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BULAK

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Front Cover: Maayong Tubig Marine Reserve
Image: Becky Tooby

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OUR MISSION

The Institute for Marine Research is a grassroots non-profit organisation that conducts long-term and fine-scale research on coastal marine ecosystems, using this scientific evidence to educate, transform and encourage locally led marine conservation strategies within the Philippines.

OUR VISION

“We at the Institute for Marine Research strive to be instrumental in the making of an environmentally literate and sustainable community through and evidence-based conservation approach, creating a world that is better and wiser than the one we have now.”

- A message from the Founders

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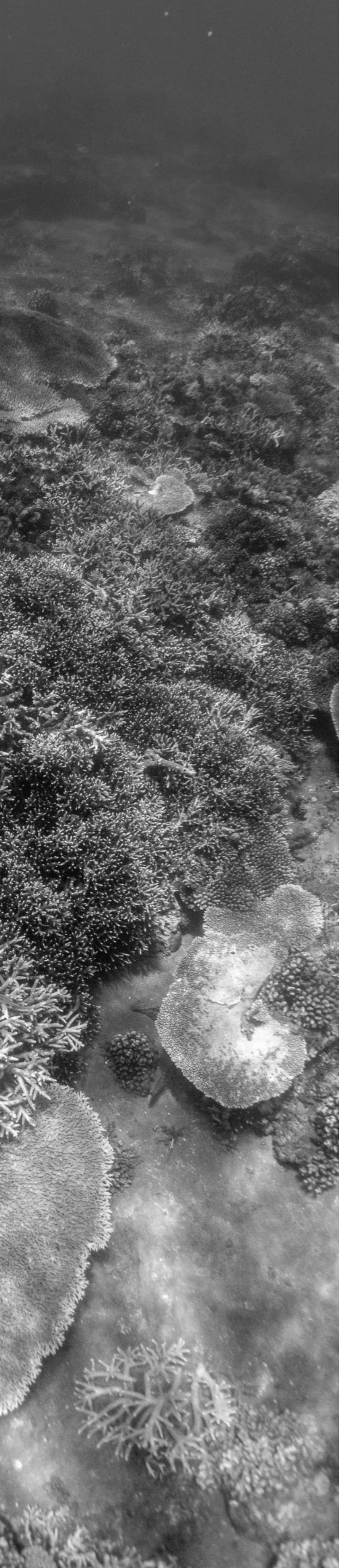

Dauin Long-Term Reef Monitoring Project Aims

1. To understand how benthic composition influences fish community structure and invertebrate community composition.

    a. Will reef fish community structure be influenced by changes to percentage coral cover, habitat structural complexity and rugosity?
    b. What habitat does the benthic cover of the Dauin Municipal reef employ?
    c. What is the relative importance of coral cover, structural complexity, and diversity in determining the structure of reef fish communities in Dauin?
    d. Do structurally complex benthic communities support a greater diversity of fish species, regardless of a low percentage coral cover?
    e. How do rugose benthic communities support fish and invertebrate communities?

2. To document the effect of disturbances such as crown of thorns outbreaks, typhoons and bleaching events, and to provide awareness of other threats to the reef and other issues of concern to reef managers.

    a. What is the resiliency factor of ecosystems composed of high structural complexity, rugosity, percentage coral cover and coral diversity in response to storms and bleaching events?
    b. Is there a relationship between benthic measurement (structural complexity, percentage cover, rugosity, diversity) and the abundance of trash, crown of thorns and disease?
    c. What are the major localised impacts that affect the Dauin reef system, and where do the major localised impacts originate from?

3. To document the effects of temperature, light and current on the annual and seasonal variability of coral and fish populations.

    a. How is coral calcification affected between seasons?
    b. Will coral calcification be higher under high temperature and light regimes, with results dependent on bleaching status and storm intensity?
    c. Are threats to the Dauin reef system directly influenced by humans, and how will these threats be manipulated by current shifts and storm intensity?
    d. How do seasonal variations affect benthic cover and fish assemblage?

ABBREVIATIONS

Abbreviation	Term in full
1-D	Simpsons Index of Diversity
2D	2-Dimensional
3D	3-Dimensional
AIMS	Australian Institute of Marine Science
ANOSIM	Analysis of Similarities
BBD	Black Band Disease
BrBD	Brown Band Disease
CPCe	Coral Point Count with Excel Extension
COTS	Crown of Thorns Starfish
DEM	Digital Elevation Model
DO-SVS	Diver-Operated Stereo Video System
HYP	Hyperplasia
IMR	Institute for Marine Research
LTRMP	Long Term Reef Monitoring Project
MIF	Mobile Invertebrate Feeder
MPA	Marine Protected Area
NEO	Neoplasia
NMDS	Non-metric Multidimensional Scaling
PP	Porites Pinking
SR	Species Richness
SCUBA	Self-Contained Underwater Breathing Apparatus
SE	Standard Error
SEB	Skeletal Eroding Band
SfM	Structure from Motion
SRH	Scheirer–Ray–Hare

TABLE OF CONTENTS

1. METHODOLOGY

1.1 SURVEY SITES

Dauin is a fourth class Municipality in the province of Negros Oriental, Philippines. Nineteen core sites at eleven locations were selected for seasonal and annual monitoring. These sites span the variation in the coral reef composition of benthic and fish communities across the Municipality, and account for the zoning history of its associated no-take marine protected areas. The nineteen core sites consist of one to two 50m transects, between depth ranges of 1 – 6 metres and 7 – 12 metres. Surveys are conducted bi-annually to account for seasonal variability, with dry season surveys from February to July, and wet season from August to January. Bulak Marine Reserve, located within Barangay Bulak, is the most northerly of all survey sites of the Dauin LTRMP. Five 50m transects were conducted between the months of February 2019 and January 2020.

1.2 RESEARCH TECHNIQUES

Benthic Assays

Images taken along the 50m transect line were analysed using Coral Point Count with excel extensions (CPCe) software[1]; a visual software designed to quickly and efficiently calculate statistical coral coverage over a specified area through the aid of photo-transects[1]. Point overlay was used to characterise the benthos and determine the percentage cover of each type of organism and substrate in the image[2]. Categories recorded are: Scleractinian coral genera, octocorals, hydroids, bivalves, other hexacorals, sponge growth forms, "other live", algae, seagrass, dead coral and abiotic (e.g. sand, rock). For each category of benthic organism, the mean values for percent cover at each site are used to analyse seasonal and temporal trends in cover of benthic organisms at each site, zone, and throughout the municipality as a whole.

SCUBA Search: Reef Impacts & Coral Mortality

The SCUBA search provides a more detailed picture of the causes and relative scale of coral mortality, which assist in examining the reef in greater detail and interpreting trends in benthic cover at permanent sites. SCUBA searches were conducted along the 50m transect, with a 2m belt. The following impacts were recorded: *Acanthaster plancii* (crown-of-thorns starfish; COTS), COTS feeding scars, *Drupella spp.*, *Drupella spp.* feeding scars, unknown scars, coral bleaching and coral disease (black band disease, white syndrome, brown band disease, Porites pinking, skeletal eroding band disease, hyperplasia and neoplasia). Images were captured to record the impact found, the affected coral genera, and the size of the affected area relative to the entire colony.

Diver-Operated Stereo Video System (D-O SVS)

Understanding of fish ecology and our ability to effectively manage fish populations requires accurate data on diversity, abundance and size. IMR utilises a Diver-Operated Stereo Video System, an innovative technology which allows our researchers to record fish species with more precision and accuracy than the traditional techniques, and efficiently quantify the abundance and size of reef fish[3,4]. Rather than relying on *in situ* identification and length estimates, collected video data can be annotated in the lab, reducing time in the field and/or enabling greater coverage.

Transects were conducted using a DO-SVS comprised of two *GoPro Hero 5 Black* cameras. The SVS operator moved at a steady pace (adjusting for currents), filming the reef scape along the 50m transect, taking 5 - 6 minutes. EventMeasure V5.25 was used to measure fish encountered along the transect. It excludes fish outside 2.5m either side of and 5m in front of the camera system, maintaining a consistent survey belt. Each fish encountered within the transect belt was identified to species level, and measured when possible. Fish biomass was estimated using the equation $W=aL^b$, where W is weight (g), L is fish length (cm), and a and b are species-specific allometric constants obtained from FishBase[5]. Fish species were classified into functional groups; grazers / detritivores, scrapers / small excavators, browsers, detritivores, obligate corallivores, planktivores, invertivores and piscivores/scavengers[6]. The invertivores / sessile group was included with the invertivores. Fish species were also categorised into IUCN Red List Categories[7] (Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct), as well as their commercial value (Commercial, Minor, Subsistence fisheries, None) according to FishBase[5].

3-Dimensional Reef Modelling

Structural complexity is a key habitat feature that influences ecological processes by providing primary and secondary resources to organisms, such as shelter from predators and food availability. As such, structural complexity of coral reefs drives numerous functions directly linked to the resilience of these ecosystems[8,9].

IMR researchers are making use of rapid advances in technology to monitor reef structural complexity by recreating and measuring reefs in 3D. The 3D structure of the reef is accurately reconstructed by using underwater images taken at pace across a reef transect, using a technique called photogrammetry[10,11]. These 3D models allow IMR scientists to measure different attributes associated with the structural complexity of coral reefs, such as surface complexity (3D/2D surface area), curvature, volume and slope, across large extents in a fraction of the time that takes to achieve the same results underwater.

A 3D camera rig was used to obtain video footage of the survey transect. The cameras were faced directly down at the substratum[12] at the beginning of the 50m transect, with the rig approximately 2m above the substrate. A lawnmower pattern was followed at a steady pace, covering 1m either side of the transect line, along the 50m transect. Stills were extracted from videos, which were used to generate a 3D model, using Structure from Motion software and photogrammetry principles. Images were aligned and alignment was optimised to fit k4 and a dense cloud was created. Surface line length (length), range, Rq (RMS), slope and variation were analysed.

Metadata

Before every survey, air temperature, wind speed, tidal state, sea state and boat activity (fishing and diving boats present) were recorded. This can be used in conjunction with any other data collected as required.

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2. RESULTS

2.1 Benthic Cover

Results of overall benthic cover at Bulak reef showed that abiotic categories (rock, rubble and sand) was the dominant substrate type in both seasons (dry: 85.3%; wet: 81.0%) (Fig 2.1.1), formed primarily of sand (dry: 82.3% ± 2.54%; wet: 78.1% ± 2.74%). Abiotic substrate is followed by coral, which showed a 1.83% increase from dry to wet season (dry: 3.24%; wet: 5.07%), and algae which decreased by 0.40% (dry: 4.04% ± 0.69%; wet: 3.63% ± 0.56%) (fig. 4.1.1) (Fig 2.1.1). A decrease was observed in the wet season in all algal categories previously recorded in the dry season (other algae, coralline algae and *Halimeda*) except for turf algae which increased by 0.80% (dry: 2.44% ± 0.49%; wet: 3.23% ± 0.74%) (Fig 2.1.2).

A total of 12 Scleractinian coral genera were recorded at Bulak reef across the year. A higher genera richness (G) was recorded in the dry season than the wet season (dry: G = 10; wet: G = 8). In both seasons, total coral cover (%) was higher at 10m than 5m (dry: 5m = 1.74%, 10m = 4.74%; wet: 5m = 2.67%, 10m = 7.47%). *Pocillopora spp.* was the most abundant coral genera present (dry: 1.56%; wet: 1.50%), followed by *Acropora spp.* which showed a 0.87% increase (dry: 0.60%; wet: 1.47%) and *Porites spp.* which increased by 0.83% from dry to wet season (dry: 0.13%; wet: 0.97%) (Fig. 2.1.3). An increase in average coral diversity (Simpson's Index (1-D)) of 0.15 was observed from dry to wet season (dry: 0.50, wet: 0.65) (Table 2) as well as an increase in average species evenness (Pielou's Evenness) of 0.12 (dry: 0.52; wet: 0.64).

2.2 Reef Impacts & Coral Mortality

Trash was the most prevalent reef impact recorded annually at Bulak reef, with a total of 13 counts across the year, although 12 of these counts were recorded in the wet season (dry: 0.5 counts/100m^2 ± 0.5; wet: 12 counts/100m^2). In the wet season, unknown scars and direct destruction recorded 4 counts/100m^2 affecting coral genera *Acropora* and *Pocillopora* (Fig 2.2.1).

Bleaching was the most prevalent impact recorded in the dry season at Bulak Reef, with 7 counts recorded (dry: 3.5 counts/100m^2 ± 1.5 counts/100m^2), no counts of bleaching were recorded in the wet season. Bleaching was more prevalent along the 10m transect compared with the 5m transect (Fig 2.2.2). Three different coral genera were affected by bleaching, *Fungia* was the most affected genera representing 71.4% of bleaching counts, *Echinopora* and *Goniastrea* both accounted for 14.3% of bleaching counts. An average of 43.6% ± 6.43% of the coral tissue was affected. There were 4 counts of coral disease recorded annually, affecting colonies from the genus *Pocillopora* and *Acropora*. In the dry season, 1 count of skeletal eroding band and 1 count of white syndrome disease were recorded, whereas in the wet season 2 counts of skeletal eroding band were recorded. In the dry season, there were an average of 2.5 counts/100m^2 ± 1.5 counts/100m^2 of *Drupella* spp. recorded, affecting an average of 34.2% ± 17.1% of coral tissue, affecting 3 different coral genera (*Acropora*, *Pocillopora* and *Stylophora*).

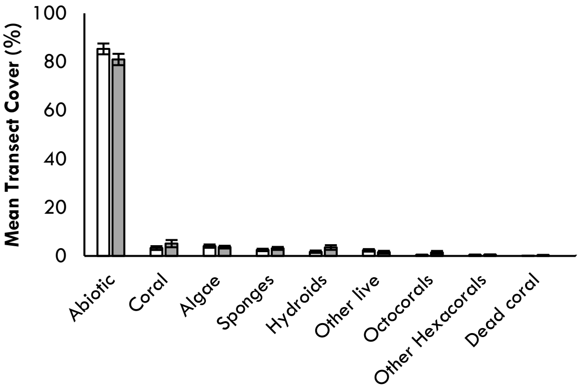

Fig 2.1.1: Mean cover (% ± SE) of all major benthic categories recorded at Bulak reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

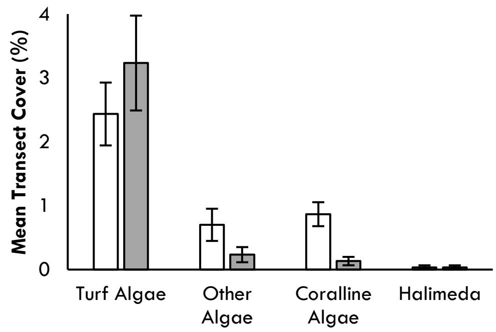

Fig 2.1.2: Mean cover (% ± SE) of algal types recorded at Bulak reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

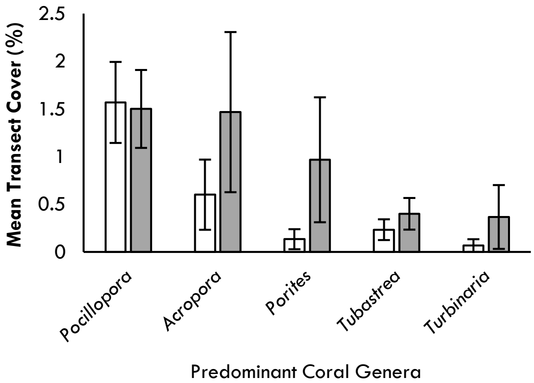

Fig 2.1.3: Mean cover (% ± SE) of predominant coral genera recorded at Bulak reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

No counts of Drupella were recorded in the wet season. Fishing gear was only recorded in the dry season, with 3 counts/100m^2 ± 0 counts/100m^2 (fig 4.2.1) (Table 1).

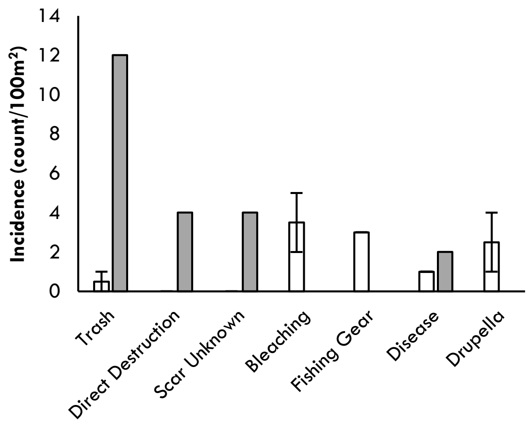

Fig 2.2.1: Mean incidence (count/100m^2 ±SE) of reef impacts recorded at Bulak reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

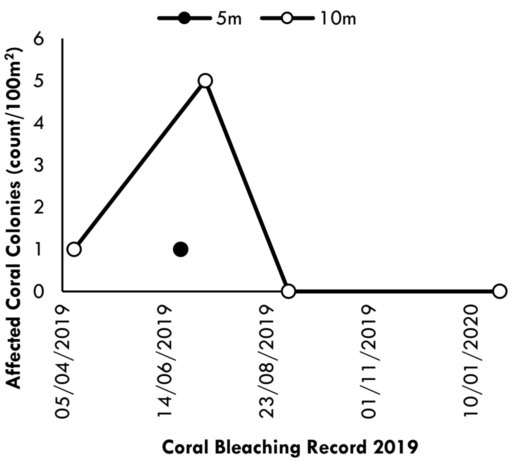

Fig 2.2.2: Number of bleaching coral colonies recorded along the transect at Bulak reef within the 2019 survey period.

Table 1: Reef impacts recorded at Bulak reef during dry and wet seasons Of 2019 with trends.

Impact (count/100m^2)	Last Season (Dry 2019)	Current Season (Wet 2019)	Trend
Coral Bleaching	1.8	0.0	↘
Direct Destruction	0.0	2.0	↗
Disease	0.5	1.0	↗
Drupella spp.	1.3	0.0	↘
Fishing Gear	1.5	0.0	↘

2.3 Fish

Bulak reef recorded an average fish abundance of n = 363 for the dry season and n = 680 for the wet season. An increase in total species richness (S) across both transect depths of S = 13 (dry S = 57; wet S = 70) was observed from dry to wet season. *Pomacentridae* recorded the highest average abundance (dry n = 189; wet n = 383), followed *by Labridae* (dry n = 97; wet n = 115) and *Serranidae* (dry n = 25; wet n = 67) across the full year. *Labridae* (dry S = 16; wet S = 18) remained the most species rich family across the year, followed by *Pomacentridae* (dry S = 13; wet S = 13). In the dry season *Chaetodontidae* followed (dry S = 3; wet S = 4) but in the wet season *Scaridae* (dry S = 2; wet S = 5) ranked higher. There was a slight decrease in average fish diversity (Simpson's Index 1-D) from dry to wet season (dry: 0.11, wet: 0.092) (Table 2). An increase in average total biomass of 24.4 kg/250m^2 from dry to wet season was observed (dry: 9.68kg/250m^2; wet: 34.1kg/250m^2). In the dry season *Siganidae* (3.06kg/250m^2) had the highest recorded average biomass followed by *Labridae* (1.88kg/250m^2) and *Pomacentridae* (1.36kg/250m^2) (Fig 2.3.1). However, in the wet season *Mugilidae* (8.16kg/250m^2) recorded the highest average biomass followed by *Labridae* (6.02kg/250m^2) and *Mullidae* respectively (5.33kg/250m^2) (Fig 2.3.1).

A seasonal shift was observed when grouping fish into trophic groups at Bulak reef. In the dry season, herbivore & planktivores accounted for the largest average biomass, followed by mobile invertebrate feeders (MIF) and piscivore & MIF, whereas in the wet season, omnivores accounted for the largest average biomass, increasing by 13.5kg/250m^2 from the dry season (dry: 0.96kg/250m^2; wet: 14.5kg/250m^2) (Fig 2.3.2). This increase is accredited to the presence of *Mugilidae* in the wet season and a 4.44kg/250m^2 increase in the average biomass of *Mullidae*. There was also a 5.54kg/250m^2 increase in the biomass of MIF recorded from dry to wet season (dry: 2.06kg/250m^2; wet: 7.60kg/250m^2), due to a 4.12kg/250m^2 and 3.08kg/250m^2 increase in *Labridae* and *Apogonidae* respectively(Fig 2.3.2). Those within three or more groups were classified as omnivores.

Species categorised as commercially important saw an 18.8kg/250m^2 increase in average fish biomass recorded from dry to wet season (dry: 6.01kg/250m^2; wet: 24.84kg/250m^2). The species *Crenimugil seheli* (*Mugilidae*), *Thalassoma lunare* (*Labridae*), *Parupeneus barberinus* (*Mullidae*) were the highest contributors of biomass in the wet season, whereas in the dry season, *Siganus guttatus* (*Siganidae*) was the highest biomass contributor followed by *Thalassoma lunare* and *Parupeneus barberinus*.

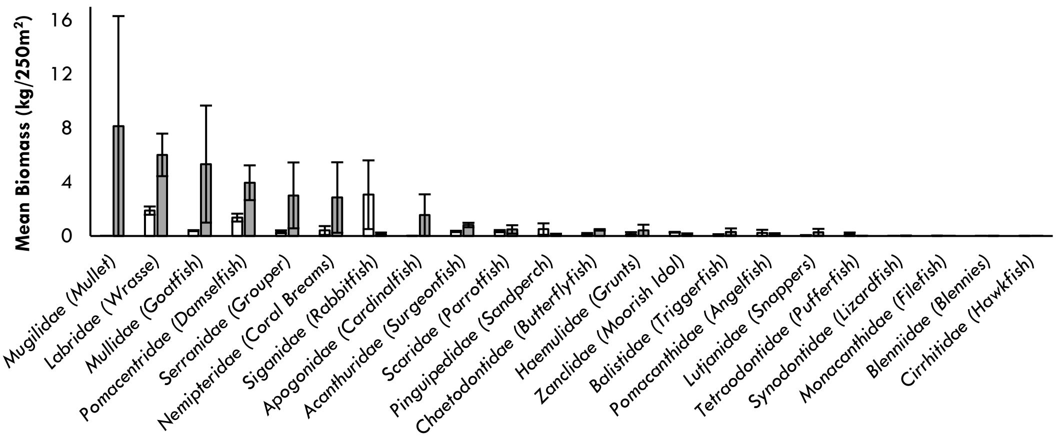

Fig 2.3.1: Mean biomass (kg/250m² ± SE) of fish families recorded at Bulak reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

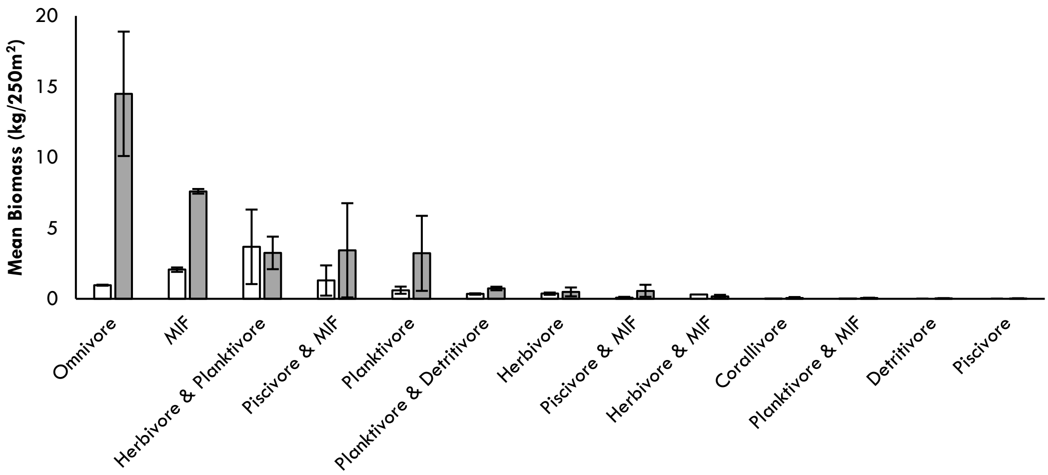

Fig 2.3.2: Mean biomass (kg/250m² ± SE) of fish trophic groups recorded at Maayong Tubig reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan). MIF = mobile invertebrate feeder

2.4 Reef Complexity

Results of the 3-Dimensional reef reconstructions reveal a decrease in the rugosity index over the 5m transect of 4.08 (dry: 6.42 ± 1.77; wet: 2.35 ± 0.33), and an increase across the 10 m transect of 11.04 (dry: 3.16 ± 1.22; wet: 14.20 ± 3.87).

There was an increase in slope value across the 5m transect of 0.12 (dry: -0.056 ± 0.26; wet: 0.068 ± 0.17), and a 0.055 decrease (dry: 0.17 ± 0.14; wet: -0.38 ± 0.21) across the 10m transect (Table 2).

Table 2. Summary of findings at Bulak reef during dry season of Feb - Jul 19 and wet season of Aug 19 - Jan 20 with trends.

Measurement	Last Season (Dry 2019)	Current Season (Wet 2019)	Trend
Coral Cover (%)	3.24	5.07	↗
Algal Cover (%)	4.04	3.63	↘
Coral 1-D	0.50	0.65	↗
Fish abundance (count/250m²)	362.5	680	↗
Fish Biomass (kg/250m²)	9.68	34.08	↗
Fish 1-D	0.11	0.092	↘
Rugosity (RQ)	5m: 6.42 10m: 3.16	5m: 2.35 10m: 14.2	↘ ↗

3.DISCUSSION

This report documents the annual monitoring of the community assemblage of Bulak Marine Reserve, with findings contributing to the baseline dataset of the Dauin IMR LTRMP. This site exhibits high-speed hydrodynamic flow rates, and above average thermal regimes due to the presence of subterranean hot springs. These environmental factors will need to be considered when understanding the community ecology and reef assemblage of the Bulak Marine Reserve.

The benthic composition of the Bulak Marine Reserve remains consistent with previous findings, characterised predominantly by the abiotic category of sand with minimal substrate availability. The limestone substrate that is present within this reef system is colonised primarily of coral, followed by algae and sponge. Coral cover has reported a linear growth of 1.83% from dry to wet season, which is encouraging considering the unique thermal and hydrodynamic characteristics of this site. Water flow is one of the most important abiotic factors influencing the growth of sedentary marine invertebrates[13], with the importance of water flow for different aspects of coral biology receiving particular attention. Water flow affects physiological processes such as photosynthesis and respiration by relieving diffusion limitation for dissolved gases[14], increases encounter and ingestion rate of food particles[15], increases the uptake of inorganic carbon[16], and aids in the removal of sediments or algae that might otherwise suffocate corals[17]. However, water flow can also have negative effects on coral biology via skeletal or tissue damage, or by restricting particle capture due to deformation and flattening of the tentacles[15]. A fine balance in flow speed is required for energy allocation to be favoured towards skeletal growth. Whilst skeletal growth appears to be promoted even under the high flow hydrodynamic conditions, the synergistic thermal effects from the subterranean hot springs must also be included.

Of the 12 Scleractinian coral genera recorded for the site, *Pocillopora spp., Acropora spp.*, and *Porites spp.* make up the major percentiles. Species-specific studies into the calcification response to business-as-usual thermal regimes reveal *Acropora spp.* to be highly susceptible to rising temperatures, with coral mortality occurring within 8 Degree Heating Weeks (DHW)[18]. In contrast, *Porites spp.* survived during a bleached state, remaining able to remove biofilms by periodic sloughing of the surface mucous layer[18]. The presence and recorded growth of temperature sensitive corals within the Bulak Marine Reserve suggests the subterranean hot springs are not a major environmental factor influencing the prevalence of coral in the area. Rather, the previously discussed hydrodynamics of the site may be offsetting the thermal regimes of the hot springs. Experimental assays designed in response to the 1998 western Pacific bleaching event reveal high coral survivorship in high water flow treatments, even when subject to high sea surface temperatures (ranging from 26.22°C to 33.65°C), whereas low water flow treatments at the same temperatures induced coral bleaching and mortality within 8 days[19]. Whilst bleaching has been recorded within the reserve, cases are low and colony-specific, suggesting temperature is not playing a large role in affecting the phytophysiology of the coral holobiont within the reserve. Identifying the drivers of coral bleaching within the Bulak Marine Reserve (e.g. microhabitat, colony size) will be important in predicting future events.

Algae also contributes to a large percentage of colonised space, particularly turf algae, with only a 1.84% difference to that of coral. Turf algae are dense, multi-species assemblages of filamentous benthic algae, including small individuals of macroalgae and cyanobacteria that are typically less than 1cm in height[20]. Compared to other algal groups such as macroalgae and coralline crustose algae (CCA), turf algae occupy available space quicker, grow faster, and are less vulnerable to grazing and water turbulence[21,22]. Turf algae has the capacity to weaken or overgrow neighbouring corals, albeit this interaction depends on the coral species involved[23]. The morphological plasticity and growth form of the corals within the Bulak reserve are typically heavily branched, allowing them to extend above the benthos and avoid interactions with neighbouring organisms. It is the slow growing and non-erect growth forms that may become vulnerable to this competitive interaction.

When assessing coral mortality and additional reef impacts within the Bulak Marine Reserve, cases of direct destruction have been recorded during the wet season period, largely affecting branched colonies of *Acropora spp.* and *Pocillopora spp.* This will result in energy allocation towards wound healing, an important process that protects the coral from invasion by pathogens. When a coral is injured, it rapidly repairs the epithelial breach and regenerates lost polyps and the surrounding tissue[24]. However, when a coral is faced with severe environmental challenges, its abilities to recover from physical injuries become compromised[25]. The threshold as to which corals within the Bulak Marine Reserve are residing under when combining the synergistic effects of high flow rate and thermal regimes, will become apparent with continued research in linear extension and recovery rates post-disturbance.

General trash has undergone a considerable rise from dry to wet season. These results coincide with the natural refilling of the Dumaguete river during the rainy season, located approximately 10km to the north of the Bulak Reserve. The predominant southerly flow of water movement from the Dumaguete outflow will result in the water quality and trash prevalence of the northern section of the Dauin inshore reef to be directly affected. Joint management decisions will need to be made between the local policy-makers of the Dauin Municipality alongside the city of Dumaguete to prevent the continued eutrophication and trash influx onto Dauin's inshore reef.

Fish biomass, abundance, and diversity have seen seasonal improvements, with the upsurge in biomass and abundance largely attributed to the presence of *Crenimugil seheli* (*Mugilidae*). *C. seheli* travel in schools and feed on fine algae, diatoms, and detritus of bottom sediments[26]. This feeding preference explains the subsequent rise in omnivores throughout the wet season. Being inhabitants of estuaries and rivers in addition to coastal waters suggest *C. seheli* have been recorded during a diel or seasonal feeding migration. In addition, most species of *Mugilidae* are catadromous, spawning in coastal waters. Newly hatched larvae drift shoreward into estuaries where they develop into juveniles[26]. Whether the Bulak Marine Reserve is being utilised as a feeding ground and/or spawning site will be determined with additional monitoring. Regardless, the aggregation behaviour and commercial importance of *C. seheli* exposes them to fishing pressures, highlighting the importance of enforcing the no-take reserve status.

The major trophic guilds present within the Reserve correlate directly with the high biomass of *Pomacentridae, Labridae, Mugilidae* and *Mullidae* families. The guild herbivore & planktivore remains dominant across seasons, followed by omnivores and Mobile Invertebrate Feeders (MIF). A combination of the unique hydrodynamic characteristics, and sandy bottom nature of the site as dictated by results of benthic and 3-Dimensional data naturally favour these feeding guilds. Whilst the hydrodynamics of this site intricately interconnects these guilds through the resuspension of bottom sediments, recent evidence suggests that *Mullidae* are also involved in this resuspension[27]. A 10 s h^{-1} resuspension activity by the Red Sea goatfish recorded plumes being formed 1m above the substrate, staying visible 1 – 2 minutes afterwards[27]. Not only does this dislocate a large amount of sediment during foraging, this should also contribute to nutrient cycling and transport, thus enriching plankton. This role of *Mullidae* as ecosystem engineers often forms mixed-species foraging associations following *Mullidae* feeding behaviour[27]. This feeding association will become of particular importance to ensure planktivores are capable of feeding during periods of slack water movement. Due to the commercial demand of *Mullidae*, these results highlight the intricate nature of feeding guilds even across sandy bottom communities, emphasizing the importance marine reserves to be designed even in coral and substrate poor areas.

Recordings of commercially important species rose from dry to wet season, excluding *Haemulidae* which were absent in wet season. *Labridae, Mullidae, Nemipteridae* and *Acanthuridae* are the dominant CIS across seasons, with abundance rising substantially from dry to wet season. The small size of home ranges for species within these abundant taxonomic families have been associated with high topography habitats, indicating that the presence of appropriate shelter influences the home range area maintained for these families[28]. Body size has also been found to influence their home range, which remains consistent with foraging theory and the relationship between metabolic demands and body size[29,30]. Larger fish families such as *Lutjanidae, Haemulidae and Serranidae* exhibit greater home ranges[28]. The low recordings of larger bodied CIS individuals may be attributed to their home range exceeding both the survey and reserve area, or due to recordings occurring during a period when members of these families are less active and seeking refuge in reef walls and crevices. Regardless, understanding the home range of these CIS and their ties to the Bulak Marine Reserve will be important in understanding the environmental and anthropogenic trends in CIS biomass.

Overall, annual findings from the Bulak Marine Reserve reveal ecosystem trends and assemblages which are intricately linked to both the sandy bottom and high flow hydrodynamic nature of the site. However, concerns are raised over the threshold at which the Scleractinian corals are currently residing under, and their subsequent resiliency towards anthropogenic or environmental disturbance. Anthropogenic disturbances that originate outside of the reserve are already in effect, with a high prevalence of general trash over the wet season recorded in conjunction with the refilling of the Dumaguete river. In addition to this, the large home range of heavy-bodied CIS exposes them to their direct removal from the ecosystem. Continued monitoring of the aforementioned trepidations will be required to prevent the continued weakening of the resiliency state of the Bulak Marine Reserve.

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