showed that a decline in coral cover has decreased fish diversity, affecting those that are not even coral-feeding or dwelling fish species. The coral reef ecosystems in the sampling areas were not necessarily highly productive and diverse; corals were heavily covered with algae and constantly subjected to heavy sedimentation and siltation. Fish indicator species from the family Chaetodontidae, known to inhabit and feed on corals and are excellent indicators of coral reefs, were only observed a few times in all sampling stations indicating the poor condition of reef ecosystems (Rina et al. 2020). The findings also showed the dominance of Pomacentridae. The higher abundance and dominance of small fishes like pomacentrids or damselfishes may be attributed to the low abundance of carnivorous reef species (Meirelles et al. 2018), which maintains the equilibrium of prey-predator relationships as well as species structure in coral reef communities (Mihalitsis et al. 2022) Aside from being the most common fish groups in most reefs, pomacentrids could be less affected by fishing pressure as they are not preferred by most fishermen (Corrales et al. 2015)

d. Marine Macrophytes

The species composition and percent cover of marine macrophytes are presented in (**Table 3, Table 4,** and **Table 5**). Three sampling sites were established for the assessment of marine macrophytes. Site 1 was located 200-250 m right of the causeway (seaward view).

Patches of *Halophila ovalis* were observed at 10-20 m from the shoreline. *H. ovalis* has an average percent cover of 5.96%. Phaeophyta (brown algae), particularly *Padina* sp. and *Sargassum* sp. Were relatively common with 6.26% and 9.64% cover, respectively. The macroalgae occurred on the surfaces of rocks, dead corals, and pebbles. Site 2 was located at the reef flat in Sitio Bato. Patches of seagrass at 150 to 250 m away from the nearby river. Mixed growth of *Oceana serrulata, Halodule pinifolia,* and *Halophila ovalis* was spotted at 20-35 m perpendicular to the shoreline (**Fig. 13**). *Oceana serrulata* contributed 7.06% of the total macrophyte cover in Site 2, while *Sargassum* sp. registered a cover of 7.92%.

Site 3 was located at the left side of the causeway. Green algae (Chlorophyta) were dominant with a percent cover of 23.22%. The algae were attached to the pebbles and rocks, forming an algal mat. The mats can be visible on the surface. *Padina* was sighted at 50-75m (from the shoreline) (**Fig. 14**). The brown algae were found on the rocky substrate, with an average cover of 16.07%. All the seagrass species were sighted in Site 2. Seagrasses were not found on the left side of the causeway, which was near the river mouth. Seagrasses most often do not colonize areas with high levels of freshwater flow. These marine plants are adapted to grow in saline environments, low sediment and nutrient levels, and clear water. Other factors such as water quality, wave energy, and substrate type also influence seagrass growth. Macroalgal communities were represented by Rhodophyceae (red algae), Chlorophyceae (green algae), and Phaeophyceae (brown algae). Ten macroalgal taxa were recorded, which were mostly found in Site 1 (right side of the causeway). In Site 2 and Site 3, two to three macroalgal species were found. Most of the species were brown algae.

The sampling sites are characterized by coralline to rocky substrate. These substrate types favor macroalgae growth. While macroalgae are attached to stones and rocks on the seafloor, seagrasses mainly require a soft substrate for rhizome elongation, roots to anchor, and nutrient absorption (Greve and Binzer 2004). Brown algae, *Sargassum* sp., is widely distributed in the intertidal and shallow sub-tidal rocky substrata of the tropical and subtropical coastal waters including the Philippines (Baldia et al. 2017). Macroalgal species may serve as bioindicators of the quality of water while some can do bioremediation by biosorption and bioaccumulation (Geraldino et al. 2005; Areco et al. 2021). The proliferation of bloom-forming macroalgal species such as the *Ulva sp* and other macroalgal assemblages are affected by different physical, chemical, and biological drivers. *Ulva* is also proliferated in many areas that receive anthropogenic nutrients (Baldia et al. 2017). The left side of the causeway where *Ulva* occurred is close to the river mouth. Another common macroalgal species in the area is *Padina.* The taxa belong to Order Dictyotales, which are commonly found in warmer waters (Geraldino et al. 2005). During the assessment, the water temperature ranges from 29 ºC to 30 ºC.

Table 3. Checklist of seagrass species observed in the three sites assessed within the vicinity of the causeway project

Family	Species	Site 1	Site 2	Site 3
Cymodoceaceae	*Oceana serrulata* (R.Brown) Byng & Christenh.	✓	✓	-
Cymodoceaceae	*Halodule pinfolia* (Miki) Hartog, 1964	-	✓	-
Hydrocharitaceae	*Halophila ovalis* (R.Brown) Hooker f., 1858	✓	✓	-

Table 4. Checklist of the macroalgae species observed in the vicinity of the causeway project

Taxa	Site 1	Site 2	Site 3
Chlorophyceae (7)			
Acetabularia major G. Martens 1866	✓	-	-
Anadyomene sp.	✓	-	-
Bornetella nitida MunierChalmas ex Sonder 1880	✓	-	-
Caulerpa sp.	✓	-	-
Codium bartlettii C.K.Tseng & W.J.Gilbert, 1942	✓	-	-
Halimeda opuntia (Linnaeus) J.V.Lamouroux, 1816	✓	-	-
Ulva sp.	-	-	✓
Phaeophyta (2)			
Sargassum polycystum C.Agardh 1824	✓	✓	✓
Padina sp.	✓	✓	✓
Rhodophyceae (1)			
Amphiroa sp.	✓	-	-

Table 5. Percent cover of seagrass and associated macroalgal species adjacent to the causeway project.

Site	Group	Family	Species	Authority	Cover (%)	StDev Cover
Site 1	Seagrass	Cymodoceaceae	*Halophila ovalis*	(R.Brown) Hooker f., 1858	5.96	6.19
Site 1	Macroalgae	Dictyotaceae	*Padina* sp.		6.26	3.50
Site 1	Macroalgae	Sargassaceae	*Sargassum* sp.		9.64	8.38
Site 2	Seagrass	Cymodoceaceae	*Oceana serrulata*	(R.Brown) Byng & Christenh.	7.06	5.30
Site 2	Seagrass	Cymodoceaceae	*Halodule pinfolia*	(Miki) Hartog	1.31	0.97
Site 2	Macroalgae	Sargassaceae	*Sargassum* sp.		7.92	10.69
Site 2	Macroalgae	Dictyotaceae	*Padina* sp.		3.73	4.23
Site 2	Macroalgae	Caulerpaceae	*Caulerpa* sp.	(Vahl) C.Agardh, 1817	6.57	6.50
Site 2	Macroalgae	Anadyomenaceae	*Anadyomene* sp.		5.72	3.03
Site 3	Macroalgae	Dictyotaceae	*Padina* sp.		16.07	26.35
Site 3	Macroalgae	Ulvaceae	*Ulva* sp.		23.22	28.13
Site 3	Macroalgae	Sargassaceae	*Sargassum* sp.		1.25	0.25

Fig. 13. Seagrass species recorded adjacent to the causeway project include *Halophila ovalis* (left) and *Oceana serrulata* (right). (Photos by IT Azucena)

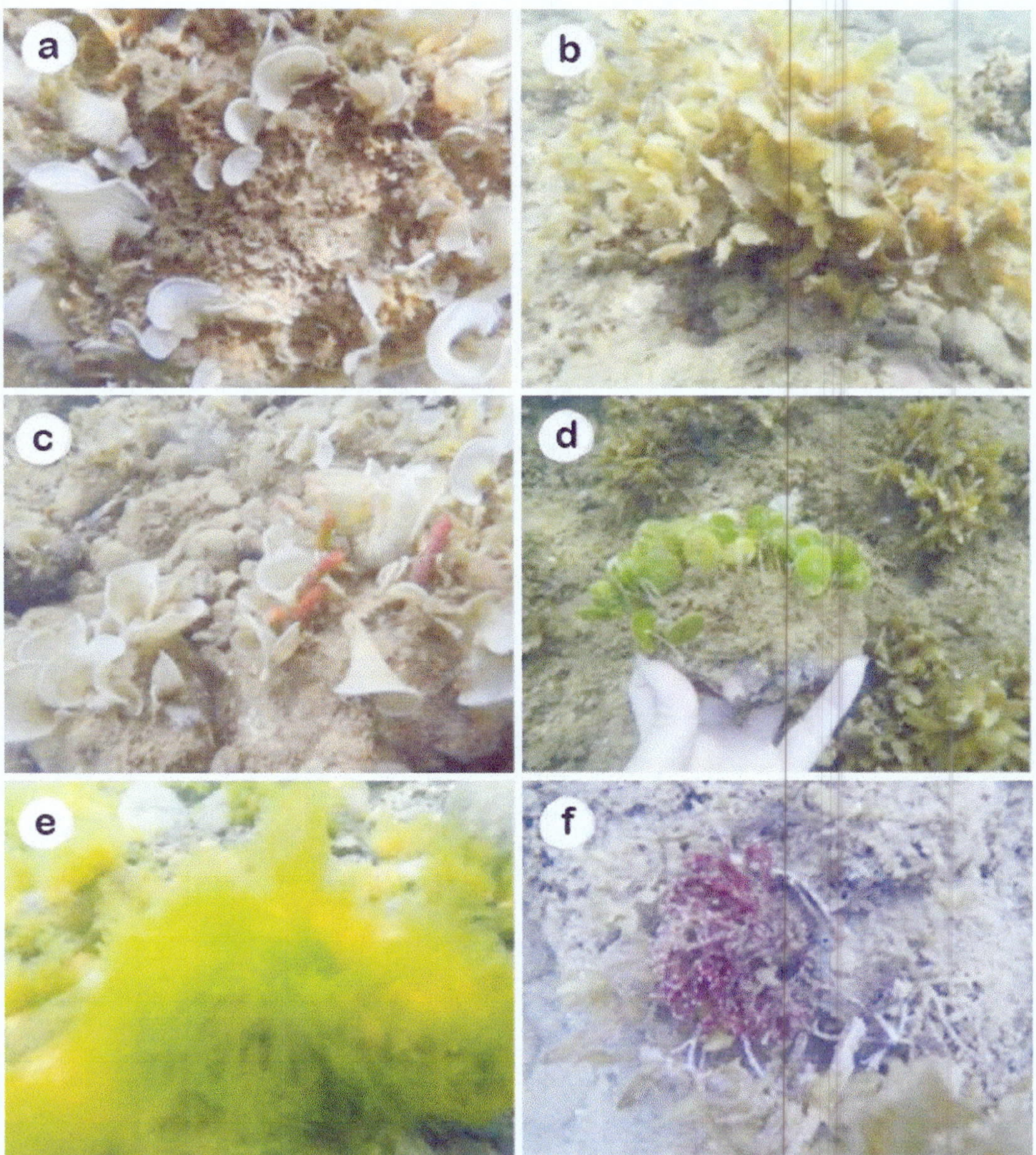


Fig. 14. Some of the macro-algal species recorded at the sampling sites: a. *Padina* sp.; b. *Sargassum* sp.; c. *Bornetella nitida*; d. *Acetabularia major*; e. *Ulva* sp.; f. *Amphiroa* sp. (Photos by IT Azucena)

Seagrass is widely distributed with 18 species found in the Philippines (Fortes 2013), and they thrive in the shallow coastal zone of marine habitat. Both abiotic and biotic factors play a role to regulate seagrass growth and dispersion. The growth and distribution of seagrasses are affected by other organisms such as macroalgae through competition or herbivory. Epiphytes and filamentous algae develop in high density due to high nutrient concentration in the water column. These epiphytes expand their boundary layers around the leaves of the seagrass limiting the uptake of oxygen, inorganic carbon, and nutrients. Filamentous algae can also form dense mats at the seafloor that will reduce water flow around the leaves and reduce the oxygen content in the water when they are degraded (Greve and Binzer 2004). Alteration of the ecological niche of any species will impact its distribution pattern and even morphological features. In the study by Emmclan et al. (2022), they investigated the morphological and biochemical responses of seagrass from family Hydrocharitaceae (*Enhalus acoroides, Thalassia hemprichii, Halophila ovalis, Halophila minor, and Halophila spinulosa)* under the colonization of macroalgae *Ulva reticulata* induced by land reclamation activities. A variation in the morphology of the seagrass leaves was observed, suggesting that species of the Hydrocharitaceae family undergo leaf morphometric changes to adapt to the altered environment. Coastal land development could deteriorate the habitat and water quality for seagrass growth and would cause the proliferation of opportunistic macroalgae that later on would affect them physically and biochemically.

IV. Summary and Recommendations

Corals and seagrass beds were absent along the periphery of the causeway. These habitats were found at the reef sites and intertidal flats adjacent to the structure. Algae dominated the benthic lifeforms in all the reef sites. Seagrasses occurred in patches, which were about 25 to 250 meters away from the causeway. The hard coral cover (HCC) in all the reef sites was at the lowest level (HCC Category D) based on the scale by Licuanan et al. (2019). Coral diversity was also in the lowest category (Coral TAUs =<18; Diversity Category D). The low levels of coral cover and diversity could be attributed to previous and/or existing perturbations such as sedimentation, nutrient runoffs, destructive fishing, overfishing, outbreak of coral predators, among other factors. There were no indications of a contiguous reef directly affected or buried during the causeway development possibly because of its proximity to the river mouth. Coral reefs rarely inhabit areas near the mouth of a river due to freshwater and sediment runoffs. Riverine runoffs may introduce sediment and nutrients into the sea, which can reduce the light illumination to the water column and affect the water quality. Corals prefer areas with low nutrient levels and high light penetration for the photosynthetic activity of their symbiotic algae (zooxanthellae). Sediments can smother and damage coral colonies. Aside from sediments, strong water velocity near the river mouth may also deter the settlement and growth of coral larvae or recruits. However, this report does not discount the possibility of reef formation or patch reefs at the current location of the causeway. If there are reef structures before the causeway was built, the conditions could be comparable to the assessed reef sites. In the absence of baseline data, anecdotal information from the nearby residents or fishing communities could be helpful. They might have a valuable understanding of the historical conditions of the marine environment before the intervention. It should be noted, however, that local knowledge may have its own biases and limitations.

Moreover, causeway construction can impact the coastal area by altering the movement of water and sediments and the speed and direction of water currents. It can also disrupt the patterns in longshore drift or movement of sediments that could result in changes in beach morphology. The altered movement of sediments may also result in changes in coastal erosion and accretion patterns that could be related to coastline stability and susceptibility to coastal floodings, surges, and extreme tidal inundations. A thorough evaluation of the project must be considered before making a causeway to determine the potential impacts and identify adaptive strategies to mitigate the negative impacts. Impact evaluation should take into account the involvement of all stakeholders to ensure that project implementation strategies have considered environmental and natural resources protection, social benefits, and economic gains.

Utilization of modern technologies such as water circulation modeling, remote sensing, and geographic information systems is also essential in coastal causeway construction. Water circulation modeling, for instance, may help in predicting the water and sediment movement, which can be used to identify the most effective and functional causeway design. Furthermore, a detailed survey of the physical profile and resources along the coastal area of Barangay España and adjoining barangays should be considered to determine the changes as the causeway project and related project progresses over some time. Management interventions should be implemented on the adjacent contiguous reef sites to protect the young coral colonies or recruits, enhance coral settlement, reduce the population of COTs, increase the population of associated target and herbivorous fish species, and regulate fishing pressure. Given the proximity of these reefs to river systems, regulatory and monitoring schemes for land-based activities that could induce sedimentation and nutrient loading, and inflict damage to natural buffers such as terrestrial, riverine, and coastal vegetation must also be in place and should adopt a landscape approach.

V. References

Acevedo, R., Morelock, J., and Olivieri, R. A. 1989. Modification of Coral Reef Zonation by Terrigenous Sediment Stress. PALAIOS, 4(1), 92.

Areco MM, Salomone VN, Afonso M dos S. 2021. Ulva lactuca: A bioindicator for anthropogenic contamination and its environmental remediation capacity. Mar Environ Res. 171:105468. doi:https://doi.org/10.1016/j.marenvres.2021.105468.

.

Baldia S, Kabiling MT, Gabriel CA, Abeleda AN, Aguinaldo RC, Clemente KJ, Cordero Jr. P. 2017. Marine macroalgal diversity assessment of Biri Island and Dalupirit Island, Northern Samar, Philippines. Acta Manila Ser A. 65:29–38. doi:10.53603/actamanil.65.2017.vmbh5085.

Connell SD (2005) Assembly and maintenance of subtidal habitat heterogeneity: synergistic effects of light penetration and sedimentation. Mar Ecol Prog Ser 289: 53−61.

Corrales, C. M., Delan, G. G., Rica, R. L. V., Piquero, A. S., Monte, I. A. (2015). A baseline study on coral reef fishes in the marine protected areas in Southern Cebu, Philippines. Tropical Technology Journal, 19 (1). https://doi.org/10.7603/s40934-015-0004-2

Emmclan LSH, Zakaria MH, Ramaiya SD, Natrah I, Bujang JS. 2022. Morphological and biochemical responses of tropical seagrasses (Family: Hydrocharitaceae) under colonization of the macroalgae Ulva reticulata Forsskål. PeerJ. 10:1–32. doi:10.7717/peerj.12821.

English S, Wilkinson C, Baker V. 1997. Survey Manual for Tropical Marine Resources. 2nd Edition. Townsville: Australian Institute of Marine Science.

Fortes MD. 2013. A Review : Biodiversity , Distribution and Conservation of Philippine Seagrasses. :95–111.

Froese, R. and D. Pauly. Editors. 2023.FishBase. World Wide Web electronic publication.www.fishbase.org, (02/2023)

Geraldino PJL, Liao LM, Boo S-M. 2005. Morphological Study of the Marine Algal Genus Padina (Dictyotales, Phaeophyceae) from Southern Philippines: 3 Species New to Philippines. Algae. 20(2):99–112. doi:10.4490/algae.2005.20.2.099.

Greve TM, Binzer T. 2004. Which factors regulate seagrass growth and distribution? Eur seagrasses an Introd to Monit Manag.:19–23.

Harrigan JF (1972) The planula larva of Pocillopora damicornis: Lunar periodicity of swarming and substratum selection behavior. Ph D dissertation, Department of Zoology, University of Hawaii, Honolulu.

Hughes, T. P. (1994). Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef. Science, 265,1547–1551.

Ismail, M., & Tsuchiya, M. (2005). Oxygen consumption rate of the corals Goniastrea aspera, Porites lobata, and Pavona frondifera under red soil stress in the Ryukyu Islands, Okinawa, Japan. Journal of the Japanese Coral Reef Society, 2005(7), 11-22.

Jones, G. P., McCormick, M. I., Srinivasan, M., Eagle, J. V. (2004). Coral decline threatens fish biodiversity in marine reserves. Proceedings of the National Academy of Sciences of the United States of America 101 (21) 8251-8253. https://doi.org/10.1073/pnas0401277101

Jones, R., Fisher, R., Bessell-Browne, P. 2019. Sediment deposition and coral smothering. PLOS ONE 14(6): e0216248.

Kelley R. 2016. Indo Pacific Coral Finder, 3rd Edition. BYOGUIDES. Townsville, Australia.

Kim J.H. 2002. Mechanisms of competition between canopy forming and turf-forming intertidal algae. Algae 17: 33−39

Kohler KE, Gill SM. 2006. Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Computers and Geosciences, Vol. 32, No. 9, pp. 1259-1269, DOI:10.1016/j.cageo.2005.11.009.

McClanahan, T. R., and Obura, D. 1997. Sedimentation effects on shallow coral communities in Kenya. Journal of Experimental Marine Biology and Ecology, 209(1-2), 103–122

McManus, John & Polsenberg, Johanna. 2004. Coral-algal phase shifts on coral reefs: Ecological and environmental aspects [review article]. Progress In Oceanography. 60. 263-279.

Meirelles, P. M., Soares, A. C., Oliveira, L. , Leomil, L., Appolinario, L. R., Francini-Filho, R. B., de Moura, R. L., de Barros Almeida, R. T., Salomon, P. S., Amado-Filho, G. M., Kruger, R., Siegle, E., Tschoeke, D. A., Kudo, I., Mino, S., Sawabe, T., Thompson, C. C., and Thompson, F. L. (2018). Metagenomics of coral reefs under phase shift and high hydrodynamics. Frontiers in Microbiology, 9 (2203). https://doi.org/10.3389/fmicb.2018.02203

Mihalitsis, M., Morais, R. A., Bellwood, D. R. (2022). Small predators dominate fish predation in coral reef communities. PLoS Biology, 20 (11). https://doi.org/10.1371/journal.pbio.3001898

Rina, I., Soemarno, K. Z., Gede Raka, W. D. (2020). Coral reef condition with chaetodontidae fish as the indicators in the waters of Sambler Gelap Island of Kotabaru, South Kalimantan. Russian Journal of Agricultural and Socio-Economic Sciences, 11 (107). https://doi.org/10.185551/rjoas.2020-11.10

Russell BD. 2007. Effects of canopy-mediated abrasion and water flow on the early colonisation of turf-forming algae. Mar Freshw Res 58: 657−665.

Sala, R., Marsaoly, D., Dasmasela, H. Y., Parenden, D., Orisu, D., Tarigan, R. B. (2020). Ecological status of target fishes inside and outside marine protected conservation area of Batbitim, Misool, Raja Ampat. IOP Conference Series: Earth and Environmental Science, 429 (012054).https://doi.org/10.1088/1755-1315/429/1/012054

Stafford-Smith, M. G. 1990. The effect of sediments on Australian scleractinian corals. DPhil thesis; University of York, England.

Stafford-Smith, M.G. 1993. Sediment-rejection efficiency of 22 species of Australian scleractinian corals. Marine Biology 115, 229–243.

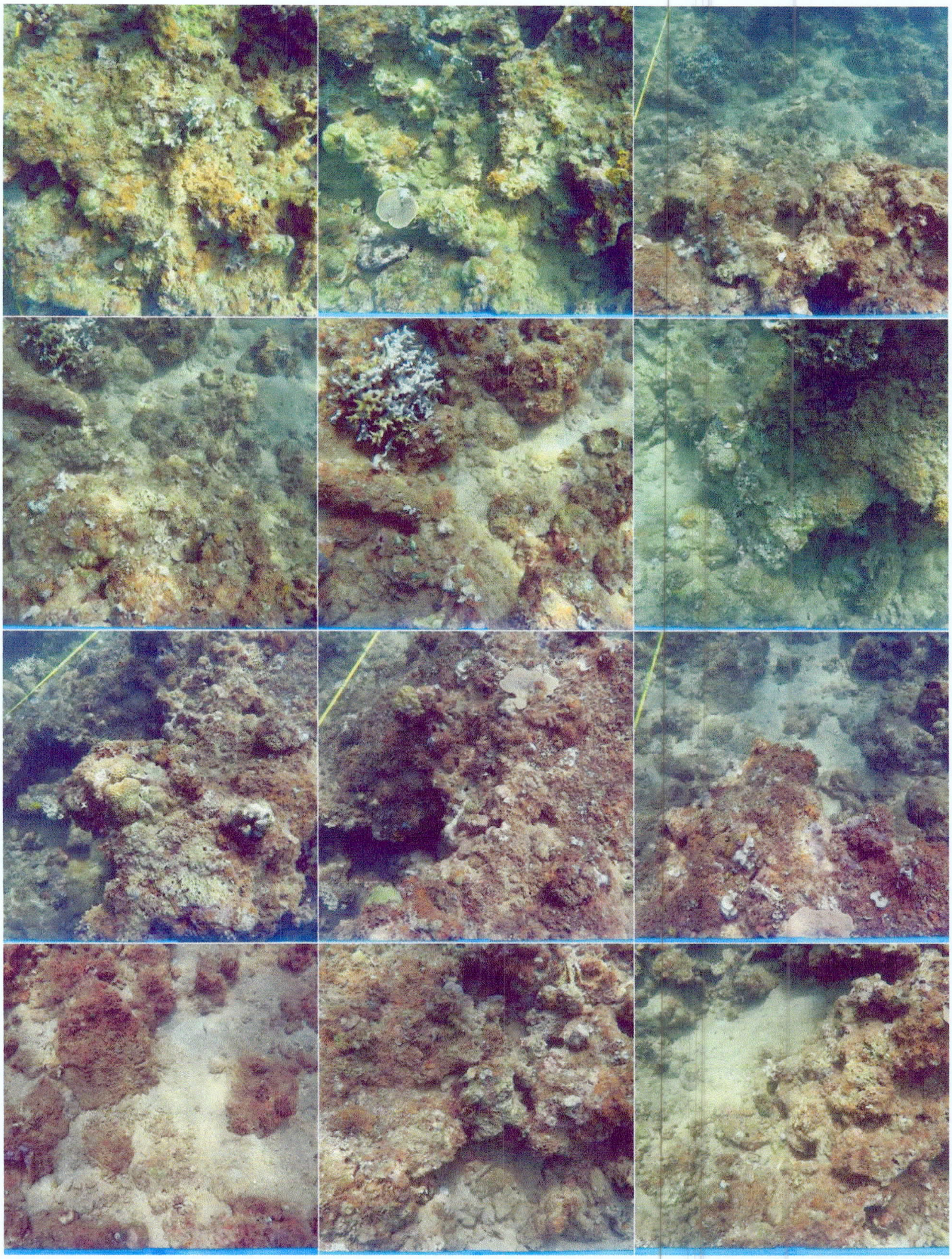
Valavi H, Savari A, Yavari V, Kochanian P, Safahieh A, Sedighi. 2010. Efficiency of Coral Reef Bio-Indicators in the Northern Part of the Persian Gulf. Research Journal of Environmental Sciences, 4: 237-249.

Veron JEN. 1993. Corals of Australia and the Indo-Pacific. University of Hawaii Press. 656 p.

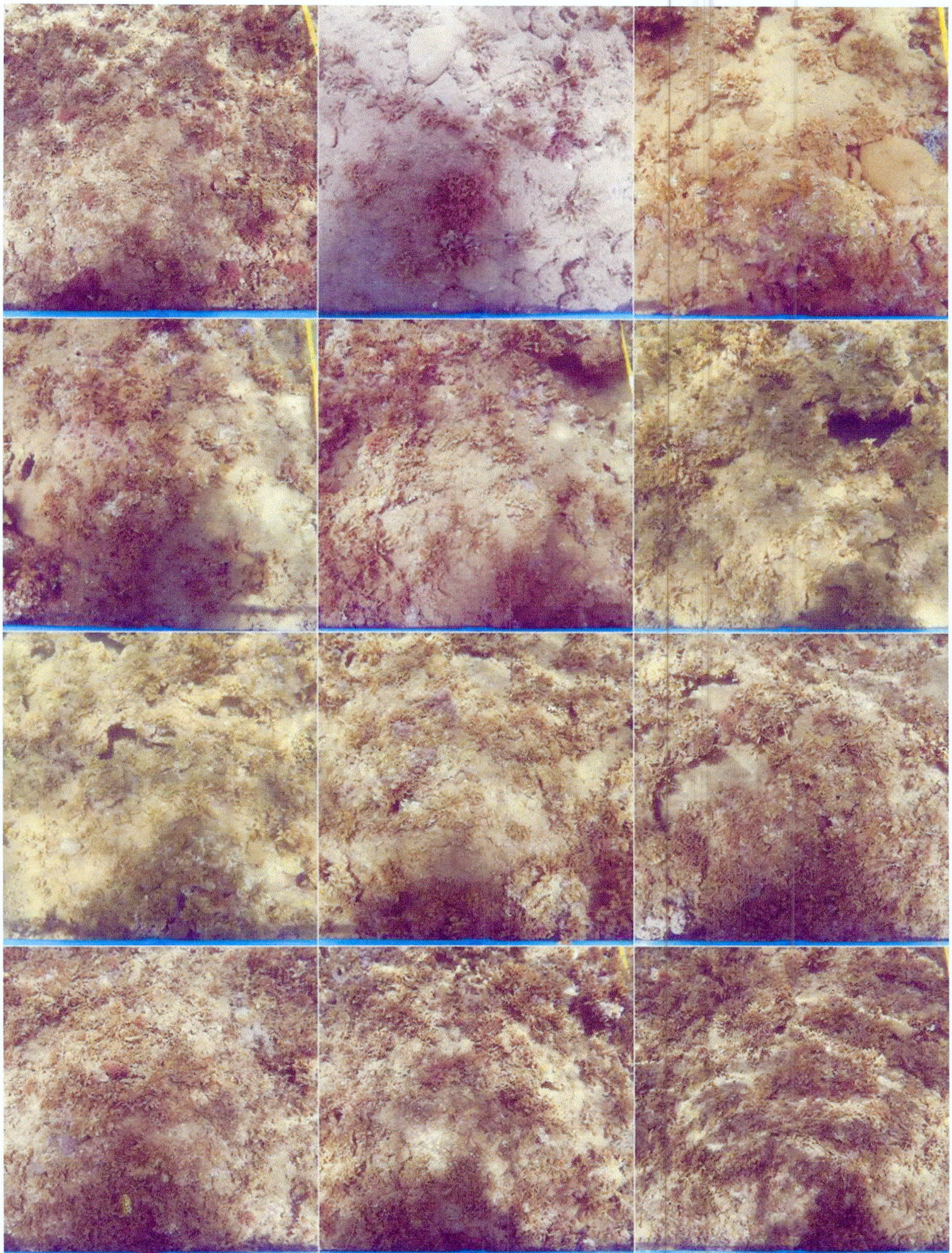
Wernberg T, Kendrick GA, Toohey BD (2005) Modification of the physical environment by an Ecklonia radiata (Laminariales) canopy and implications for associated foliose algae. Aquat Ecol 39: 419−430

Wolanski, E., Richmond, R., McCook, L., & Sweatman, H. (2003). Mud, marine snow and coral reefs. American Scientist, 91(1), 44–51.

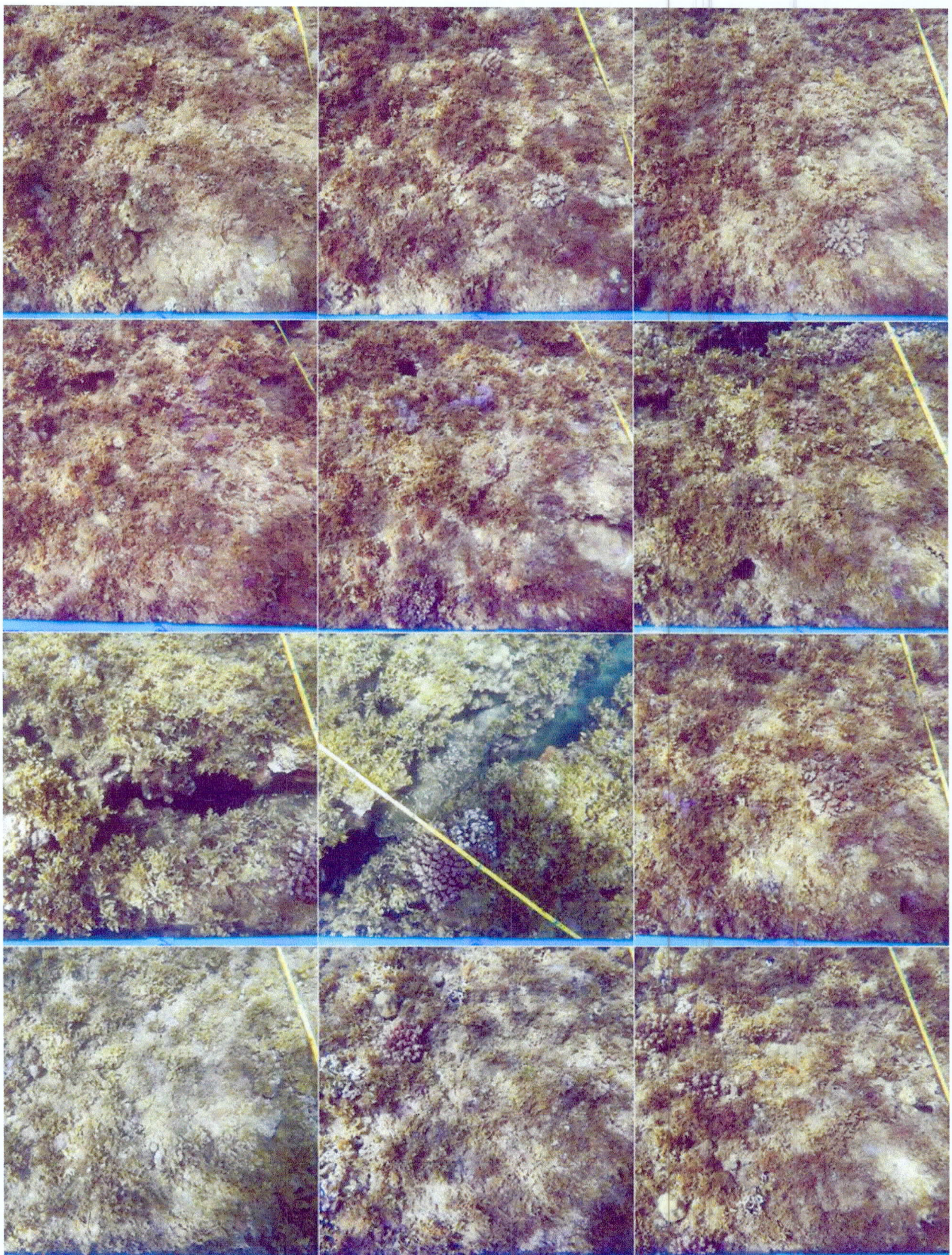
VI. Appendices



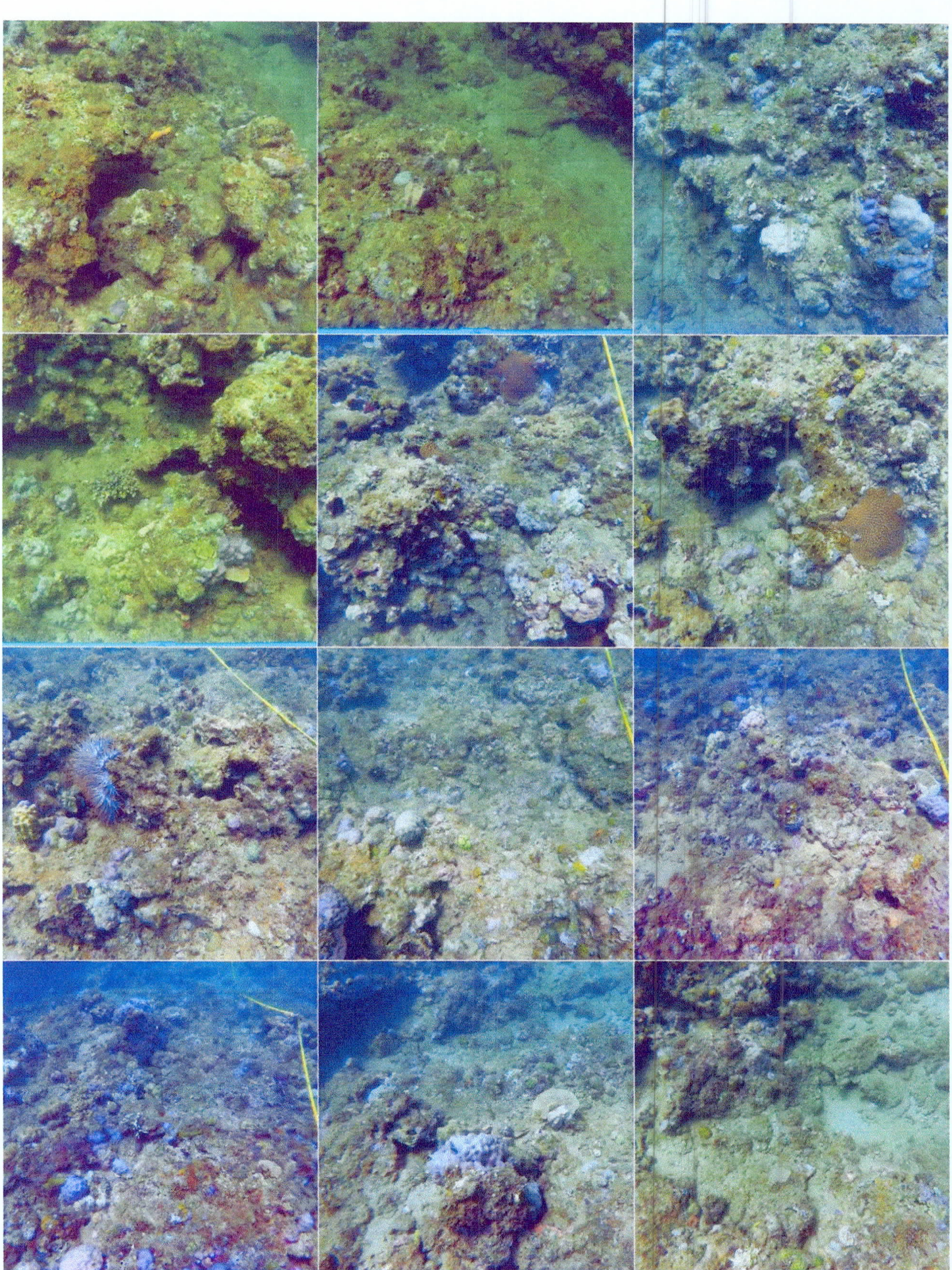
Appendix Fig. 1. Bottom features of Reef Site 2 (RS1) in Sitio Bato. The water depth was between 5 and 6.2 meters. (Photos by: JIM Padin)



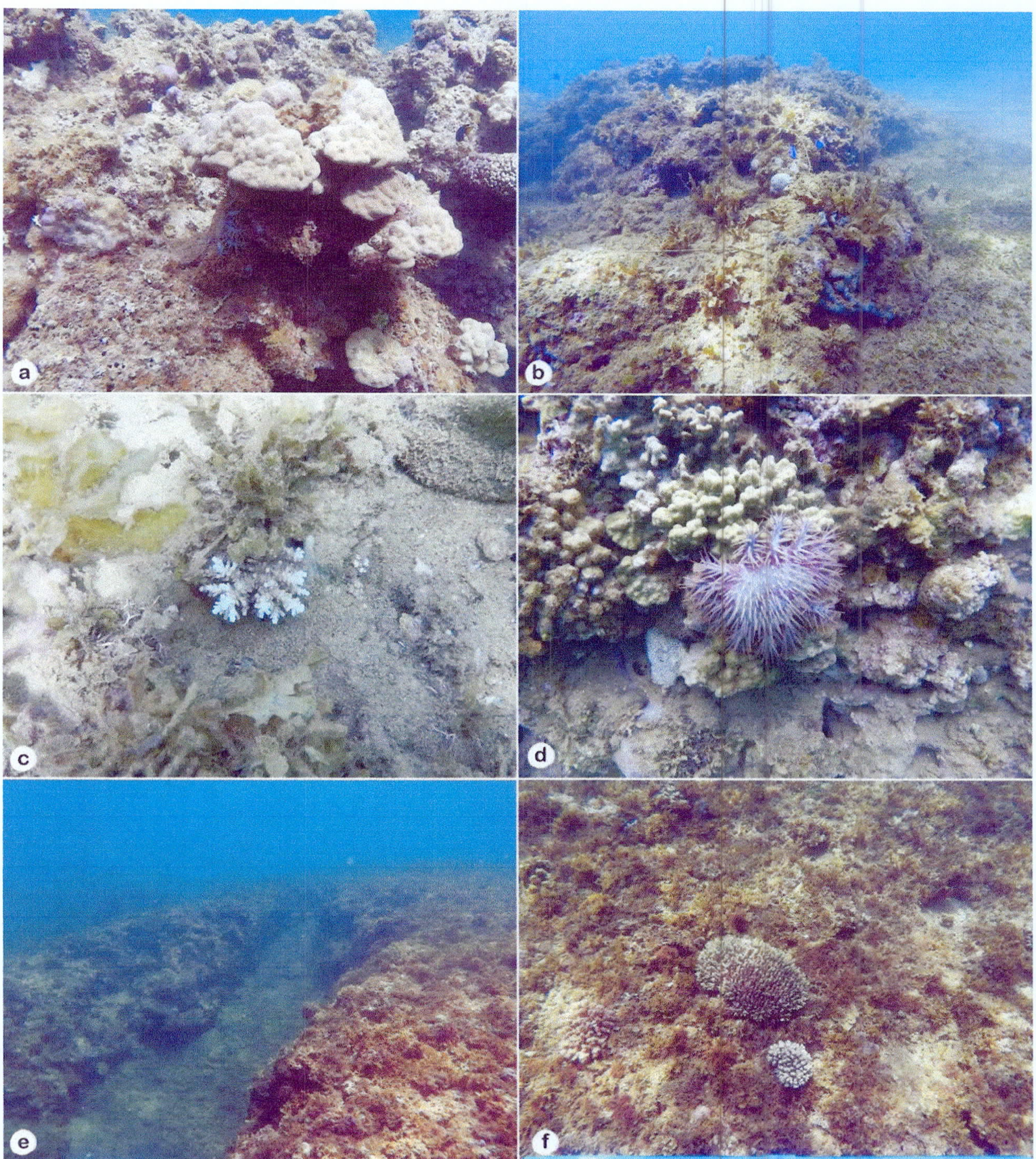
Appendix Fig. 2. Bottom features of Reef Site (RS2) in Sitio Bato. The water depth was between 2.6 and 3 meters. (Photos by: JIM Padin)



Appendix Fig. 3. Bottom features of Reef Site 3 (RS3) in Sitio Taclobo. The water depth was between 3 and 4 meters. (Photos by: JIM Padin)



Appendix Fig. 4. Bottom features of Reef Site 4 (RS4) in Sitio Taclobo. The water depth ranged from 4.8 to 6.2 meters. (Photos by: JIM Padin)



Appendix Fig. 5. Other observations during the underwater survey: a. vertical expansion of *Porites* corals in RS1 Sitio Bato Reef; **b.** macro-algal shift on the reef structure in RS2; **c.** young colony of *Acropora* coral in RS 2; **d.** COT feeding on *Porites* colony in RS2; **e.** groove formation at the shallow reef of RS 4; **f**. *Acropora* and *Pocillopora* growing on algal-dominated reef surfaces in RS4. (Photos by JIM Padin)

Appendix Fig. 6. Coordination and linking up the assessment activities: **a.** courtesy visit at the office of the municipal mayor of San Fernando, Sibuyan; **b.** leveling-off meeting with APMC representative staff; **c-e.** equipment preparation and site orientation; **f.** CRERDEC and PENRO Romblon assessment team with APMC field staff. (Photos by DENR PENRO Romblon)