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Honiara Coastal and Marine Assessment Report, Solomon Islands

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Honiara Coastal and Marine Assessment Report, Solomon Islands

Prepared by Ronnie Posala & Stephen Mosese

The authors prepared this report in contribution to the Honiara Coastal Assessment consultancy led by Pasifiki Consulting Services in Honiara and commissioned by the Solomon Islands International Waters Ridge to Reef Project.

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ABBREVIATIONS

B & F	Benthic and Fish Sampling stations
BYO	Be Your Own
CITES	Convention on International Trade in Endangered Species of wild fauna and flora
COTs	Crown of thorns starfish
CPCe	Coral Point Count extension
GPS	Global Positioning System
IWR2R	International Waters Ridge to Reef
MECDM	Ministry of Environment, Climate change, Disaster & Management
MFMR	Ministry of FISHERIES AND Marine Resources
MT	Manta Tow
PICT	Pacific Island Countries Territories
RFID	Reef Fisheries Integrated Database
R2R	Ridge to Reef
SCUBA	Self-Contained Underwater Breathing Apparatus
SPC	Secretariat of the Pacific Community
UPT	Underwater Photographic Sampling methods with Transects
UVC	Underwater Visual Fish Census Survey

EXECUTIVE SUMMARY

This report was prepared in contribution to the Honiara Coastal Assessment consultancy led by Pasifiki Consulting Services in Honiara and commissioned by the Solomon Islands International Waters Ridge to Reef Project.

The researchers conducted the Honiara coastal ecology baseline assessment in late July to August 2020. The assessment covered a total sampling area of 15,000m² and it employs broad-scale and fine-scale assessment methods to obtain descriptive information and data of Honiara coastal habitat, benthic communities and the diversities of corals, invertebrates, and reef fish.

The coastal reef conditions of Honiara are relatively poor, with an overall average live coral cover being 5%. This coral cover estimate is alarmingly lower than the average cover range in other major archipelagic sites of the Solomon Islands. The recent national coral survey (2018 – 2019) by MFMR indicated a live coral coverage of 13% to 27%, and 29.4% to 47.5% by TNC report (Hughes 2006). Live coral cover decreases from west to east Honiara, whereby findings indicated sand, silt, and dead corals with algae to be dominant in the central and east section of Honiara.

The benthic communities mainly consist of sub-massive and massive forms of corals belonging to the genus *Porites* spp. A total of fifteen (15) genera and nine families of corals were recorded. Other common invertebrates recorded were *Laevigata laevigata*, *Holothuria atra*, *Diadema setosum*, *Niloticus niloticus*, *Acanthaster planci* and *Tridacna maxima*.

A fish list was compiled and consists of thirty-one (31) species, twenty (20) genera and nine (9) families. Pomacentridae was the dominant family in species diversity and abundance. Pomacentrids are smaller non targeted fish species which are virtually common in most coastal and reef habitats. Key targeted fish species were few (Labridae, Mullidae and Scaridae) and uncommon which may have been overfished by local fishers.

The survey results suggest dominance of algae overgrowth, sand and rubbles suggesting quality of water is polluted and contaminated with nutrient overloads and discharges. A small proportion of live coral cover in the western end of Honiara, around Whiteriver and Kakabona suggests processes of dilution and dispersion more pronounced which enables cleaning of sediments and silts suspended in the water column thereby impacting on the coral growth.

However, the opposite trend of extremely poor growth of live corals in the areas adjacent to the main city area to Lungga suggest that the extent of the impacts was due to land-use activities, sediment/ waste exported from upstream and local populations into the waterways. Fishers and locals who frequently fish from fishing grounds close by Honiara are affected because of relatively low numbers of targeted fish species and the contamination levels exceeding safe thresholds in key strategic areas along the Honiara coastline.

The study provides the opportunity to collect baselines of key indicators relative to the ecology and biology of coastal/ marine ecosystems along reef and non-reef areas along the Honiara City waterfront stretching from Kavare-Whiteriver to Ranadi Seafront.

1.0 INTRODUCTION

In 2020 the Solomon Islands International Waters Ridge to Reef (IW R2R) Project and the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDMM) commissioned a consultancy to prepare a Honiara Coastal Assessment. This consultancy is expected to produce the outputs and deliverables necessary to achieve the intended outcomes of the project that document the sources of pollution and nutrient along the Honiara coastal areas, identify the environment impacts and suggested management measures addressing such impacts.

Consequently, a Coastal Impact Assessment is required as an initial task for IW R2R to undertake Honiara Coastal Environment Baseline Assessment (covering water quality & habitats). The Honiara Coastline Baseline Assessment presents the key results, highlighting brief descriptions of existing natural environment and anthropogenic development actions along the Honiara coast to ultimately guide policy and action.

There are four main studies informing this report - Ecological & Biological, Bathymetry & Hydrography, Water quality, and a cumulative environmental impact assessment. This report focuses on the ecological and biological assessment of Honiara coastal areas. The Honiara coastal ecology baseline assessment was conducted in July-October 2020, led by researchers from the Ministry of Fisheries.

The objectives of the ecological and biological assessment study were to conduct baseline surveys and document results on the;

i. Honiara coastal habitat and major substrate cover,
ii. Benthic communities and coral diversity,
iii. Invertebrate and fish diversity.

The results establish the vital baseline information on the status of the Honiara coastal ecology and biodiversity.

2.0 METHODOLOGY

The study follows the Honiara Coastal and Marine Biodiversity Assessment Sampling Strategy and Standard Operation Protocol for Macro Benthic Survey in Honiara Coast, appended as Annex 1. The strategy covers broad and fine scale assessment protocols published and used by the SPC FAME Division and fisheries agencies throughout the SPC membership – see details below.

2.1 BROAD-SCALE ASSESSMENT METHOD

The manta tow (MT) survey was based on the standardized SPC methods (see Figure 1). Details of the assessment methods are found in Pakoa *et al* 2014, which is an SPC manual on tropical marine invertebrate resource assessment.

The MT method requires these set of basic equipment, personals and the following procedures;

A. Equipment:

i. Boat with working engine.
ii. GPS to record start and end positions of transect.
iii. MT board with pencil attached to a boat using a 20m rope in length (see Figure 1b).
iv. Invertebrate data recording sheet and specific manta data sheet to record transect positions, weather, and water conditions (Figure 1c).
v. Hand counter mounted on manta tow board.
vi. Snorkeling gear, wetsuit, and protective gloves.

B. Personals: a team of three people was involved, a surveyor, a manta tow director who records GPS positions and a skillful boat driver (see Figure 1d).

C. Procedure:

i. Locate where the MT survey will begin. Prior planning is important for selecting MT survey sites.
ii. Data record sheet was mounted onto the manta board with pencil attached to the board using a string.
iii. A 20m manta rope was attached to the boat.
iv. The MT director coordinates the MT sampling from the boat by communicating with the boat skipper and the surveyor. Visual contact with the surveyor was maintained to ensure safety, whilst the skipper was responsible for the safety of the boat by looking out for shallow reefs, rocks, and other vessels.
v. The MT survey was conducted along the reef flat and edge of the reef system. The MT director measures the distance (300m) on the GPS using the 'odometer' trip function.
vi. The boat stops at the end of each tow and the surveyor records the habitat data for the completed MT replicates. The boat was then moved 10m – 20m from the end position of the previous replicate, and in the general directions of the tows, before starting the next replicate. This ensures that the tows are not contiguous but instead randomly placed. This was repeated until all six manta tows (replicates) a completed for each station.

The broad-scale MT survey provides habitat descriptive data and invertebrate species occurrences. With a coverage of 300m x 2m per transect, a MT station[1] covers 3,600m² sampling area, sufficient number of MT stations had supported with site selections for conducting fine-scale assessments.

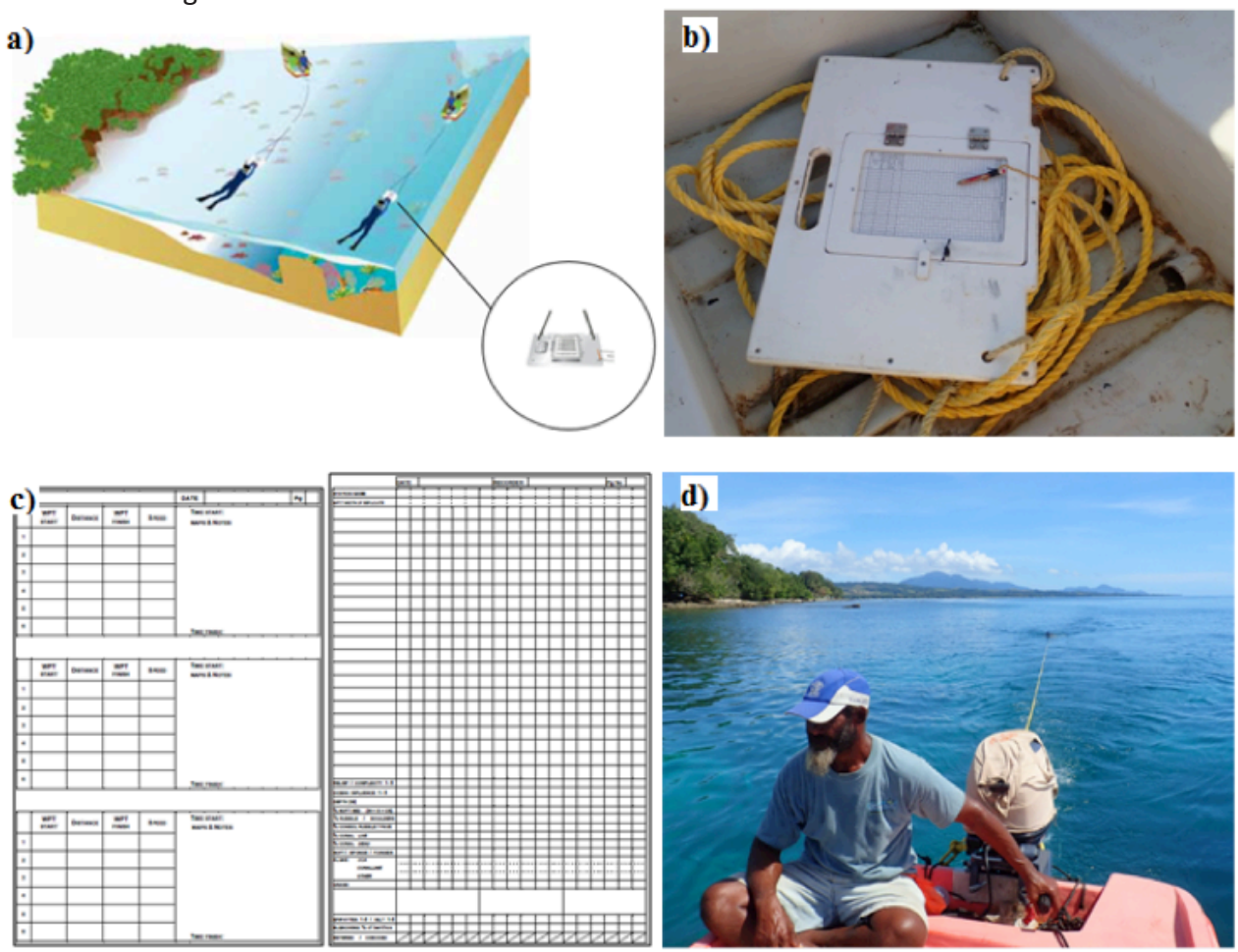


Photo (b) and (d): Stephen A. Mosese and Ronnie Posala

Figure 1: (a) Manta tow (MT) illustration; (b) MT board with pencil and 20m rope attached; (c) Specific MT data sheets and invertebrate data recording sheets; (d) MT being conducted in Honiara coastal area, 2020.

The researchers utilized the Reef Fisheries Integrated Database (RFID) in the analysis of the MT data sets (Invertebrates and major substrate data's). The RFID is a standardized regional data management tool developed by SPC for PICT's. It was designed to ease data entry and data analysis and provide quality control and data storage for future comparisons.

2.2 FINE-SCALE ASSESSMENT METHOD

2.2.1 BENTHIC COMMUNITY ASSESSMENT

The fine-scale assessment-design involved the integration of several standardized methods, specifically to capture representative data samples at target sites, while enabling coral resources by specific taxa to be captured in sufficient detail. Corals were identified at the genus level based on the Indo-Pacific Coral Finder[2] BYO guides.

1 *Manta tow (MT) station consists of six transects (300m x 2m per transect).*

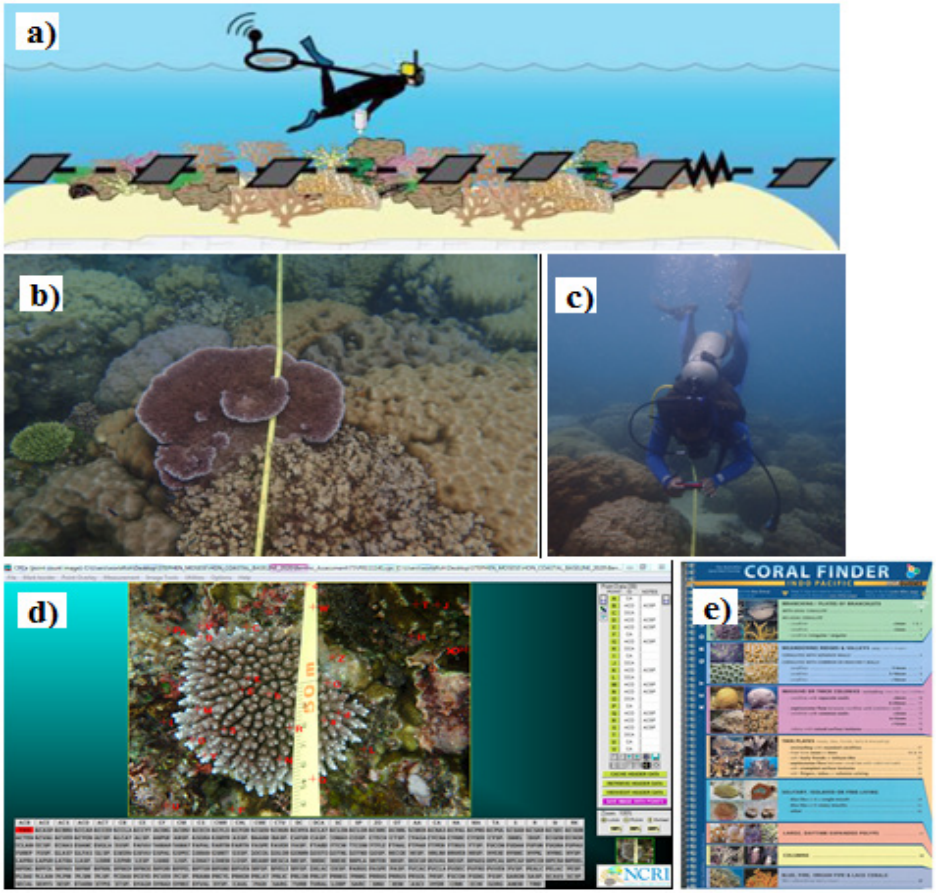
2 *The Indo-Pacific Coral Finder is a Visual Decision Tool that brings reliable genus level identification. Using a visual navigation system the Coral Finder requires nothing more than a keen eye to get results (https://www.byoguides.com/coralfinder/).*

The methods employed (Figure 2) were:

A. UPT: the Under Water Photographic Sampling method with Transects. A 50m x 2m transect line was laid on the seafloor within depths of 3m – 25m; photographic samples of the benthic cover were taken along the transect at every meter interval, thus a total of 51[3] photos per transect. A single station was established per site, consisting of two transect replicates.

B. The photos were analyzed using CPCe computer software. The Coral Point Count with Excel extension is a windows-based software that provides a tool for the determination of benthic and coral cover along the transect. Thirty (30) random points were spatially distributed on each photographic sample, and each point was broadly classified into major benthic/substrate cover, up to the genus level where corals were present.

C. Indo-Pacific Coral Finder Tool: the coral finder visual tool was utilized in the classifications of coral taxa by genus, supplemented by available sources of references by Veron and online databases[4].



Photos (b), (c) and (d): Stephen A. Mosese and Ronnie Posala

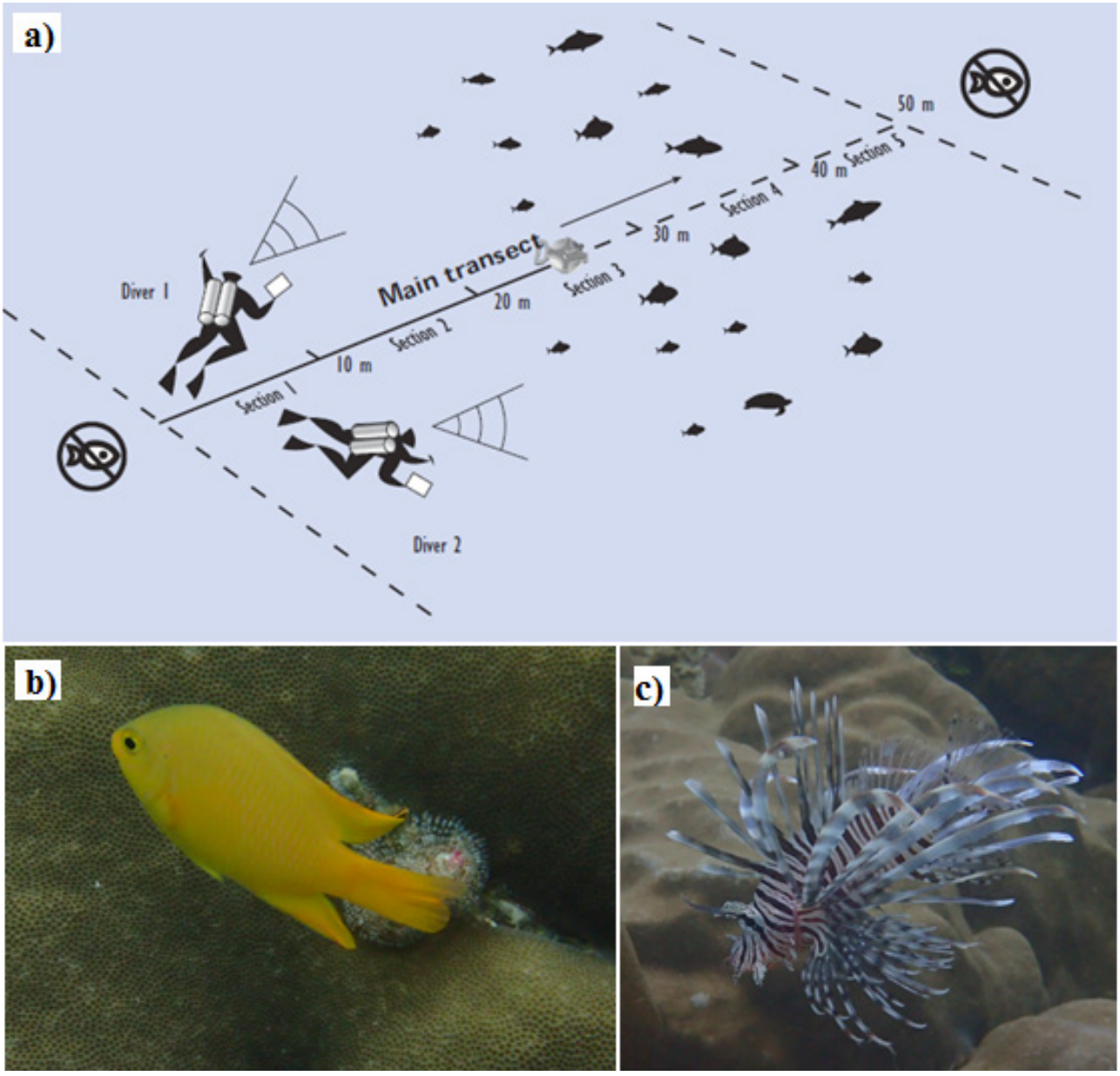
Figure 2: (a) Underwater Photographic Sampling with Transect (UPT) illustration; (b) Transect being laid on sea floor; (c) Photographic sampling of benthic cover being gathered by surveyor with SCUBA gears; (d) CPCe software utilized in the analysis of photographic samples of benthic cover and corals; (e): classifications of coral taxa based on the coral finder tool.

[3] *Not limited to 50 photos. Additional sampling photos were being collected for coral species where thorough identifications of the corallite structure were required. These are photo-imagery captured in close-up view – macroscopic mode of the underwater camera (T5 Olympus canon).*

[4] *Supplementary sources for coral species classifications include the online databases: Corals of the World (http://www.coralsoftheworld.org/) and Coralpedia (https://coralpedia.bio.warwick.ac.uk/).*

2.2.2 FISH ASSESSMENT

Underwater Visual Fish Census Survey (UVC) was based on SPC standard method (Labrosse *et al* 2002). In Figure 3, each transect measures 50m in length and 2m in width. With SCUBA gears, the researchers carried out the surveys within the 2m width and along the 50m transect line, giving an area of 100m² per transect. Underwater videos and photographic samples of reef fin-fish species were gathered with underwater cameras for thorough desktop analysis.



Photos (b) and (c): Ronnie Posala

Figure 3: (a) Standard SPC Underwater Visual Fish Census Survey (UVS) illustration; with fish photographic samples of (b) Pomacentrus moluccensis and (c) Pterois volitans.

3.0 RESULTS

3.1 SURVEY COVERAGE

Ten sampling stations were established along the coastal waters of Honiara. Broad-scale and fine-scale survey methods were employed, which constitute to four MT stations and six B&F[6] stations (Table 1 and 2). A total sampling area of 15,000m² was covered of back and fore front reef habitats. Manta tow covered 96% of the total assessed area whilst 4% were covered by fine-scale method; see Table 1, 2 and Figure 4.

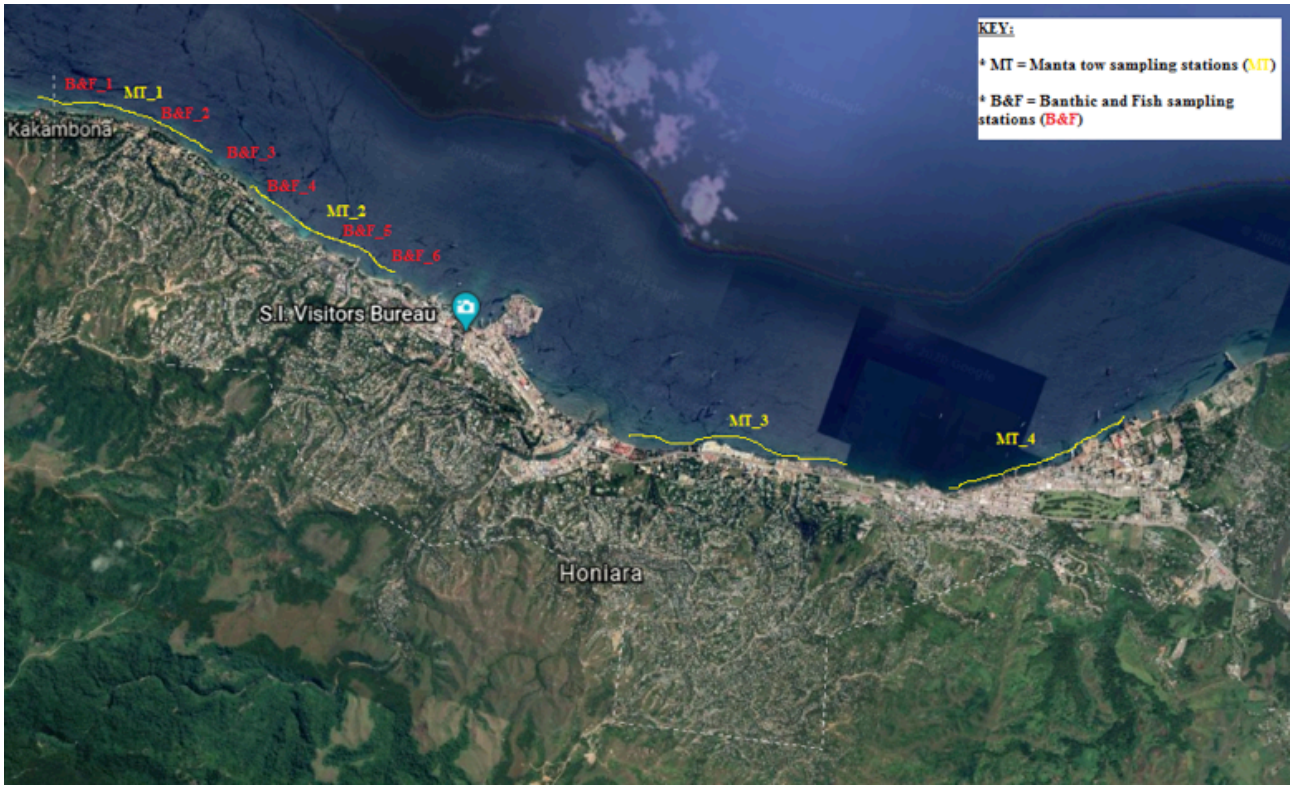
Table 1: Manta tow (MT) stations and sampling details .

Station/Site	Description	Replicates	Start point		End point		Total surface area (m²)
			Latitude	Longitude	Latitude	Longitude	
MT_1	Kavare area to Whiteriver seafront; 3.17m mean depth.	1	09 25'40.8	159 54'42.4	09 25'37.3"	159 54'51.4"	600
		2	09 25'37.3"	159 54'51.4"	09 25,35.3"	159 55'01.3"	600
		3	09 25,35.3"	159 55'01.3"	09 25'33.8"	159 55'11.3"	600
		4	09 25'33.8"	159 55'11.3'	09 25'32.9"	159 55'21.4"	600
		5	09 25'32.9"	159 55'21.4"	09 25'34.8"	159 55'31.4"	600
		6	09 25'34.8"	159 55'31.4"	09 25 36.9"	159 55'41.3"	600
MT_2	Tandai to Mendana Avenue seafront; 4.33m mean depth.	1	09 25'37.6	159 55'43.9	09 25 39.6"	159 55'55.8"	600
		2	09 25 39.6"	159 55'55.8"	09 25'44.9"	159 56'04.7"	600
		3	09 25'44.9"	159 56'04.7"	09 25'47.5"	159 56'14.8"	600
		4	09 25'47.5"	159 56'14.8	09 25'49.6"	159 56'24.6"	600
		5	09 25'49.6"	159 56'24.6"	09 25'52.7"	159 56'39.1"	600
		6	09 25'52.7"	159 56'39.1"	09 25'51.6"	159 56'49.3"	600
MT_3	National Referal Hospital to Fishing village seafront; 3.17m mean depth, dark sandy bottom dorminates.	1	09 26'11.3"	159 58'15.6"	09 26'09.9"	159 58'26.7"	600
		2	09 26'09.9"	159 58'26.7"	09 26'06.1"	159 58'36.3"	600
		3	09 26'06.1"	159 58'36.3"	09 26'04.8"	159 58'46.7"	600
		4	09 26'04.8"	159 58'46.7"	09 26'03.5"	159 58'57.1"	600
		5	09 26'03.5"	159 58'57.1"	09 26'00.2"	159 59'06.4"	600
		6	09 26'00.2"	159 59'06.4"	09 25'59.0"	159 59'16.6"	600
MT_4	Marine school to Ranadi seafront; 3.33m mean depth, dark sandy bottom, dead corals and high turbidity with litterings and urban wastes.	1	09 25'55.6"	159 59'50.9"	09 25'51.1"	159 59'59.2"	600
		2	09 25'51.1"	159 59'59.2"	09 25'44.6"	160 00'07.5"	600
		3	09 25'44.6"	160 00'07.5"	09 25'39.6"	160 00'16.3"	600
		4	09 25'39.6"	160 00'16.3"	09 25'32.3"	160 00'22.9"	600
		5	09 25'32.3"	160 00'22.9"	09 25'24.9"	160 00'28.5"	600
		6	09 25'24.9"	160 00'28.5"	09 25'17.7"	160'00'35.4"	600
				Total:			14,400

[6] *B&F: Benthic and Fish sampling stations.*

Table 2: Benthic and fish sampling stations details.

Station/Site	Description	Start point		End point		Total surface area (m²)
		Latitude	Longitude	Latitude	Longitude	
B&F_1	Kavare seafront	09° 25'38.8"	159° 54'47.4"	09° 25'38.5"	159° 54'48.6"	100
B&F_2	Kakabona area	09° 25'37.0"	159° 54'53.5"	09° 25'36.8"	159° 54'54.9"	100
B&F_3	Kakabona/Whiteriver area	09°25'36.3"	159° 55'40.1"	09° 25'37.6"	159° 55.40.9"	100
B&F_4	Tandai seafront	09° 25'44.0"	159° 56'03.1"	09° 25'45.0"	159° 56'04.3"	100
B&F_5	Iron Bottom Sound (IBS) area	09° 25'50.8"	159° 56'36.8"	09° 25'52.0"	159° 56'37.9"	100
B&F_6	Mendana Avenue seafront	09° 25'51.6"	159° 56'56.0"	09 °25'52.5"	159 °56'57.0"	100
					Total:	600



Source: Google earth, 2020.

Figure 4: Manta tow (MT), benthic and fish (B&F) sampling sites in Honiara coastal areas, 2020.

3.2 HABITAT AND MAJOR SUBSTRATES

MT survey results of the major substrates in Honiara coastal areas were provided in Figure 5 and Figure 6: (a), (b), (c) and (d); respectively, working from west Honiara to east Honiara.

Results for the western boundary of Honiara at Kakabona, Kavare seafront, shows a similar trend in major substrate cover all the way to Whiteriver, Tandai and Mendana Avenue seafront (see MT_1 and MT_2); 10% – 40% cover ranges for boulders, 10% – 60% for sand, dead coral cover ranges in 20% – 30%, and live coral cover falls in 10% in all replicates. These are the four dominant substrates for the coastal areas in west Honiara. Noting that, few minor freshwater outlets were present amongst these sites.

Third MT sampling station (MT_3) was conducted along the central section of Honiara coastal area, from the National Referral Hospital seafront to the Fishing village seafront. Result shows the dominance of sand in all replicates. Specifically, these are mixture of silt, sand and dark inland sediments that are common in these sites due to the proximity of the Mataniko outlet – the source site – and the influence of water movements and sediment discharges.

Marine school to Ranadi seafront area shows much similar trend in major substrate cover in all replicates (fourth MT sampling station – MT_4). Sand dominates in cover ranging from 50% – 100% amongst replicates, followed by boulders, dead corals, and consolidated rubbles. Hard substrates and live corals were becoming much less common within these parts of Honiara coastal areas.

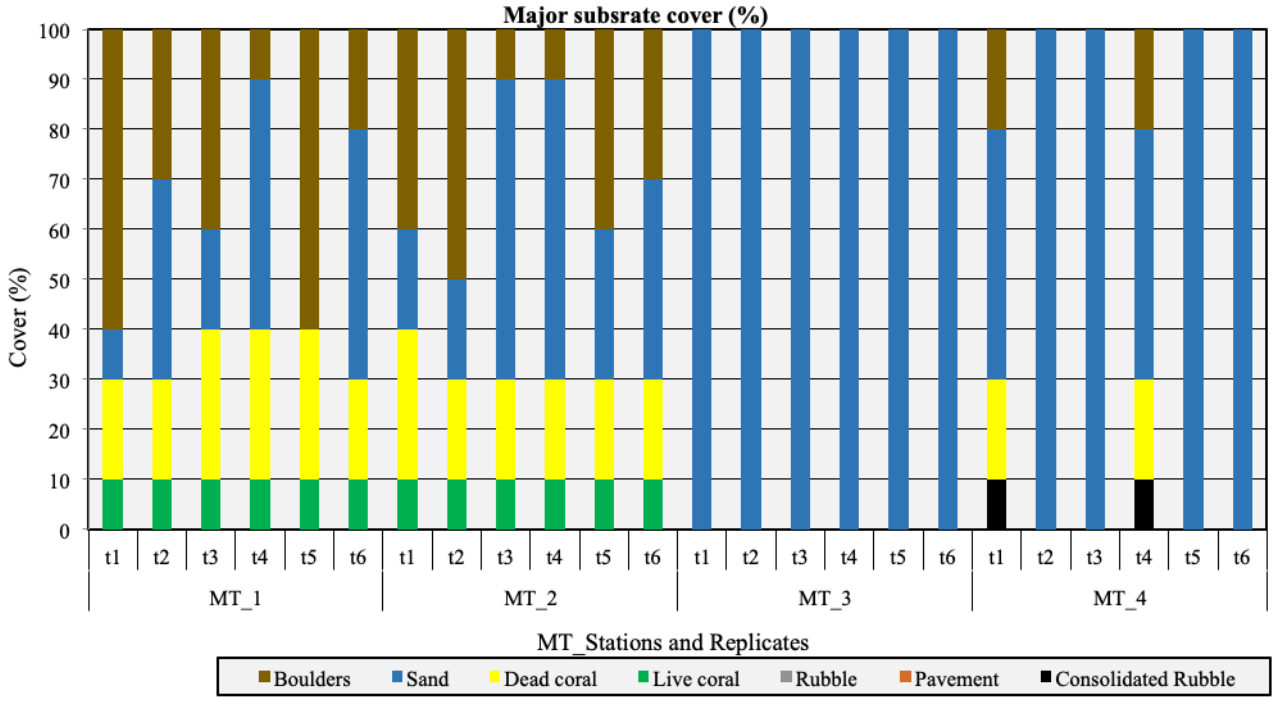
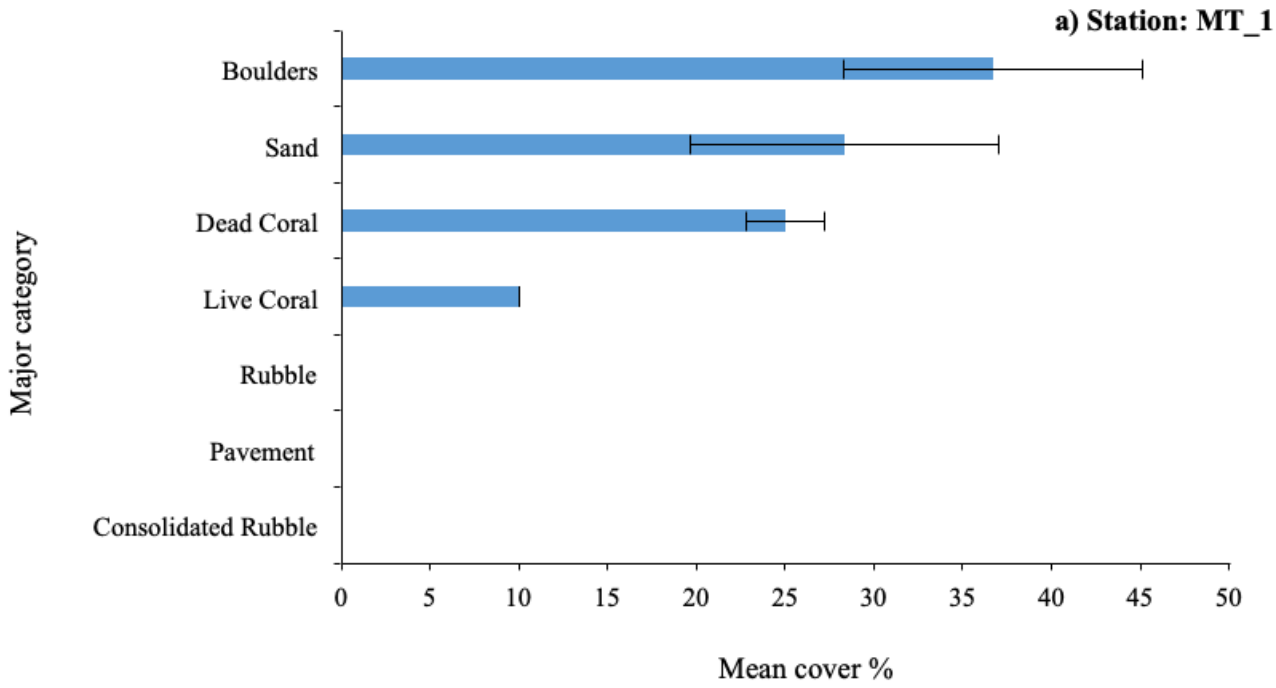


Figure 5: The MT survey results across all sampling stations and replicates.



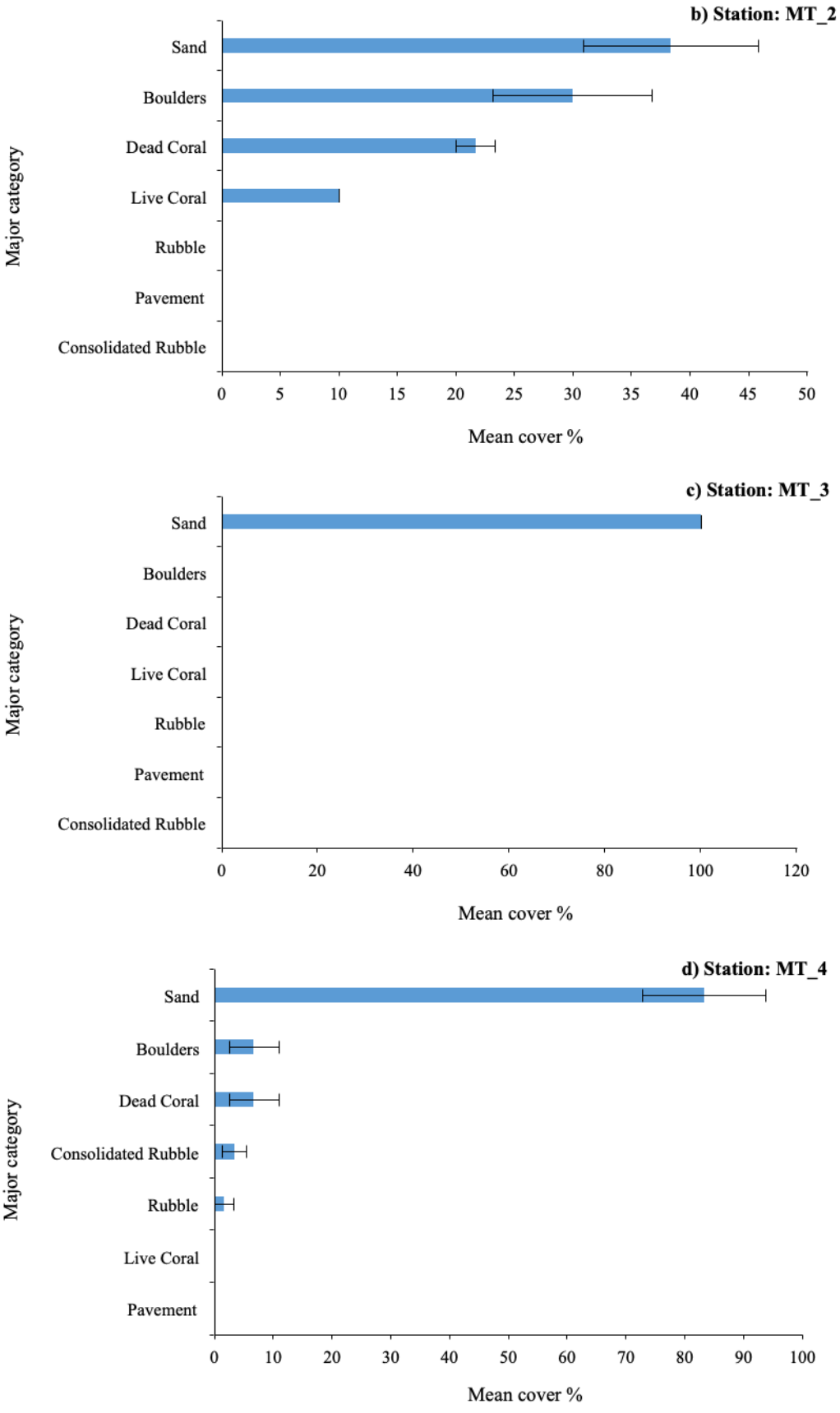


Figure 6: Major substrates mean % cover (± SE) across MT sampling stations 1(a), 2(b), 3(c) and 4(d).

3.3 BENTHIC COMMUNITIES

3.3.1 BENTHIC COMPOSITION

Fine-scale assessments were conducted on the reefs of west Honiara where live coral communities are present. The results are shown in Figure 6. MT results (Figure 5 and 6) had indicated the dominance of sand and dead corals in the central and east Honiara coastal sites thus these areas were excluded.

Hard corals were more common than other biota. The result indicates the coverage of 31.36% ± 4.99 of sub-massive corals and 19.85% ± 6.54 of massive corals, these are the two dominant hard coral forms. Dead corals with algae and coralline algae consist of 17.6% ± 4.6 and 11.84% ± 3.75 in coverage respectively. Other coral forms observed were encrusting (3.72% ± 2.53), branching (2.96% ± 1), digitate (0.56% ± 0.35), tabulate (0.39% ± 0.34), foliose (0.23% ± 0.09), Acropora branching (0.14% ± 0.1) and tubipora (0.11% ± 0.1).

Sponge (0.47% ± 0.19) and other biota observed were relatively lower; these includes macro algae (1.22% ± 0.5), halimeda (1.14% ± 0.6), other species of marine fauna (unclassified) (0.14% ± 0.01) and turf algae's (0.14% ± 0.06).

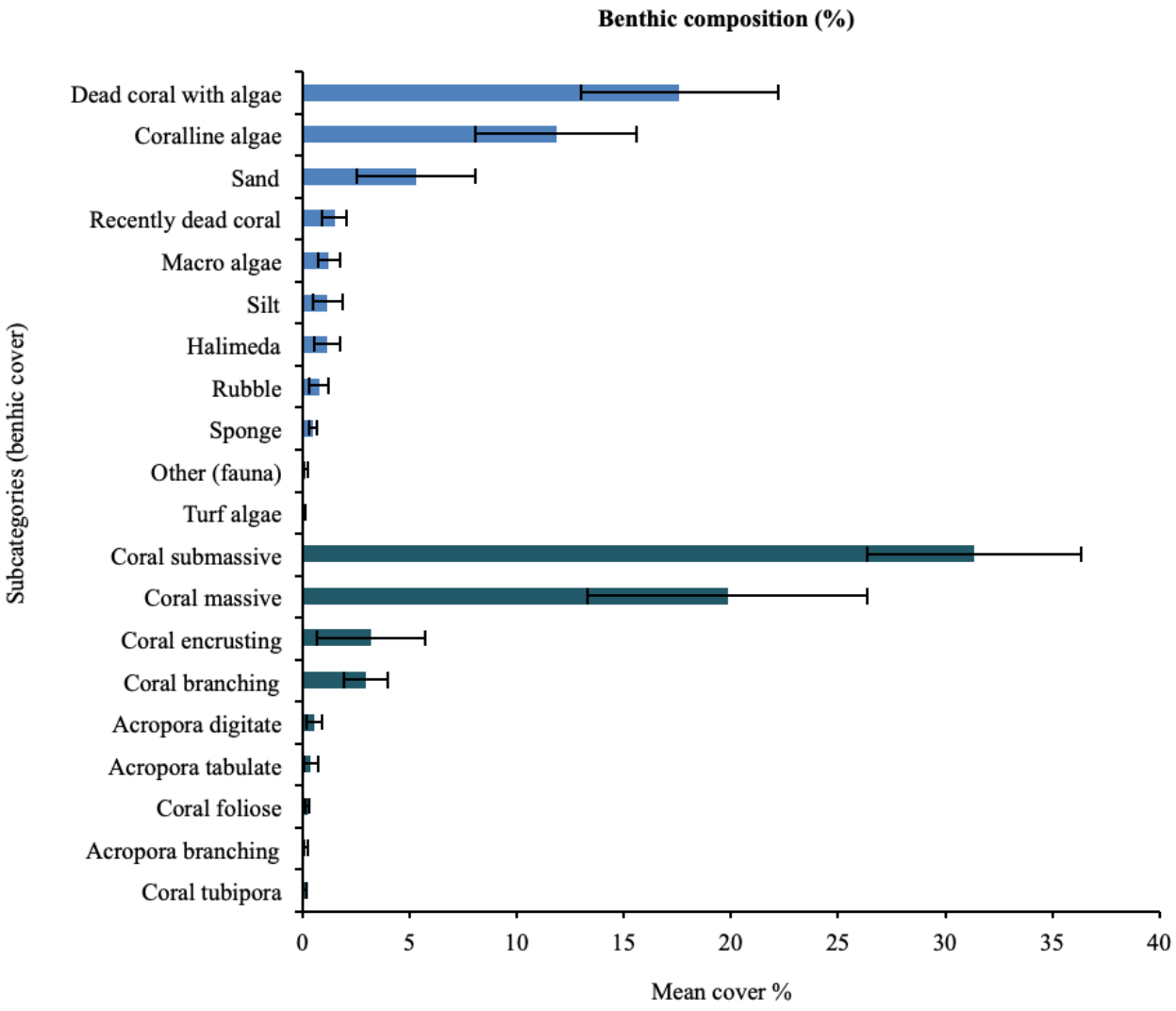


Figure 7: The subcategories and mean % cover (± SE).

3.3.2 CORAL DIVERSITY AND COMPOSITION

Nine families and 15 genera of corals were recorded in the study; see Table 3 for the complete list. These are stony corals of the Order Scleractinia. The dominant coral families are shown in Figures 8 and 9.

Results in Figure 7 indicate coral composition in mean % cover; the genera *Porites* spp. is relatively the highest with 54.46% ± 6.49; followed by *Acropora* spp. (1.39% ± 0.44), *Pocillopora* spp. (1.12% ± 0.47) and *Diploastrea* spp. (0.78% ± 0.62). Other genera fall in at 0.01% – 0.26%, much lower than the four dominant genera.

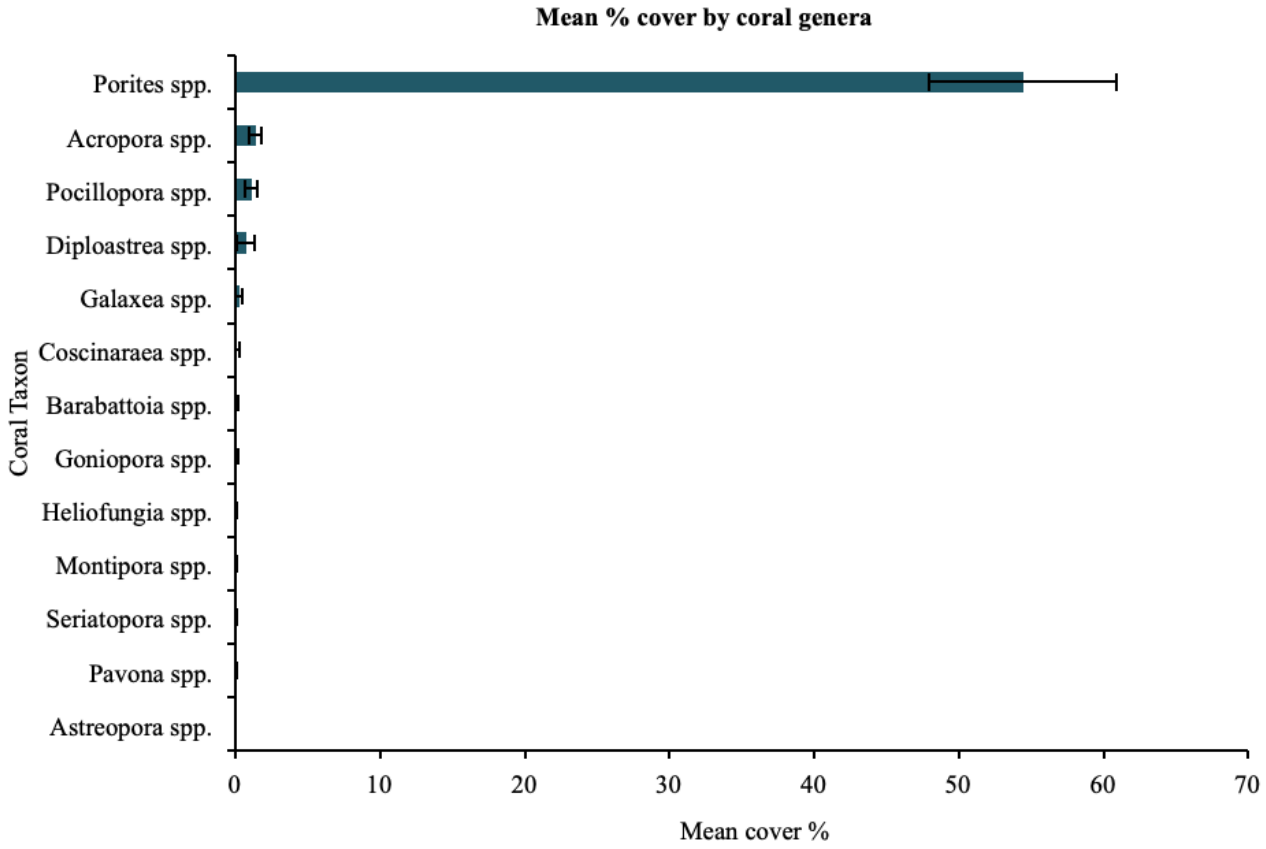


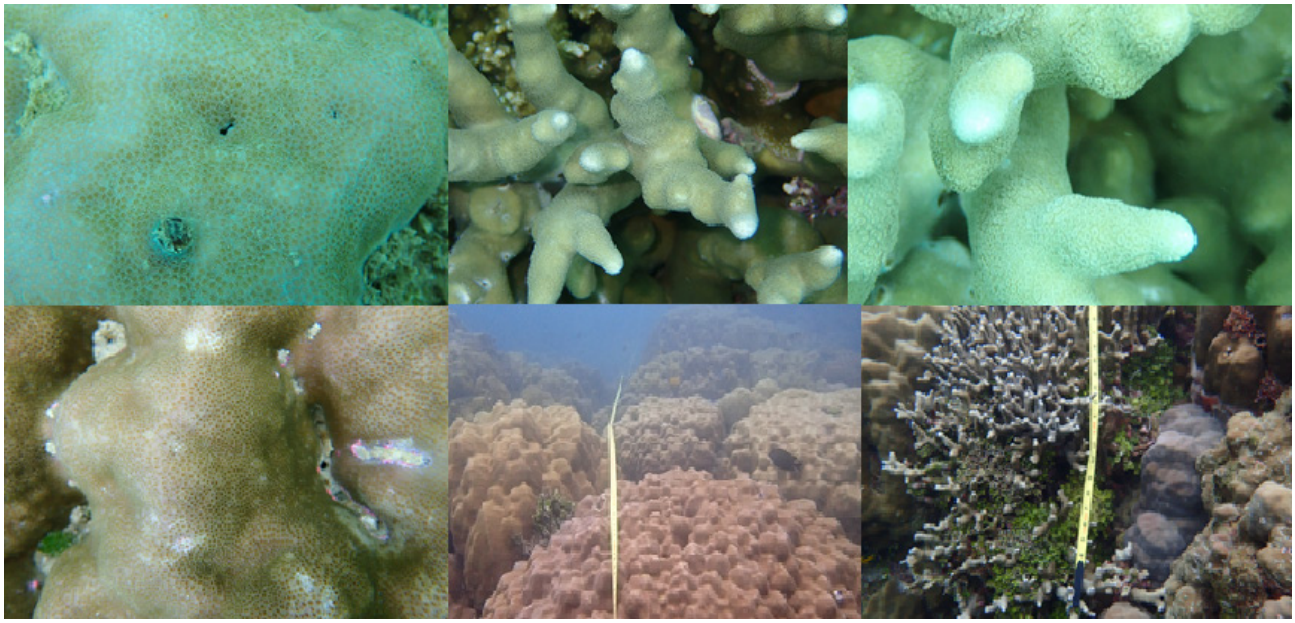
Figure 8: The overall composition of genera by mean % cover (± SE).

Table 3: The list of coral families and genera identified in the Honiara coastal assessment, 2020.

Family	Genus	Family	Genus
Acroporidae:	a) Acropora b) Montipora c) Astreopora	**Agriciidae:**	a) Pavona
Pocilloporidae:	a) Pocillopora b) Seriotopora	**Faviidae:**	a) Diplostrea b) Barabattoia b) Barabattoia
Ocullinidae:	a) Galaxea	**Poritidae:**	a) Porites b) Goniopora
Siderasteridea:	a) Coscinaraea	**Heliofungia:**	a) Heliofungia
		***Fungiidae:**	a) Fungia

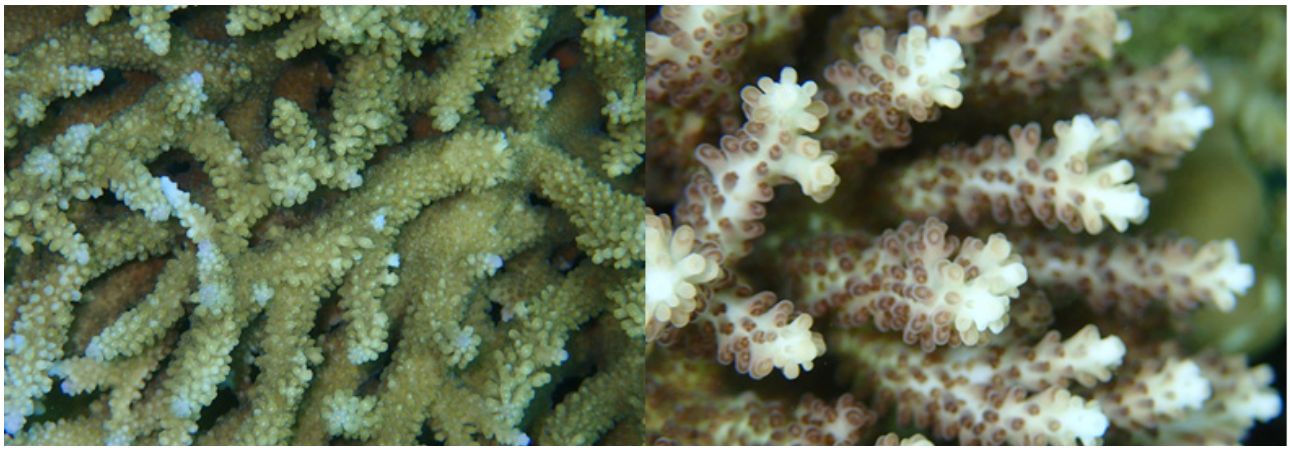
*Not included in Figure 8.

A. Poritidae



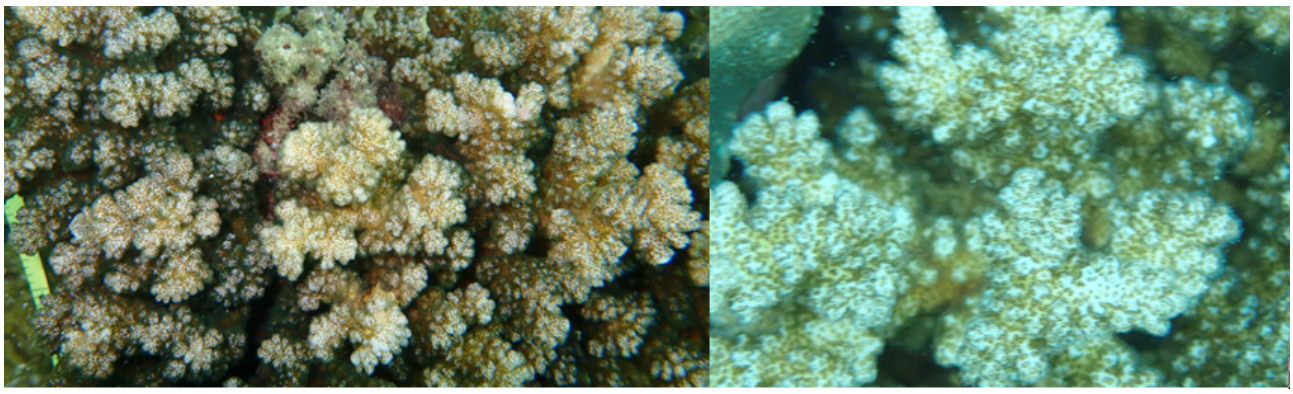
Photos: Stephen A. Mosese

B. Acroporidae: *Acropora* spp.



Photos: Stephen A. Mosese

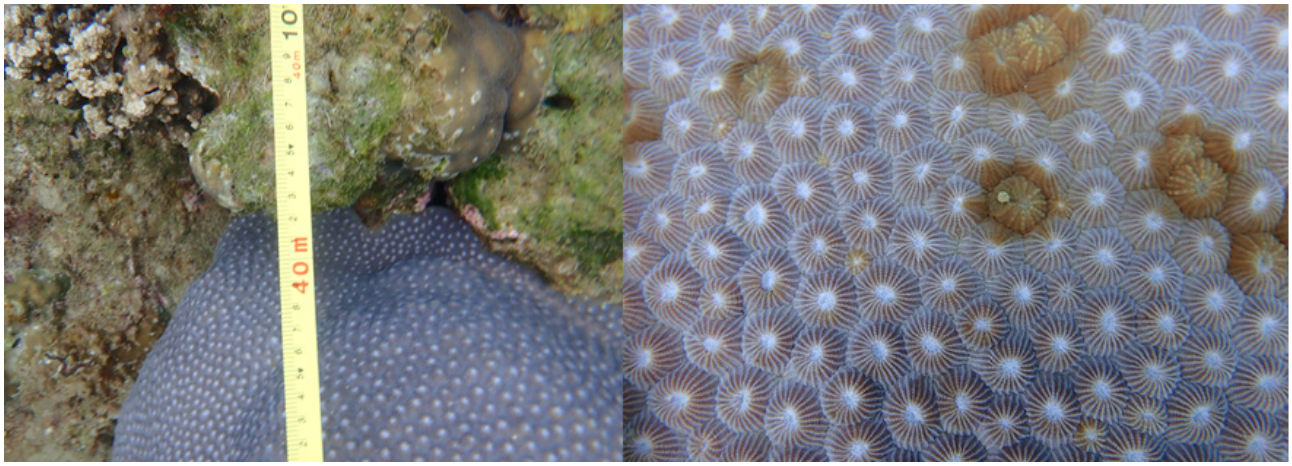
C. Pocilloporidae: *Pocillopora* spp.



Photos: Stephen A. Mosese

Figure 9: (A) Poritidae: the dominant coral family in the study in coverage (%). Two genera (Porites spp. and Seriotopora spp.) confirmed with high variations in coral growth forms; (B) Acroporidae: the second dominant coral family with three genera (Acropora spp., Montipora spp. and Astreopora spp.); (C) Pocilloporidae: two genera (Pocillopora spp. and Seriotopora spp.).

D. Faviidae: *Diplostrea* spp.



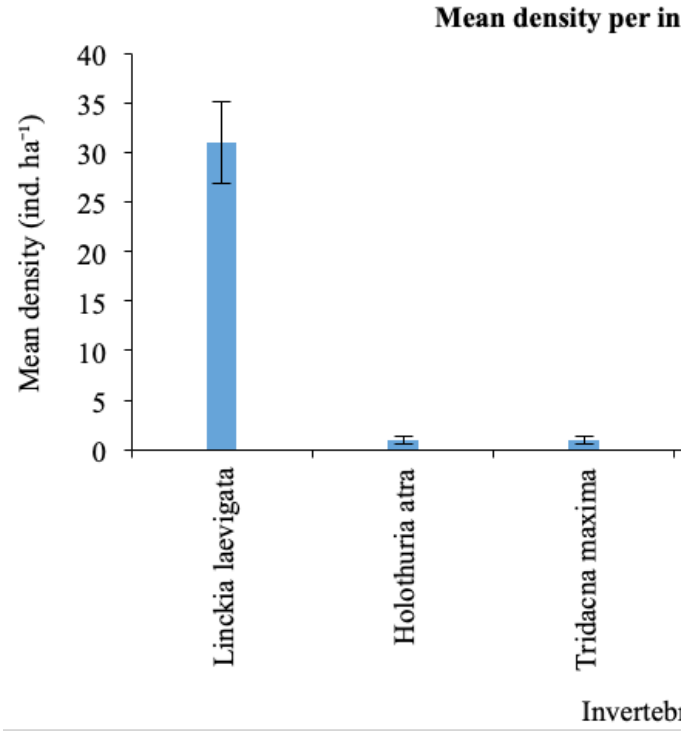
Photos: Stephen A. Mosese

Figure 10: (D) Faviidae: a single genus (Diplostrea spp.) recorded.

3.4 MARINE INVERTEBRATES AND VERTEBRATES (FISH)

3.4.1 INVERTEBRATE SPECIES AND ABUNDANCE

Apart from corals, the most occurring invertebrates and cnidarians, other common invertebrates observed are shown in Figure 8 with their abundance (Figure 9); from most to least abundant (density), Blue starfish (L. *laevigata*) and sea urchins (D. *setosum*) with 31 ± 4.15 ind. ha^{-1} and 12 ± 3.76 ind. ha^{-1} respectively; followed by Lollyfish (H. *atra*), T. *maxima*, trochus (T. *niloticus*) and COTS (crown-of-thorn starfish – A. *planci*) with lower densities of 1 ± 0.41 ind. ha^{-1}.



Photos: Stephen A. Mosese and Ronnie Posala

Figure 11: Invertebrate species observed; (a) Linkia laevigata, (b) Holothuria atra, (c) Tridacna maxima, (d) Tectus niloticus, (e) Acanthaster planci and (f) Diadema setosum.

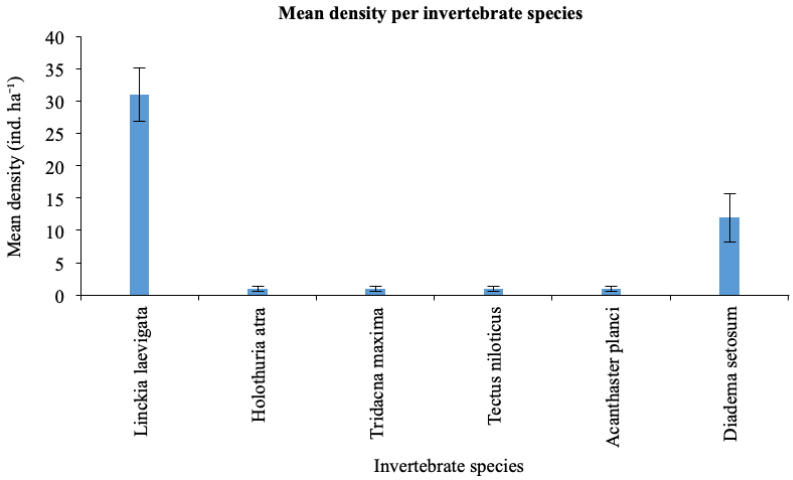


Figure 12: Invertebrate species mean density (± SE).

3.4.2 FISH DIVERSITY AND ABUNDANCE

Table 4 presents the results of fish composition, a total of 31 species, 20 genera and nine families of reef-fin fish was observed in this study.

Pomacentridae was the dominant fish family observed with 13 species identified; the species Lemon damsel (*Pomacentrus moluccensis*) with the highest density of 306 ± 68.78 ind. ha^{-1}, followed by four other damselfish species (*Neoglyphidodon nigoris*, *Neopomacentrus azysron*, *Pomacentrus brachialis* and *Chromis margaritifer*) with densities of 58 – 111 ind. ha^{-1}. Other common fish groups were Labridae, Chaetodontidae and Acanthuridae with more than a single (1 > 7) species identified and densities of 3 – 44 ind. ha^{-1}. The fish group Scaridae, Mullidae, Pempheridae and Pomacanthathidae records a single species each and the least abundance of 3 – 11 ind. ha^{-1}.

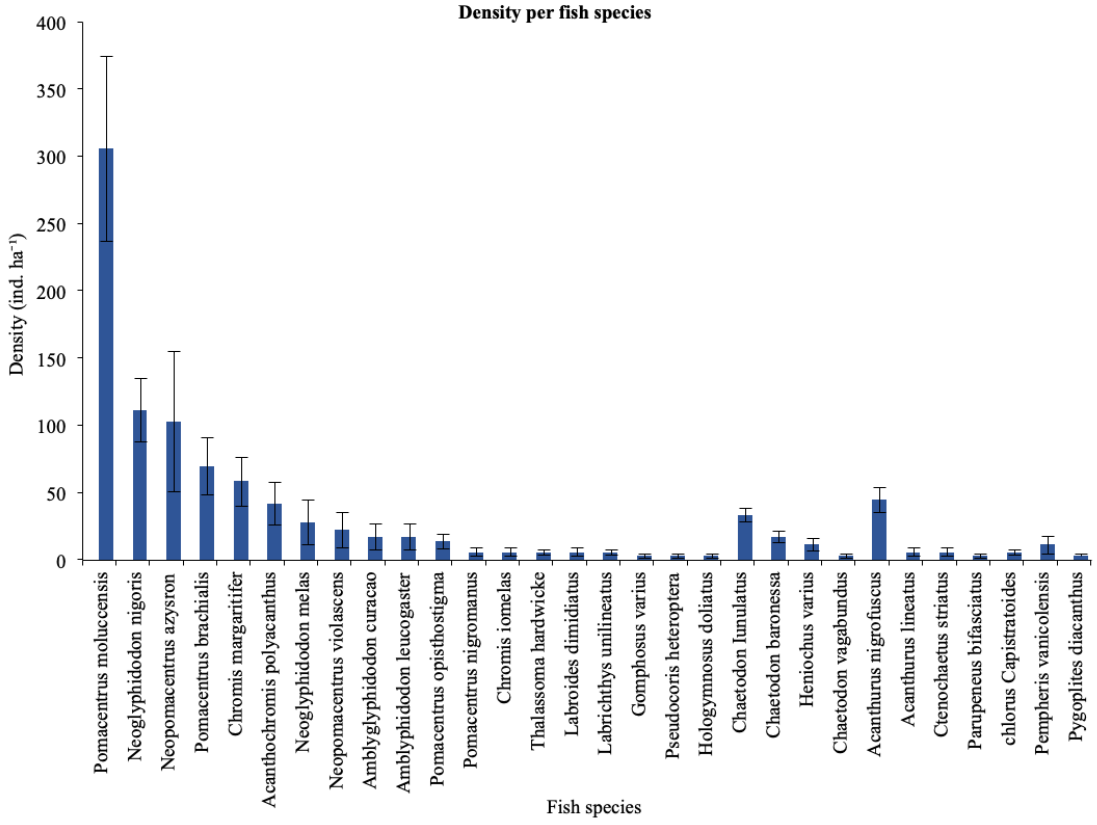


Figure 13: Fish species mean density (± SE).

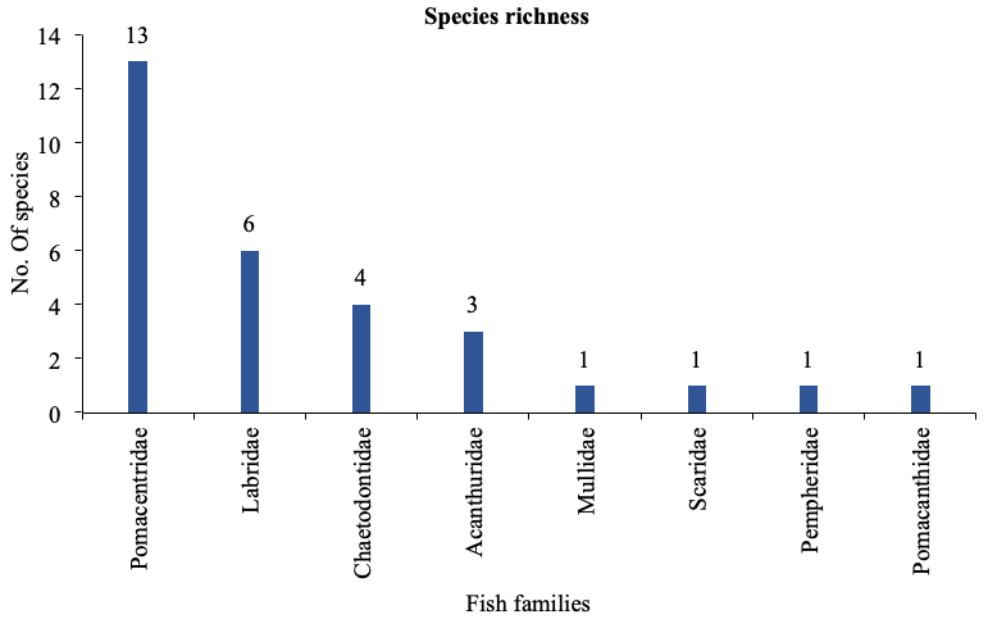


Figure 14: Species richness – number of species per fish family.

Table 4: The list of fish families and species identified in the Honiara coastal assessment, 2020.

No.	Families	Common name	Scientific name
1	**Pomacentridae:**	Lemon Damsel	*Pomacentrus moluccensis*
2		Yellowtail Damsel	*Neoglyphidodon nigoris*
3		Yellowtail Demoiselle	*Neopomacentrus azysron*
4		Charcoal Damsel	*Pomacentrus brachialis*
5		Bicolor Chromis	*Chromis margaritifer*
6		Spiny chromis	*Acanthochromis polyacanthus*
7		Black Damsel	*Neoglyphidodon melas*
8		Violet Demoiselle	*Neopomacentrus violascens*
9		Staghorn Damsel	*Amblyglyphidodon curacao*
10		White-Belly Damsel	*Amblglyyphidodon leucogaster*
11		Brown Damsel	*Pomacentrus opisthostigma*
12		Goldback Damsel	*Pomacentrus nigromanus*
13		Pacific Half and Half Chromis	*Chromis iomelas*
14	**Labridae:**	Sixbar Wrasse	*Thalassoma hardwicke*
15		Bluestreak Cleaner Wrasse	*Labroides dimidiatus*
16		Tublip Wrass-JP	*Labrichthys unilineatus*
17		Bird Wrasse	*Gomphosus varius*
18		Torpedo wrass	*Pseudocoris heteroptera*
19		Pastel Ring Wrasse	*Hologymnosus doliatus*

No.	Families	Common name	Scientific name
20	**Chaetodontidae:**	Redfin Butterflyfish	*Chaetodon Iunulatus*
21		Eastern Triangular Butterflyfish	*Chaetodon baronessa*
22		Humphead Bannerfish	*Heniochus varius*
23		Vagabond Butterflyfish	*Chaetodon vagabundus*
24	**Acanthuridae:**	Brown Surgeonfish	*Acanthurus nigrofuscus*
25		Striped Surgeonfish	*Acanthurus lineatus*
26		Lined Bristletooth	*Ctenochaetus striatus*
27	**Mullidae:**	Doublebar Goatfish	*Parupeneus bifasciatus*
28	**Scaridae:**	Indian Parrotfish	*chlorus Capistratoides*
29	**Pempheridae:**	Vanicolo sweeper	*Pempheris vanicolensis*
30	**Pomacanthidae:**	Regal Angelfish	*Pygoplites diacanthus*
31	**Scorpaenidae:**	*Common Lionfish	Pterois volitans

*Not included in Figure 13.

3.5 ENDANGERED AND REGULATED SPECIES

There were no endangered or endemic species of special interest encountered in this study. The exception is for *Tridacna maxima*, *Tectus niloticus* and *Holothuria atria*, which are, regulated under the Fisheries Management Act 2015 and the Fisheries Management (Prohibited Activities) Regulations 2018. All giant clam species are also included in the second appendix of CITES and therefore protected from any form of harvesting.

The international trades of stony corals of the family Scleractinia spp. are subjected to CITES under the second appendix. As such, the removal of corals and the commercial exploitations of these species are being regulated and managed under the national authority MFMR and MECDM, which plays the role of the national scientific and management authority for CITES.

4.0 DISCUSSION

Overall reef health condition is poor. Live coral cover rapidly degrades from the west to east Honiara. The coral resource and reef conditions assessment conducted by MFMR (2018 – 2019) indicates an overall average of live coral cover of 13% to 27% in 13 sites across six provinces, more so, Hughes *et al* 2006 had indicated an average coral cover of 29.4% to 47.5% for Solomon Islands – these are sites (in both studies) not situated in urbanized settings such as Honiara.

The Honiara coastal assessment yielded an overall average of only 5% of live coral cover in the Honiara coastal area. This is much lower cover comparatively. It was noted that some live coral cover (10%) was present in the western section of Honiara, where patches of healthy coral communities had sparsely distributed along the intertidal waters and coastal reef flats. Sand, silt, dead corals, and algae had dominated the central and eastern section of the Honiara coastal areas. Field observations had noted significant impacts of natural and anthropogenic factors which had deteriorated the reef conditions overtime; these are negative impacts and damages on reef and benthic structures due to cyclonic activities, urban-coastal developments, freshwater outlets (discharges/sedimentation, etc.), sewage run-offs and pollutions (plastics, metal-scraps, etc.).

Fine-scale assessments of benthic communities in the western section of Honiara had shown the dominance of sub-massive and massive coral growth forms; these are varieties of the stony coral family Poritidae, belonging especially to the genus *Porites* spp. Over 76 genera of corals were described by Veron *et al* 2006 for the Solomon Islands, 15 genera were identified in this study for Honiara.

Result indicates the presence of other key-targeted invertebrates such as sea cucumbers, giant clams, and trochus. However, only a single species was identified for each with a very low density. This indicates frequent harvesting within these reefs by local fishermen. COTS was also low in density, no signs of outbreak or possible threat.

Total of 31 species of reef-fin fish was recorded for Honiara with Pomacentridae being the most dominant in diversity and abundance. A lower reef fish fauna in contrast to the assessment by Allen *et al* 2006 which determined a total of 100 – 279 fish species per sampling site, with an average of 187.4 – an assessment conducted in 65 sites throughout the main archipelago of Solomon Islands. Species richness and abundance are highly dependent on the availability of food and the diversity of substrata or habitat. Well-developed reefs with relatively high coral diversity with significant live coral cover and strong currents were usually the richest areas for fishes.

The major threat to the Honiara coastal ecology and reefs is due to land-based developments and activities. These include the high influx of nutrients and pollutants from outlets which are distributed along the Honiara coastal sites from Whiteriver to Lungga. There are more than 11 outlets and two major sewage pumps. Also, urban developments which had expanded over the coastal shoreline and onto the reefs, and outward into the sea; sea walls and reclamation were established along the coastal sites. Uncontrollable run-offs and sedimentation from streams and major water outfalls such as Mataniko and Lungga.

5.0 CONCLUSIONS

The Honiara coastal reefs have been degraded over a long period primarily due to land-based activities and coastal developments. Honiara is exposed to strong westerlies' winds and tropical storms yet, only minimal impacts on coastal habitats compared to land-based activities and discharge. The reef health conditions are severely impacted especially within the central Honiara sites at the Point Cruz wharf to the Ranadi area. This includes sites that are within close proximity of the major outfalls like Mataniko and Lungga River. Water quality assessment component of this study had also indicated the poor water quality conditions due to high nutrient influxes and pollutants.

Presence of live coral cover was determined within the west Honiara coastal sites. However, diversity and abundance were relatively low. A similar trend was also indicated for invertebrates and fish biodiversity assessment. Should any conservation/green zone sites be established, coastal reefs of west Honiara would be a good place to start.

Importantly the study had accomplished its outlined objectives and established baseline data sets and information's for the status of the Honiara coastal ecology and biodiversity. This will provide an overview against which comparisons can be made with future studies and monitoring.

6.0 LESSONS LEARNED AND RECOMMENDATIONS

This study is probably the first comprehensive coastal ecological and biological assessment been carried out along Honiara coastline that include the Mataniko River mouth. The data and information's obtained sets as baseline of the general habitat, benthic communities, and biodiversity. However, the accomplishments had not been achieved without some challenges and constraints from the initial up to the final phase. This section will deliberate on the findings, the challenges and provides important measures for considerations should similar studies be conducted in the future.

6.1 SUCCESS AND ACCOMPLISHMENTS

The overall success of the project is entirely due to the cooperation, commitment and coordination between the implementing project teams which consist of Pasifiki Consulting Services, MECDM, MFMR and the Solomon Islands Ridge to Reef Project team, and the GEF/SPC International Waters Ridge to Reef Project (IWR2R) team in Suva, Fiji for providing invaluable insights and support. A strong collaboration and partnership are paramount to this project.

The study had provided important lessons that will be considered to improve future monitoring and survey of the Honiara coastal ecology.

6.2 SHORTCOMINGS

The ecological/biological component for this project was pre – planned and conducted under a very tight work time frame with limited resources. Implementing project teams have had to adjust and improvise with work time schedules throughout the course of the study.

6.3 RECOMMENDATIONS

Several recommendations below aim to support future ecological and biological studies and monitoring programme along the Honiara coastline including the Mataniko River:

i. Increase number of sampling stations and replicates in fine-scale assessments, this could possibly lead to uncovering other species of corals (Hard and soft corals), reef and pelagic fish species.

ii. High turbidity in the major water outlet areas (Mataniko and Lungga River etc.) of Honiara. Fieldwork was conducted in late July of 2020 whereby rainfall had affected work schedule and data collections. High turbid sites were avoided both for safety resources (e.g., presence of seawater crocodiles) and minimize wasting limited resources – include these sites in future studies.

iii. Heavily polluted sites (sewage run-offs, shipwrecks, etc.) were avoided; future assessments could include these sites – depending on the objectives of future studies.

iv. Maintain assessment methods in the future for consistency but open to new ideas of improvement nonetheless keeping within best practices and standards of carrying out resource surveys in coastal marine areas.

v. Establish strong collaborative network with relevant stakeholders in addressing land-based activities and waste management.

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ANNEX 1: HONIARA COASTAL AND MARINE BIODIVERSITY ASSESSMENT SAMPLING STRATEGY AND STANDARD OPERATING PROTOCOL FOR MACRO BENTHIC COMMUNITY

1. Introduction

This document describes the procedures for sampling, data collection and analysis used by the GEF Pacific International Waters Ridge to Reef Solomon Islands Project staff in long-term coastal biodiversity assessment and monitoring. Although it is intended as a guide for staff doing field sampling, it is also useful to individuals who are interested to know about the GEF Pacific IWR2R_SI Project marine aquatic macro-benthic survey sampling protocols.

The GEF Pacific IWR2R_SI Project in carrying out the Honiara coastal macro-benthic survey for the Honiara Coastal Environment Baseline Assessment, it was a requirement that the IWR2R Solomon Islands Project to develop a macro-benthic survey sampling methodology and protocols to carry out a baseline survey and monitoring at the identified sites within the Honiara Coast within the national town boundary from White River to Lungga point.

The major objective of the benthic survey in the Honiara Coast is to assess the status of benthic coral reef communities and macro-benthic communities, and to detect and quantify major spatial and temporal changes in the cover of a variety of benthos type in the Honiara coast. This will be achieved through the following methods: a) Manta Tow, b) Reef Benthos Transect, b) Shallow Water Scuba Transect and c) Underwater Visual Fish Census (UVS) Survey; other supporting methods includes the d) Indo-Pacific BYO guide[6] and the e) Underwater Photo Transect (UPT) method.

2. Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for sampling and processing macro benthic communities of the Honiara coastal environment. The SOP provides details of sampling methods and procedures, including data processing and management which is essential in the monitoring program protocols for the Honiara Coastal Environment.

This sampling protocol will provide the standardized methods for data collection, data cleaning and entry, quality assurance and control, and data management, for use by project staff and relevant stakeholders in Solomon Islands. The data collected will provide baseline information on resources and will be provided to the general public and technical group in particular the catchment and land care groups, to gain an understanding of macro-benthic communities in coastal sites in Honiara to address site-specific macro-benthic survey purposes.

3. Intended users of the Standard Operational Protocol

This SOP is intended to be used by:

- GEF Pacific R2R International Waters Project team
- Consultants conducting macro-benthic assessments and monitoring on behalf of the GEF Pacific R2R Programme
- Community groups in association with the GEF Pacific R2R Programme

[6] *The Indo-Pacific Coral Finder is a Visual Decision Tool that brings reliable genus level identification. Using a visual navigation system the Coral Finder requires nothing more than a keen eye to get results (https://www.byoguides.com/coralfinder/).*

4. Acknowledgements

A combination of existing protocols was used to develop this standard operating procedure for the sampling and data processing (marine invertebrates, benthic cover, and coral reef finfish) within the Honiara coastal environment and ecology. The Pacific Community (SPC) (Assessing Tropical Marine Invertebrates: A Manual for Pacific Island Resource Managers 2014), National Coral Reef Institution (CPCe, 2001-2011), The Secretariat of the Pacific Community (SPC) (Underwater visual fish census surveys: Proper use and implementation, 2002) were all consulted in the development this document.

5. Survey Design and Sampling Station/replicates

The survey design enables the GEF Pacific R2R International Waters Project team to ensure that there are sufficient data collected by surveyors when conducting the invertebrate and fish assessment. Invertebrate species may be highly grouped in specific habitats, or evenly distributed over a reef system and among several different habitats and depths. A careful and well-planned survey design is important for capturing all potential habitats and typical characteristics of a species of interest to present a representative sample in a defined area. Survey points or stations are selected across the site of interest.

The Project Management Unit of the National Ridge to Reef Project (SIR2R) has identified 10 survey sites to conduct the Coastal Baseline Assessment. The survey will consist of macrobenthic survey, water quality survey, and Bathymetry/Hydrography survey. The 10 survey stations are: White River, Rove, Yacht Club, Solomon Islands Ports Authority area, Central Market, Mataniko River Mouth, Baha'i, Fishing Village, Ranadi (AE Oval), and Lungga Point. In each station, there are six (6) standardised replicates[7] per station for all survey sites. The purpose of carrying out 6 replicates per station is to yield high quality data.

6. Survey Techniques and Methodologies

The survey methods employed are standardised for substrate and benthic cover, coral species composition, and fish species composition and abundance. This section outlines the methodologies used to survey invertebrate species that are of interest in the Solomon Islands and are present within the coral reefs and marine habitats in Honiara.

[7] *A sampling target of 6 replicates per station is established. However, a minimum of 3 replicates will be accepted considering site conditions such as reef size and geomorphology, including water turbidity and conditions.*

5.1 Manta Tow

A manta tow is used to assess large sedentary invertebrates and habitats using a tow board technique. A surveyor holds on to the manta board, which is towed behind a boat that travels at low speeds of less than 2.5 km per hour, equivalent to half the normal pace of a pedestrian walking.

Equipment

- Boat with working engine
- GPS to record start and end positions of transect
- Manta tow board with pencil attached to a boat using a 20 m-long rope
- Invertebrate data record sheet (Appendix 5a), specific manta data sheet to record transect position from the GPS (Appendix 5b) and identification cards (Appendix 3) mounted on manta tow board
- Hand counter mounted on manta tow board
- Snorkelling gear, wetsuit, and protective gloves

Procedure

Manta Tow Method requires at least four (4) persons:

- A boat operator
- An observer who records GPS positions and time tracker
- 2 surveyors or divers

1. Attach manta board to boat with 17m length of rope.
2. Locate where the manta tow survey will begin. Prior planning should help to point out where to conduct manta tows.
3. Mount the data record sheet on the manta board and attach a pencil to the board using a string.
4. Follow the command of the manta tow director on the boat. He or she directs both the surveyor and skipper as to the start and end of each tow and where to go. The manta tow director is also in charge of the safety of the surveyor and should always maintain visual contact with the surveyor. The boat skipper is responsible for the safety of the boat and must coordinate with the manta tow director.
5. Conduct the manta tow survey along the flat or edge of a reef system. The manta tow director measures the distance (300 m) on the GPS using the 'odometer' function.
6. Stop the boat at the end of each tow so that the surveyor can record the habitat data for the completed manta tow replicate. The boat is then moved 10–20 m from the end position of the previous replicate, and in the general direction of the tows, before starting the next replicate. This ensures that the tows are not exactly contiguous but instead randomly placed. This is repeated until all 6 manta tows (replicates) have been completed for that station.
7. The observer should keep track of every run and signal the boat operator to reduce speed every two minutes for recording. At the same time, pull and jerk the rope to give signal to the observer to record.
8. The surveyor or diver, on the other hand, should mark or record the coordinates of each stop using a GPS together with a map sketch.
9. The surveyor#1 will follow a tow sequence for each stop in sync with the surveyor#2 at each stop, the surveyor will write down his/her rating of the percent live hard coral cover on the waterproof data sheet or writing slate attached to the manta board.

Both surveyors will also take note of any occurrence of disturbances such as coral bleaching.

5.2 Reef Benthos Transect (RBt)

Reef benthos transect (RBt) survey is conducted on hard bottom substrates on fringing reefs, lagoon patch reefs, back-reefs, reef flats and reef crest areas to capture invertebrates associated with these habitats. RBt assessments provide a high level of accuracy of the range, abundance, size and condition of invertebrate species and their habitats on smaller spatial scales within fishing areas and areas of aggregated stocks.

Surveys consist of six 40 m x 1 m transects. Observations are made by snorkelling or walking at low tide. Species and habitat data are recorded, and a single waypoint is logged for each station (to an accuracy of within 10 m).

Equipment

- Boat with working engine
- 40-m transect line with a weight and buoy at the end to indicate the length of the transect
- GPS to record start and end positions of station
- Two writing slates with pencil, one per surveyor
- Invertebrate data record sheet mounted on slates
- Snorkelling gear, wetsuit and protective gloves

Procedure

At least four people are required for this assessment: four surveyors and a boat skipper.

1. Anchor the boat when a suitable reef benthos habitat is located. Record the GPS waypoint as close to the survey position as possible (only one position is required for the six replicate transects of the station).
2. Two surveyors get into the water (with their mask and snorkel) and attach one end of their 40-m line to a point on the reef (or places the weight) before swimming the other end of their line to a point 40 m away where the end weight is placed (or lines may be tied to dead coral).
3. Surveyors swim along each side of the transect line and record all epibenthic invertebrate resources, including gastropods, sea cucumbers, giant clams, sea stars and urchin species (as potential indicators of habitat condition) within a 1-m swath of benthos. An estimate of habitat cover is recorded at the end of each replicate.
4. Three transects are conducted by each surveyor giving a total of six replicates per station.
5. Habitat observations are made at the end of the search.

5.3 Shallow water scuba transects

A shallow water scuba transects (SWSt) entails six 40 m x 2 m transects (Fig. 12) and is designed to provide a fine-scale assessment. The depth range for this assessment is 3–12 m. Transects are placed randomly within identified areas, generally across depth and habitat gradients.

Equipment

- Boat with working engine
- GPS to record start and end positions of station
- Two writing slates with pencil, one per surveyor
- Invertebrate data record sheet and identification cards mounted on slates
- Chainman loaded with thread line
- Scuba gear, dive computer, wetsuit and protective gloves

Procedure

1. Allocate time at the end of each 40-m transect to complete all observations, including habitat data. A 5–10 m space is left between transects before a new transect is begun.
2. Two surveyors on scuba dive side-by-side (5–10 m apart) along the reef front at a depth range of 3–12 m. One surveyor controls the Chainman and communicates the start and end point of each 40-m transect to the other surveyor. Because scuba diving presents some risk, surveyors should always be aware of each other, and ensure they are close enough from their partner to be able to render assistance if needed.
3. Surveyors should progress at a similar pace to the other surveyor, maintaining the same distance apart for the length of the transect. The surveyor who is not holding the Chainman should ensure they stop their transect at the signal of the partner that has the Chainman.
4. Each surveyor takes accurate measurements (to the nearest millimetre) of species observed such as trochus, gastropods and giant clams along the 40-m transect.
5. Surveyors record the size of a subset (e.g., 15–20) of the species of interest (if they are too numerous) and record the rest only as a count.

5.4 Fish Survey Assessment /Fish Identification (Underwater Visual Census Method)

Underwater Visual Census (UVC) methods are the most effective method for monitoring coral reef fishes, particularly in remote locations along the Honiara Coast and away from Mataniko River mouth. Coral reef fish populations are surveyed using Underwater Visual Census (UVC) methods.

Belt transects will be used as they provide a high degree of precision and are suitable for surveying for multiple objectives (fisheries and resilience) and because they allow for multiple passes of the transect to count different species. This method provides the most effective technique for surveying most coral reef fishes that are responsive to visual census techniques. However, if possible, the transects should be combined with a long swim method, which provides more precise estimates of the abundance and biomass of large, highly mobile species, that tend to be rare, patchy, or clumped in distribution.

Equipment

A minimum of four people is required for the collection of visual census data using this technique. Two divers conduct the surveys, while the other two divers are required to lay and wind-up measuring tapes along the centre line of each transect.

On the Boat:

On the boat be sure there are:

- ID books
- different coloured pocket folders (1 for the blank record sheets, 1 for completed sheets)
- 1 portable GPS + spare batteries
- erasers
- pencil sharpener

For working underwater, you should have:

- 3 fifty-metre measuring tapes
- 1 hard plastic board with clips (at least two) per diver
- record sheets (at least 3 station sheets and 5 fish record sheets)
- pencils (at least 2 per diver: 1 in the sleeve of the diving suit or knife sheath + 1 attached by string to the board)
- waterproof watch
- depth gauge

Transect:

The method presented below uses standard 50-metre-long transects.

During the dive:

- Before descending, make a final check with your buddy to ensure nothing has been forgotten (double verification).
- Descend.
- Once you arrive at the bottom, determine the starting point for the transect
- Attach one end of the measuring tape to a rock, or in the sand, using a metal stake and lay the other two measuring tapes next to it.
- Determine the direction for laying out the measuring tape.

- Wait two or three minutes to give the fish time to calm down and get use to your presence.
- Begin counting the fish.
- One of the divers unrolls the measuring tape as the count progresses
- Once the fish count is done, leave the main transect in place and unroll the other two tape measures about three metres on either side of the main transect.
- Record the visibility, current and other known parameters for this station in the top part of the station sheet.
- For each of the three transects and in every 10-metre section, identify once every metre the nature of the substrate and the living organism cover just below the measuring tape. Record your observations on the station sheet by putting check marks in the corresponding headings.
- In the one-metre strips on either side of each transect, count the number of associated organisms (invertebrates).
- On the back of the station sheet, record any special remarks about that station.
- Make sure the sheets have been filled out fully and accurately.
- Roll up the three tape measures.
- Begin your ascent.

After the dive:

On the boat:

- Proceed with initial discussions immediately, then complete and correct the sheets, if necessary.
- Take the sheets off the clipboards and put them into the corresponding plastic pocket folders.

On land:

- Rinse the sheets one by one in fresh water, then place them separately to dry.
- Once they are dry, take the sheets and finish or correct them, as needed.
- Begin data entry.

5.4 Other Supporting survey methods:

A. Indo-Pacific Coral Finder Tool: the coral finder visual tool will be utilized in the classifications of coral taxa by genus, supplemented by other available sources of references by Veron and online databases[8].

B. UPT: the Under Water Photographic Sampling method with Transects. A 50m x 2m transect line was laid on the seafloor within depths of 3m-25m; photographic samples of the benthic cover were taken along the transect at every meter interval, thus a total of 50[9] photos per transect.

7. Data Processing and Management

Due to the large volume of data collected during each survey trip, strict data management procedures must be followed to ensure safe and efficient storage of data.

Data Processing Techniques:

Coral Reef and Macrobenthic Survey

Windows based databases and statistics Analytical tool (CPCe) will be utilized in data analysis and data management and storage. These includes the SPC Reef Fisheries Integrated Database (RFID) and the Coral Point Count with excel extension software. There are software's that can export processed data to excel spread sheets for further analysis and modelling of results. Other measures include the Excel spreadsheets which can be designed to organize data collected for assessment and monitoring of coral reef biodiversity and facilitate processing, storage, and management.

Data processing methods are:

1. Point Intercept Technique

The excel spreadsheet contain the formula to automatically compute the percent cover of live hard coral, dead coral, other animals, plants, and algae, and abiotics with the entry of the PIT data collected. But in the absence of these files, the percent cover of each lifeform and benthic category considered in the survey can be computed by dividing the frequency of the lifeform intercepted by the transect at 0.25m interval) by 200 (i.e., the total number of recordings made for the whole transect), then finally multiplying by 100 to convert the value into percentage.Photo-Transect

The digital images obtained from the reef survey will be processed using **the Coral Point**

Count with Excel Extension (CPCe) Version 4.1, a Windows-based software that provides a tool for the determination of coral cover using transect photographs (Kohler & Gill 2006). Coral Point Count with Excel extensions (CPCe) is a Windows-based program that provides a tool for the determination of coral cover using underwater images. A specified number of random points are distributed on an image, and coral species/substrate lying under these points are user-identified. Microsoft Excel spreadsheets can be created to further analyse the data. Additionally, the planar area and length of benthic features can be calculated and analysed.

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[8] *Supplementary sources for coral species classifications include the online databases: Corals of the World (http://www.coralsoftheworld.org/) and Coralpedia (https://coralpedia.bio.warwick.ac.uk/).*

[9] *Not limited to 50 photos. Additional sampling photos were being collected for coral species where thorough identifications of the corallite structure was required. These are photo-imagery captured in close-up view – macroscopic mode of the underwater camera (T5 Olympus canon).*

2. Underwater Visual Fish Census

Equipment:

Lap top computer running Windows 10 and current data entry software.

Procedures:

- Field

On the same day data are collected, conduct the following procedure:

1. Rinse data sheets in fresh water and then dry.
2. Assign sample identification numbers1 to each transect.
3. Enter data onto a laptop computer using current data entry software. Fish species names are entered in the database as a seven-digit fish code. The first three letters represent a genus code, and the following four letters represent the species code.

- Office

After the field trip, data are checked and added to the main data base using the following procedure:

1. Give laptop to database manager to synchronise.
2. Print raw data entered at sea and check against field data sheets. This checking procedure requires two personnel. One person reads out the species, abundance, length, and phase from the field sheets while the other person checks these values against the printout of field entered data.
3. Correct any errors in the data and save.
4. Inform database manager that corrections have been made into the database.
5. File field data sheets and data printout.

8. Data communication

After surveys have been completed and the resulting data analysed, it is important to present the results in a format that is useful to key stakeholders. The actual data and analyses are more relevant to scientific audiences, but for community consultative meetings it may be more effective to communicate by talking and using visual presentations (e.g., advisory sheets, posters) than through written reports.

Where relevant, it is essential to communicate the survey results with community leaders such as chiefs, resource custodians and religious leaders, who can interpret the results of the baseline survey efforts and explain the value of management actions to the broader community.

The steps in this process should include identifying the:

- target audience;
- key messages to get across and when; and
- communication products that will best suit the needs of the project (many products may be required for different audiences).

Appendix: Field Survey Data sheets

A) Marine Invertebrates Data Sheets: MT, RBt and SWSt

DATE		RECORDER		Pg No	

STATION NAME																		
WPT / WIDTH OF REPLICATE																		
RELIEF / COMPLEXITY 1-5																		
OCEAN INFLUENCE 1-5																		
DEPTH (M)																		
% SOFT SED (M – S – CS)																		
% RUBBLE / BOULDERS																		
% CONSOL RUBBLE / PAVE																		
% CORAL *LIVE*																		
% CORAL *DEAD*																		
SOFT / SPONGE / FUNGIDS																		
ALGAE *CCA*																		
CORALLINE																		
OTHER																		
GRASS																		
EPIPHYTES 1-5 / SILT 1-5																		
BLEACHING: % of benthos																		
ENTERED / CHECKED																		

B) Reef Fin-Fish Data Sheets: UVS

LOCATION: PAGE:

DATE	LAT.	LONG.	TRA.	DI.

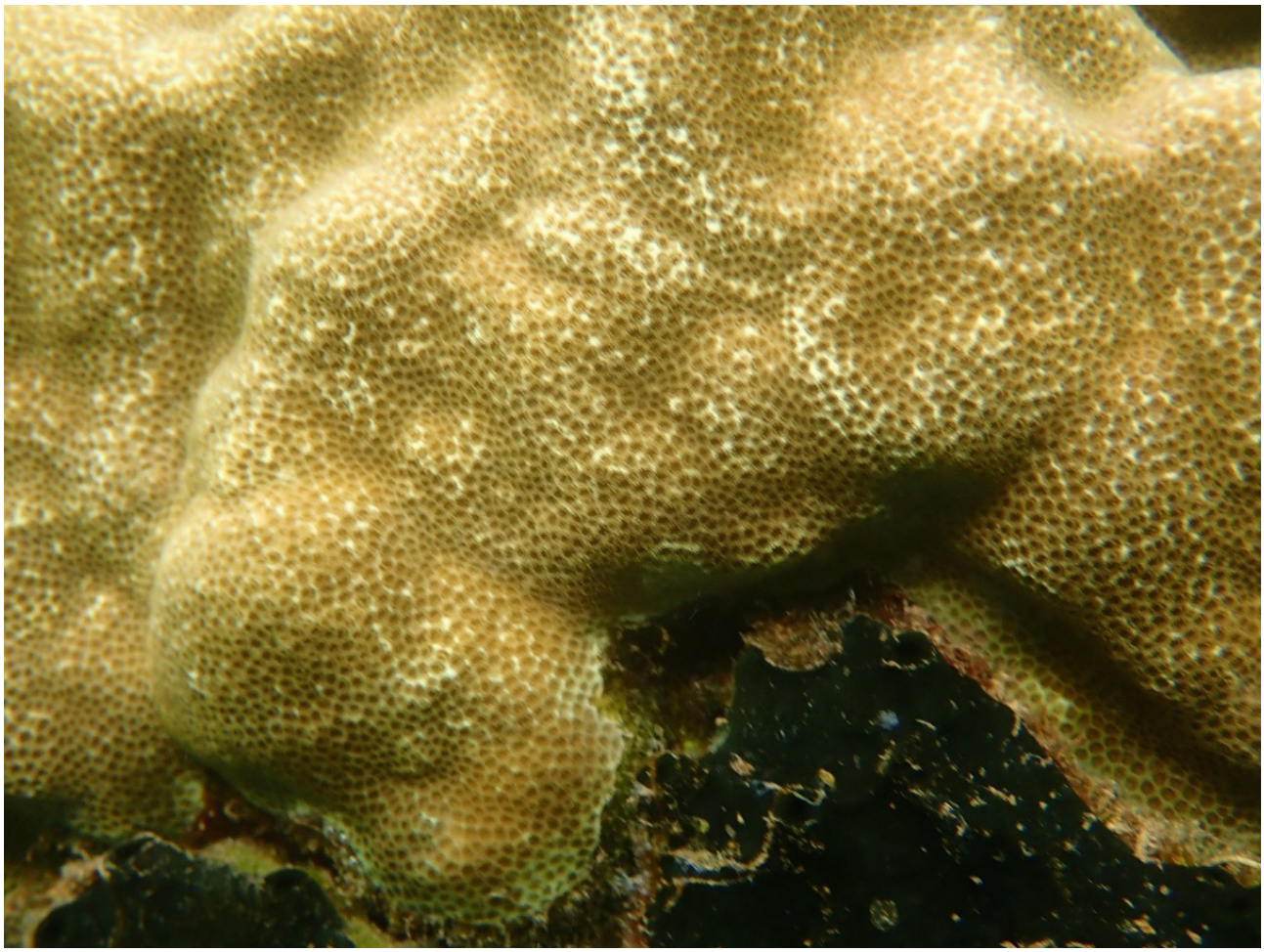
REC.	SCIENTIFIC NAME	CODE	NUM	LGT	ST	D1	D2

NB: The use of underwater video footage of fish per transects can be employed to strengthen fish count and identification accuracy. T5 Canon Olympus Underwater camera and available waterproof Go-pro devices will be employed.

C) Benthic Cover and Coral Assessment: UPT & CPCe

This requires photographic sampling of benthic cover and corals, please refer to image below:

1. Field Photo (raw) collected:



2. Photos being analysed with the CPCe software: