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Front Cover: Maayong Tubig Marine Reserve
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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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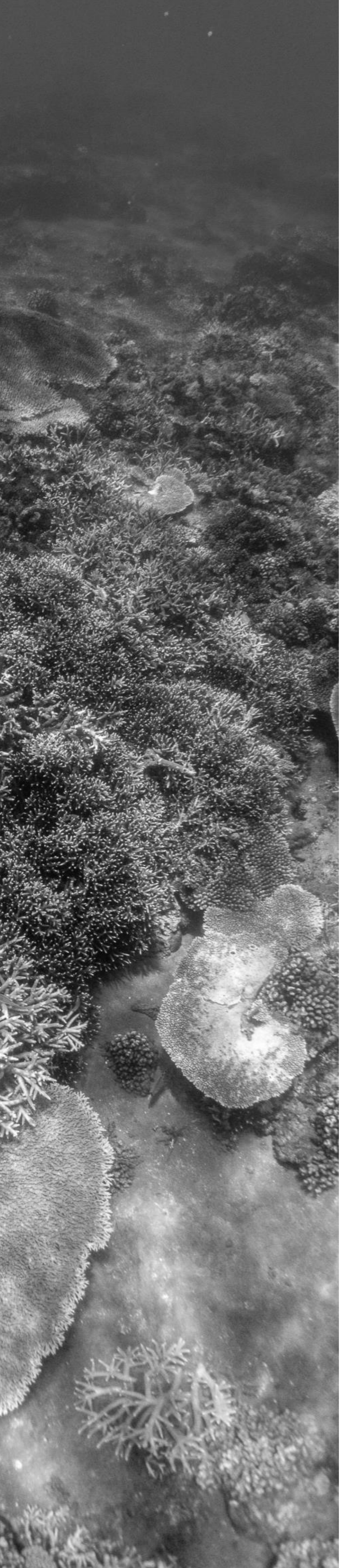

Daiun Long-Term Reef Monitoring Project Aims

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

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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. The Masaplod Norte is located in the southern region of the Dauin LTRMP, with a more exposed shoreline than the more northerly sites. Eight 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

Benthic composition at Masaplod Norte is dominated by abiotic components (principally sand and rubble), with an annual mean of 47.6%, which decreased by 9.6% from dry to wet season (dry: 52.4%, wet: 42.8) (Fig 2.1.1) Abiotic substrate is followed by dead coral (annual mean 22.9%), which marginally increased from dry to wet season (dry: 21.3%, wet 24.4%) (Fig 2.1.1). Within the dead coral major category, the largest seasonal change in cover is from coral rubble; dead coral with algae and recently dead coral decreased marginally from dry to wet seasons (Fig 2.1.2). Algae is the third largest contributor to overall benthic composition (annual mean 11.6%), increasing from dry to wet season (dry: 6.9%, wet:16.2%) (Fig 2.1.1). Both turf algae and coralline algae increased from dry to wet season (Fig 2.1.3), whereas Halimeda and 'other algae' decreased (dry: 3.8%, wet: 0.9%, and dry: 1.3%, wet: 0.3% respectively) (Fig 2.1.3).

Scleractinian corals make up approximately 5% of the benthic cover at this site, with minimal differences between dry and wet seasons (dry: 5.1%, wet 5.0%) (Fig 2.1.1). A total of 26 Scleractinian coral genera were recorded at this site, with *Pocillopora* (dry: 1.2%, wet 0.9%) as the most abundant, followed by *Porites* (dry: 1.2%, wet 0.8%) and *Fungia* (dry: 0.5%, wet: 0.4%) (Fig 2.1.4). Simpson's diversity index (1-D) for hard corals remained fairly consistent between seasons (dry 1-D= 0.82, wet 1-D= 0.87). The 10m site had higher diversity and genera richness (10m 1-D= 0.87, G=21) than the 5m site (5m 1-D= 0.83, G=13). Pielou's evenness (*J'*) of coral spread was similar at both depths (5m J'=0.76, 10m J'=0.78).

2.2 Reef Impacts & Coral Mortality

Coral bleaching was the most prevalent impact recorded at Masaplod Norte (Fig 2.2.1), with 29 instances over the year, impacting on average 46.9% of the colony. Seasonal variations saw a marginal increase in the instances of coral bleaching from dry to wet season (Dry:4.8 count/100m^2, Wet: 5.0 count/100m^2) (Fig 2.2.1), although on average a smaller percentage of the colony was affected (dry: 60%, wet: 43.1%). Seven coral genera were affected by bleaching (*Favites, Fungia, Goniastrea, Leptoria, Merulina, Montastrea*). The 5m site recorded an increase in bleaching throughout the year, whereas the 10m site saw a spike in May and then decreased (Fig 2.2.2).

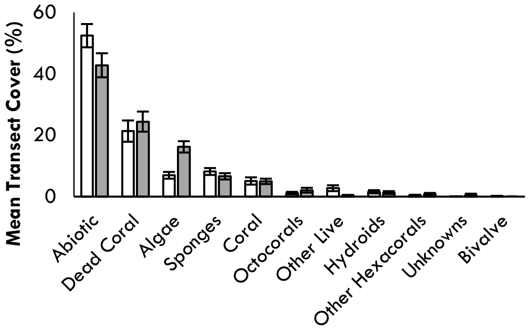

Fig 2.1.1: Mean cover (% ± SE) of all major benthic categories recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

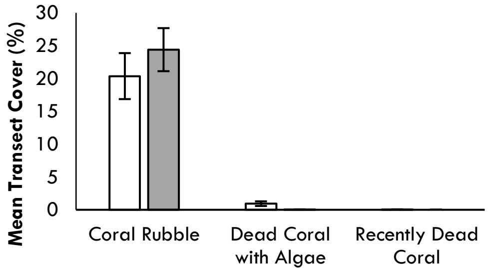

Fig 2.1.2: Mean cover (% ± SE) of dead coral types recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

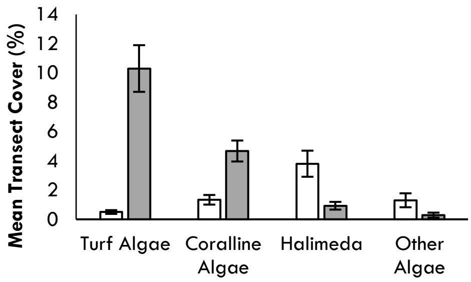

Fig 2.1.3: Mean cover (% ± SE) of algal types recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

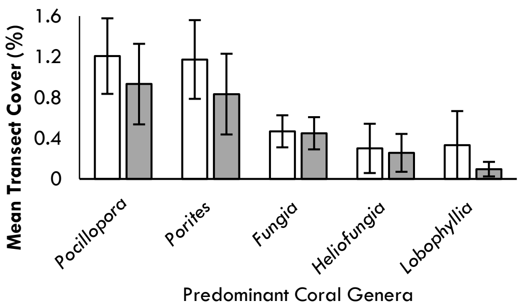

Fig 2.1.4: Mean cover (% ± SE) of predominant coral genera recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

General and fishing trash were also recorded at Masaplod Norte, with general trash consistent between seasons and fishing gear increasing from dry to wet season (Fig 2.2.1, Table 1). Unknown scarring was recorded at this site during both seasons, with more being recorded in wet season (dry: 0.8 count/100m^2, wet: 1.5 count/100m^2). Only one instance of *Drupella* spp. feeding activity was recorded at this site during the entire survey year (recorded in the dry season, Fig 2.2.1), affecting 1.6% of a *Pocillopora* colony.

Overall, seasonal trends at Masaplod Norte indicate an increase in bleaching, unknown scarring, fishing gear and direct destruction from dry to wet season (Table 1). Decreases were seen in disease and *Drupella* spp. feeding activity (Table 1). Trash was consistent between seasons (Table 1). There were no recorded instances of *Acanthaster plancii* (Crown of Thorns Starfish).

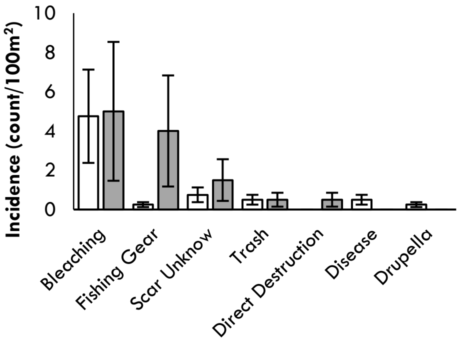

Fig 2.2.1. Mean incidence (count/100m^2 ±SE) of reef impacts recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

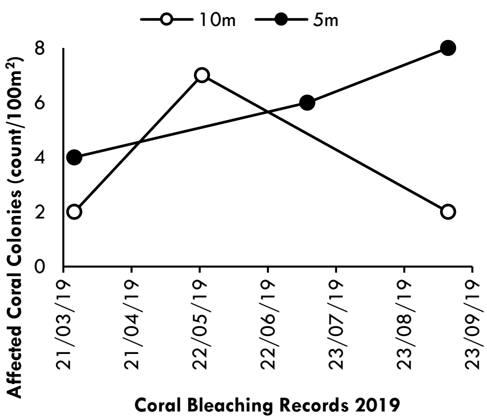

Fig 2.2.2: Number of bleaching coral colonies recorded along the transect at Masaplod Norte reef within the 2019 survey period.

Table 1: Reef impacts recorded at Masaplod Norte 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	4.8	5.0	↗
Fishing Gear	0.3	4.0	↗
Scar Unknown	0.8	1.5	↗
Trash	0.5	0.5	⇔
Disease	0.5	0.0	↘
Drupella spp.	0.3	0.0	↘

2.3 Fish

Masaplod Norte recorded a total fish abundance for 2019 of 1,888 (dry n=836, wet n=1052) *Pomacentridae* was the most abundant family in both seasons (dry n=286 S=19, wet n=351 S= 19). There were seasonal differences between the 2nd and 3rd most abundant fish families; during dry season, the next most abundant were *Caesionidae* (dry n=171 S=2, wet n=95 S= 1) and *Labridae* (dry n=103 S=17, wet n=158 S= 19), whereas during wet season, the 2nd and 3rd most abundant respectively were *Labridae* (see above) and *Plotosidae* (dry n=56 S=1, wet n=110 S= 1) (Fig 2.3.1).

Species richness and overall biomass increased from dry to wet season (dry 39.96kg S= 70, wet 43.44kg S=78). The family with the greatest biomass during dry season was *Lutjanidae* (8.16kg/250m^2), although it was exclusively recorded at the 10m site. *Lutjanidae* was followed by *Caesionidae* (4.19kg/250m^2) and *Pomacentridae* (1.77kg/250m^2), with the second and third largest biomass respectively during dry season. During wet season, the greatest contributor to biomass remained consistent with the *Lutjanidae* (4.84kg/250m^2), although this is followed by *Serranidae* (3.97kg/250m^2) and *Holocentridae* (3.77kg/250m^2). The recorded lengths and the average biomass of an individual fish are both the second largest of all survey locations along the Dauin reef system, second to Bulak I in average biomass per fish, and to Lipayo II for average recorded length.

Commercially important species (CIS) at Masaplod Norte make up 33% of total fish abundance and 57% of total fish biomass. The most abundant CIS are within the fish families *Caesionidae* and *Plotosidae*, although by biomass the biggest contributors are *Lutjanidae* and *Caesionidae*. Seasonal variations in the abundance and biomass of CIS at this site are notable (Fig 2.3.4). The biggest changes are within *Caesionidae* and *Lutjanidae*, both abundance and biomass, which drop substantially from dry to wet season. The decrease in *Caesionidae* is attributable to

Pterocaesio tessellata which was absent from records in wet season, although *Pterocaesio pisang* did see a slight increase from dry to wet season. The decline in *Lutjanidae* is attributable to *Lutjanus argentimaculatus*, which exhibited a six-fold decline in biomass, and Macolor macularis which exhibited a three-fold decline to totally absent in wet season. A large increase in *Plotosidae* abundance from dry to wet season was observed, specifically *Plotosus lineatus*, although this had little effect on biomass. A large increase in *Serranidae* biomass is seen from dry to wet season, although this is attributable to a few large individual fish; both the abundance and biomass of *Cephalopholis argus* approximately doubled from dry to wet season, but the largest biomass increase is from one *Epinephelus fuscoguttatus* individual, which single-handedly added 6kg to the biomass of this family in the wet season.

Grouping fish into trophic groups collectively across depths, dry season showed a greater biomass in Omnivores (dry: 9.17kg/250m^2, mean n=74, wet: 3.75kg/250m^2, mean n=113.5) but a greater abundance in Planktivores (dry: 6.29kg/250m^2, mean n=147, wet: 6.17kg/250m^2, mean n=194.5). During wet season, the most abundant and greatest biomass fish family were the same; Planktivores. The second greatest biomass during dry season was from Planktivores, followed by Herbivore & Planktivores (dry: 1.42kg/250m^2, mean n=107, wet: 1.93kg/250m^2, mean n=106.5) (Fig 2.3.3). The second greatest biomass during dry season was from Piscivores & MIF (dry: 0.16kg/250m^2, mean n=17, wet: 0.27kg/250m^2, mean n=26), followed by Omnivores (Fig 2.3.3).

2.4 Reef Complexity

Results from our 3-Dimensional reef reconstructions at 5 m during dry season reveal a rugosity index of 1.034 ± 0.2093 and a slope value of -0.1428 ± 0.2439. The wet season 5m survey shows a rugosity index of 8.837 ± 0.284 and a slope value of 0.01855 ± 0.002587. At 10m our results from the 3-Dimensional reconstructions reveal, during dry season, a rugosity index of 1.434 ± 0.5907, and a slope value of -0.114 ± 0.09753. During wet season at 10m, a rugosity index of 6.25 ± 2.04 and a slope value of 0.1127 ± 0.08495.

Table 2. Summary of findings at Masaplod Norte 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 (%)	5.09	4.96	↘
Algal Cover (%)	6.94	16.19	↗
Coral 1-D	0.82	0.87	↗
Fish Abundance (count/250m^2)	418	526	↗
Fish Biomass (kg/250m^2)	19.98	21.72	↗
Fish 1-D	0.08	0.06	↘
Rugosity (Rq)	**5m** 1.034 ± 0.2093 **10m** 1.434 ± 0.5907	**5m** 8.837 ± 0.284 **10m** 6.25 ± 2.04	↗

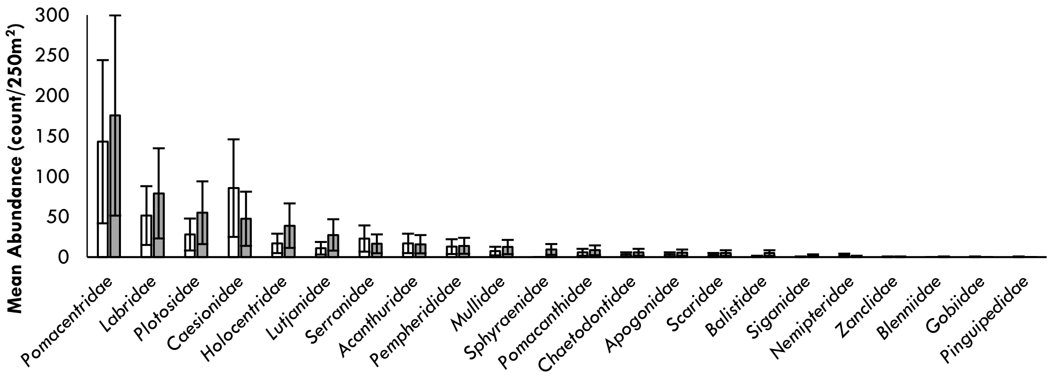

Fig 2.3.1: Mean abundance (count/250m^2 ± SE) of fish families recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

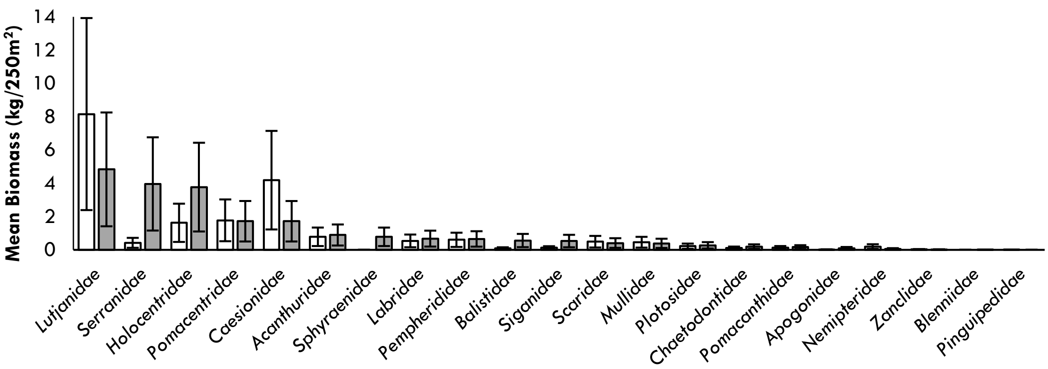

Fig 2.3.2: Mean biomass (kg/250m^2 ± SE) of fish families recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan).

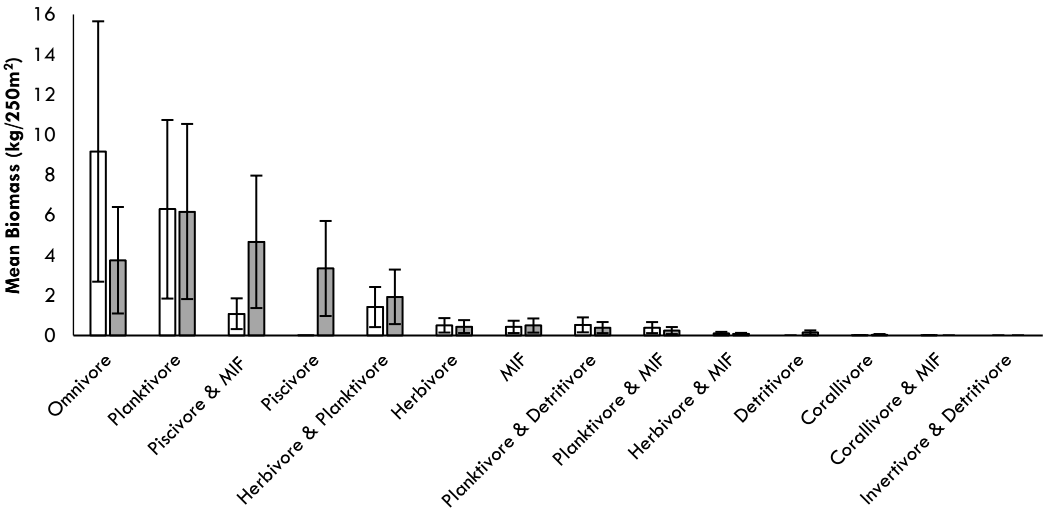

Fig 2.3.3: Mean biomass (kg/250m^2 ± SE) of fish trophic groups recorded at Masaplod Norte reef, with white representing dry season (Feb - Jul), and grey representing wet season (Aug - Jan). MIF = mobile invertebrate feeder

3.DISCUSSION

This report documents the annual development of the reef assemblage and community make-up of the Masaplod Norte reef, with findings contributing to the baseline dataset of the IMR Dauin LTRMP. It must be noted that any differences observed between seasons from this first survey year may be as a result of seasonal fluctuations in the ecology of the reef, or long-term trends that will continue over several years; data from several years of the IMR Dauin LTRMP is required in order to determine this.

The Masaplod Norte reef is dominated by abiotic substrate (largely sand and rubble), followed by dead coral, algae, sponge and live Scleractinian coral. Live coral cover remains stable from dry to wet season, with *Pocillopora* and *Porites* as the dominant genera. Substantial changes are seen in the coverage of abiotic substrate and algae. Within abiotic substrate, large decreases are seen in sand and rubble cover. Within algae, substantial increases are seen in turf algae and coralline algae, with smaller changes (decreases) in *Halimeda* and 'other algae'. Small changes are observed in the coverage sponge (small decrease in encrusting sponge) and dead coral (small increase in coral rubble).

Masaplod Norte was one of the more damaged reefs along the Dauin coast when typhoon Pablo hit the Southern Visayas in 2012 (one of the strongest tropical cyclones to ever hit the area). Typhoons are one of the most severe natural disturbances on coral reefs[13], affecting their structure and functioning through mechanical destruction and changes in sedimentation, turbidity, salinity and sea level[14]. Inshore reefs are usually more damaged than offshore reefs in terms of coral breakage and dislodgement[13]; the fringing nature and proximity to shore of the Dauin reef system is therefore vulnerable to extensive damage. This storm damage at Masaplod Norte is still evident some eight years later in the high proportion of dead coral cover, specifically coral rubble, as well as the very low (albeit increasing) rugosity and structural complexity at this site. Following severe storm damage, successive benthic algal blooms generally develop first[14]. When examining the aforementioned changes in relative substrate cover, it is likely that the coral rubble at this site is becoming increasingly colonised by algae. Turf algae is one of the first colonisers of bleached coral[15], dead coral[16-18] and bare substrate[19]. Coralline algae is an important reef builder[20,21] and agent for rigid binding of loose rubble in shallow reef environments[22]. The increase in coralline algae cover is therefore promising, as it is stabilising rubble and reconsolidating the substrate post-disturbance, providing suitable substrate for and inducing coral larvae settlement[23,24], as well as reducing turnover and burial of established juvenile corals[25]. Previous research has shown that the colonisation of bare substrate by different organisms is dependent on pre-existing conditions; filamentous turf algae establishes faster in previously and/or currently algal-dominated habitats[26,27], whereas healthy coral-dominated habitats are more often colonised by coralline algae and other calcifiers[27]. As the Masaplod Norte reef shows increases in both turf and coralline algae (coupled with the storm damage preceding the establishment of the Dauin LTRMP), the coral-algal balance of the reef pre-disturbance is unknown.

Recovery of post-disturbance coral reefs usually occurs through the recolonisation of bare substrate by the settlement of coral larvae[28]. Depending on the extent of the damage and the history of the reef, recovery can take anywhere from a few years to centuries[14]. A study on post-disturbance coral reefs in the Caribbean found no evidence of recovery to a pre-disturbance level for at least eight years after impact[29]. Whilst recovery after disturbances is complex and variable spatiotemporally[14], we may begin to see signs of recovery and coral recolonisation and growth in the near future. Shifts to algal-dominated systems may occur if the reef cannot recover[14]. Although the increase in turf algae may suggest a shift towards an algal-dominated system, the decrease, albeit small, of macroalgae (within the 'other algae' category), suggests this is not yet significant. The increase in coralline algae cover and its properties regarding substrate reconsolidation and the inducement of coral larval settlement and metamorphosis[24] supports the recovery of this post-disturbance ecosystem to a coral-dominated system. The Dauin LTRMP will continue to monitor the succession of the Masaplod Norte reef in its post-disturbance state, identifying potential signs of recovery to a coral-dominated system.

A total of 22 fish families were recorded at the Masaplod Norte reef during the 2019 survey year, with a total species richness of 98. The relatively high fish biomass and average length at this site compared to others along the Dauin coast indicates that the fish population at Masaplod Norte consists of larger individuals than most other locations along the coastline. The most abundant fish families at Masaplod Norte are *Pomacentridae*, followed by *Labridae*, *Caesionidae*, *Plotosidae*. Regarding biomass, greatest contributors to the reef assemblage are *Lutjanidae*, followed by *Serranidae*, *Holocentridae*, *Caesionidae* and *Pomacentridae*.

Overall fish abundance, biomass and species richness increased at this site from dry to wet season. The effects of seasonality on coral reef ecosystems vary according to latitude; reefs closer to the equator are exposed to monsoonal conditions (changes in wind and rainfall), whereas further from the equator seasonality is principally driven by changes in water temperature[30]. The Philippines is influenced by the reversing wind pattern of the East Asian monsoon[31], although much of the study area for the Dauin LTRMP is sheltered from the southwest monsoon by tall mountains. The observed increase in fish abundance at this site from dry to wet season may therefore be as a result of enhanced retention of larvae during the southwest monsoon and inter-monsoonal periods when wind strength and currents weaken. It has been previously found in reefs close to the equator that wind has the most significant impact on the settlement of reef fishes, particularly *Pomacentridae*[30,32,33]. Further research on the effects of seasonality and local shelter on the hydrodynamics at this site will elucidate links between the hydrodynamics of this area and the fish assemblages present.

The Masaplod Reef supports a high proportion of habitat generalists over specialists, as shown by the high prevalence of omnivores, followed by planktivores, piscivores, mobile invertebrate feeders and herbivores. Within the omnivorous group, the most common feeding guilds are herbivores, planktivores, piscivores and mobile invertebrate feeders, consistent with the dominant feeding guilds outside of the omnivore category. Many studies have examined the susceptibility of habitat and feeding generalists versus specialists following disturbances, such as bleaching and severe tropical storms on coral reefs[34-36]. Ecological theory predicts that habitat specialists are more prone to decline or extinction in response to habitat disturbance than habitat generalists[35]. One study on a post-bleaching community on the Great Barrier Reef found the fish assemblage to be dominated by generalist planktivores, benthic omnivores and detritivores[37]; a similar assemblage is found at Masaplod Norte. Research has also found strong positive relationships between fish abundance and live coral cover, particularly with regards to habitat specialists, i.e. obligate coral-dwelling species, corallivorous fishes, or species reliant on coral habitat for recruitment[38-41]. Reef fish assemblages have also been found to be linked closely to structural complexity[42-44]. Masaplod Norte is a post-disturbance reef system, with high rubble cover, low live coral cover and low rugosity (a measure of structural complexity). It is therefore unsurprising that these conditions favour habitat generalists over specialists; explaining the high proportion of omnivores, planktivores and piscivores, as well as the very low proportion of corallivores – arguably the most specialist trophic group. If coral cover and structural complexity remains low for a prolonged period of time, the few remaining habitat specialists at this site may be lost, as they are forced to increase their home ranges when resources are limited. In the case of Masaplod Norte, a fairly small MPA, the extension of their home ranges will likely require travelling outside of protected waters, potentially exacerbating fishing pressures on these species. The continued monitoring of this post-disturbance reef is therefore imperative in understanding the shifting fish community structure from habitat specialists to generalists.

Of the 98 species recorded at the Masaplod Norte reef, 30 are categorised as commercially-important species (CIS), compared to 55 that are not commercially-important (non-CIS). By abundance, all CIS comprise 33% (consisting largely of *Caesionidae* and *Plotosidae*) of the fish assemblage at the Masaplod Norte reef, whereas by biomass they consist of 57% (largely *Lutjanidae and Caesionidae*). Although overall abundance, biomass and species richness increases from dry to wet season, both abundance and biomass of CIS decline. Biggest decreases in abundance and biomass of CIS are seen in the *Caesonidae* and *Lutjanidae*. The decline of *Caesionidae* is attributable to *Pterocaesio tessellata* which was completely absent in the wet season, (although a small increase in *Pterocaesio pisang* was observed). Within *Lutjanidae,* the decrease is attributable to *Lutjanus argentimaculatus*, which exhibited approximately a six-fold decrease in abundance and biomass, and *Macolor macularis* which exhibited a three-fold decline, to complete absence in wet season. A substantial increase in *Serranidae* biomass was seen from dry to wet season, although the change in abundance was small. Within the *Serranidae*, the abundance and biomass of *Cephalopholis argus* doubles, but the biggest biomass increase is from *Epinephelus fuscoguttatus*, which was absent from dry season, but one individual recorded in wet season added 6kg to the *Serranidae* biomass. A substantial increase in *Plotosidae* (*Plotosus lineatus*) abundance was observed from dry to wet season, although this had little effect on biomass of the family, hence the change in abundance is due to a large number of small individuals.

The health of coral reefs are often jeopardised by multiple stressors, natural and anthropogenic[45]. When a coral is damaged or weakened, energy is diverted to tissue repair and regeneration[46]; this is particularly pertinent on the Masaplod Norte reef following the damage caused by typhoon Pablo. It has been suggested that the metabolic cost of this energy diversion lowers the immune responses of the coral, increasing its susceptibility to secondary stressors such as disease[47]. Secondary stressors can have synergistic or antagonistic effects if acting simultaneously[45,48]. On the Masaplod Norte reef system, the most prevalent impacts recorded in the 2019 survey year are bleaching, trash (fishing gear and general), disease and *Drupella* spp. predation. It is likely that some of these impacts are acting synergistically, although further research is required to determine and quantify stressor interactions, in order to subsequently reduce their impact on the reef.

Bleaching is the most common impact recorded at this site, with *Fungia* the most commonly affected genus accounting for 55% of bleaching records. *Fungia* has been found to be one of the coral genera most susceptible to bleaching, along with *Acropora* and *Pocillopora*[49]. Although *Pocillopora* is the most prevalent coral genus at this site, there were no records of this genus bleaching across the 2019 survey year. Bleaching of corals can be highly size-dependent and largely connected to their life histories[50]. Of the genera recorded bleached at this site, *Fungia* corals were the smallest, more than 100 times smaller than the mean size of all bleached colonies. The prevalence of bleaching across the year and the two survey depths show no clear trends at this point in the Dauin LTRMP. The environmental factors that determine the extent and severity of bleaching along the Dauin coastline requires further investigation, as enhanced understanding of this can aid in predicting future bleaching events[51].

The second most prevalent impact recorded at this site, fishing gear, is also the impact that shows the largest change (increasing) between seasons. Conversely, the prevalence of general trash remains largely unchanged between seasons. This increase in fishing gear trash is coupled with an increase in direct destruction. Direct destruction can be caused by natural processes (storms, wave action) or anthropogenic activities (boat anchors, recreational use from snorkelling/diving). It is acutely detrimental to coral health, both directly through fragmentation (which is particularly detrimental for slower growing species), and indirectly through reduced fitness and susceptibility to secondary stressors as previously discussed. It is possible that the increase in both direct destruction and fishing gear trash is due to increased fishing activity within the Masaplod Norte Marine Protected Area (MPA), highlighting the need for stricter enforcement of the MPA regulations at this site.

Disease is present at the Masaplod Norte reef, although at fairly low prevalence in comparison to other sites along the Dauin coast. One count of *Porites* trematodiasis (also known as *Porites* pinking) was recorded, and one count of Skeletal Eroding Band (SEB), both of which were found on *Porites* colonies. Lesions from direct destruction[52], temperature stress[53,54] and nutrient enrichment[55,56] amongst other factors have been shown to increase disease outbreaks. Additionally, lesions may attract corallivores such as *Drupella*[57,58] and corallivorous fish[59], which in turn may act as vectors for disease[60-62]. Little is known about disease dynamics specific to the Philippines, with few studies and reviews available[63,64]. However, *Porites* is known as a dominant disease host within the Philippines, particularly in the Central Visayas[65]. *Porites* trematodiasis has been recorded to drastically reduce growth rates of *Porites* colonies, up to 50% reductions[66,67], hence potentially reducing the capacity of the infected colony to compete for space on the reef[68]. However, it has been postulated that a high prevalence of *Porites* trematodiasis is indicative of a healthy reef ecosystem, as the disease (caused by a parasitic flatworm) requires multiple hosts (molluscs, coral and fish) during its life cycle[69]. As such, although the disease will have negative impacts on individual *Porites* hosts, the prevalence of this disease on the Masaplod Norte reef may infer a healthy reef ecosystem. SEB is a ciliate infection associated with tissue loss in corals [70] and is strongly linked with coral damage and injuries[71]. The reef at Masaplod Norte may be more susceptible to SEB due to the higher prevalence of direct destruction and unknown scarring, both of which will leave exposed coral skeleton. The putative agent of SEB has been shown to readily colonise recently exposed coral skeleton in the absence of a vector, but did not colonise intact coral tissue[72]. Although it can readily colonise exposed tissue, it is not able to cause tissue mortality alone; it requires additional agents or factors (stressors) to increase the virulence of the putative agent or to lower the disease resistance of the coral host in order to cause tissue loss[72]. A study on the Great Barrier Reef found 12 Scleractinian families were affected by SEB, with *Pocilloporidae* and *Acroporidae* as the most susceptible[72]. Despite the high prevalence of *Pocillopora* spp. on the Masaplod Norte reef, no SEB was found on this genus during the 2019 surveys, with the only incidence of SEB recorded on a *Porites* sp. colony. Although the presence of disease can be concerning, the prevalence on the Masaplod Norte reef is very low, with only two records from the 2019 survey year. Additionally, both of these records were from the dry season, with all diseases absent from the wet season surveys. This decline in disease from dry to wet season may be due to decreased water temperature in the wet season and therefore temperature stress, which is known to affect disease outbreaks as aforementioned.

Overall, the succession of the benthos thus far is promising, indicating the potential recovery of a coral-dominated system, although algal overgrowth may hinder this. The high proportion of habitat generalists is indicative of a post-disturbance reef; reef recovery may support a rise of habitat specialists. The decline in commercially important fishes at this site despite overall increase in fish abundance and biomass is concerning, as is the extent of coral mortality potentially as a result of fishing activity within this marine protected area. The key areas for continued monitoring at this reef are the succession and potential recovery of the reef itself (continued substrate reconsolidation, recruitment and growth of corals), the effect of reef recovery on the fish assemblage, and the extent and impacts of fishing pressures on the commercially important fishes. In tandem with this continued monitoring, improved enforcement of the MPA regulations is required.

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