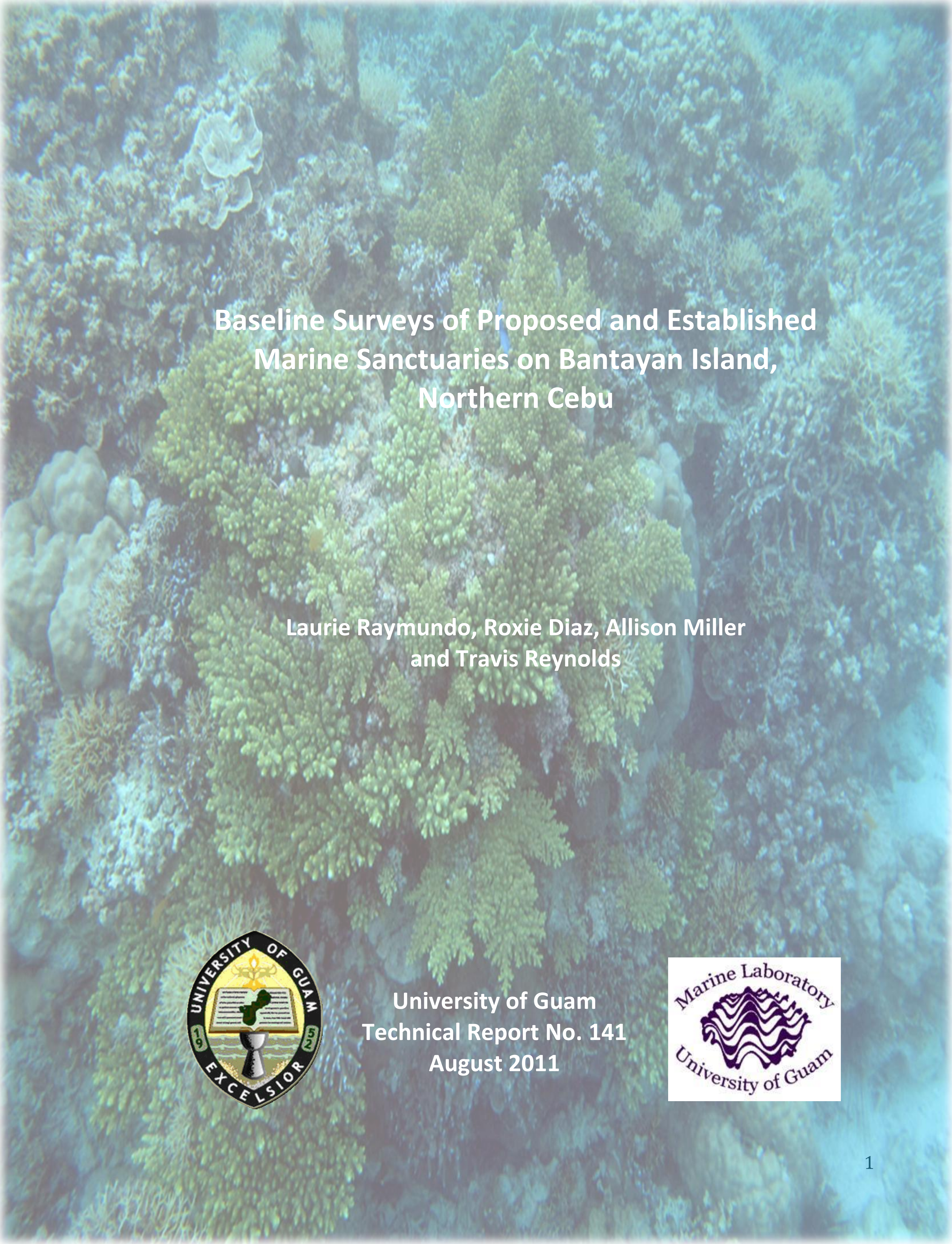

Baseline Surveys of Proposed and Established Marine Sanctuaries on Bantayan Island, Northern Cebu

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EXECUTIVE SUMMARY

A total of nine declared and proposed Marine Sanctuaries were visited by researchers from University of Guam Marine Lab from June 13 to 17, 2011, with assistance from managers from the *Batas Kalikasan* Foundation. The purpose of this work was to perform baseline surveys of the benthic communities within three proposed marine reserves (Bunakan, Tabagak, and Tarong). Four established marine reserves (Jojo de la Victoria, Maricaban, Talangnan, and Hilantagaan) were resurveyed, to determine how effective their management plans were. Two sites, Kodia and Poblacion, were briefly snorkel surveyed, but no quantitative data were obtained due to time limitations (Kodia) and strong current (Poblacion). Surveys included qualitative site description including the location of the boundary corners, obtaining quantitative data on fish abundance and diversity using fish visual census, quantifying benthic composition using replicate line intercept transects, and describing mobile invertebrate abundance and diversity, and diversity, population structure and health status of the coral community, using replicate belt transects.

Results showed that the marine reserves of JDL Victoria and Hilantagaan appear to be meeting management objectives of improving fish abundance and diversity. Abundance of both targeted reef fish species and all reef fish species were significantly higher at these two sites than at all others. Furthermore, comparisons with surveys done on JDL Victoria and Hilantagaan in 2007 revealed large increases in fish abundance within these reserves in the 2011 surveys. The Maricaban MPA, which is much younger than the other two, also appeared to have improved during the first year of no-take enforcement regulations, though the large abundance of fish was predominantly explained by a large herbivore population. However, this is characteristic of newly-established MPAs; herbivore species tend to respond rapidly to protection from fishing. The MPA at Talangnan, however, which was the oldest MPA of those surveyed (11 years) had obviously not been managed; it appeared to be in very similar condition as the proposed sites, which low diversity and abundance of fish, few target individuals, and low coral cover.

The proposed sites all showed similar characteristics of dominance by extensive mixed seagrass beds, very limited coral reef area, high turbidity and silt, and depauperate fish communities of low abundance. Charismatic and economically important benthic macroinvertebrates were also of low abundance and diversity. While these sites would most definitely benefit from protection, these current attributes suggest that recovery would be slow, particularly if land use practices resulting in nearshore siltation do not change. The dominance by seagrass suggests that none of these sites had significant coral cover historically, and siltation has undoubtedly resulted in further reduction. Conclusions and recommendations for management are provided at the end of the report.

INTRODUCTION

Marine reserves are, at present, the dominant tool employed to protect and manage remaining coastal resources in many parts of the world. As a growing number of reserves worldwide are at least a decade old, critical assessments of their efficacy can now be made. A number of recent publications highlight potential and realized benefits of well-managed marine reserves beyond the traditional goals of fisheries management and biodiversity protection (Botsford et al. 2003; Alban et al. 2006). Alban et al. (2006), in fact, state that non-extractive uses which can boost local economy (tourism, recreation) may be the driving force behind the establishment of protected areas in many cases. However, this motivation is often considered of minor importance in the literature, much of which focuses on biological and ecological impacts.

While managing fisheries remains an important overarching goal, recent studies have addressed the mechanisms by which this goal may be manifested. Recovery of large predatory species, for instance, is estimated to require a minimum of 15 years (Russ and Alcala 2004). Herbivores, in contrast, respond very quickly to protection and have a positive cascade effect on coral growth, survival and recruitment, due to their impacts on macroalgal reduction (Stockwell et al. 2009; Mumby and Harborne 2010). A component of marine reserve science is optimum design of reserves; i.e., how might size, composition and location be best utilized to maximize benefits. Botsford et al. (2003) considered movement of recruits and adults to be essential, while Cinner (2007) examined the question from the point of view of traditional management approaches and socioeconomic considerations. Marine reserve size, age and management effectiveness were drivers of positive change in fish populations (Maliao et al. 2009), highlighting the importance of continual commitment to enforcement. Expanding our perception of marine reserves beyond that of simply a primary fisheries management tool to one of an ecosystem-based management approach (Browman and Stergiou 2004) has allowed us to consider the roles of functional diversity (Raymundo et al. 2009) and essential habitat (Friedlander et al. 2007) in maintaining ecosystem function.

The Philippines remains on the cutting edge of research that explores the development of marine reserves as a management tool in marine conservation; it is a nation-wide experiment in community-based management. While the protocol for establishing community-based marine reserves is now well-documented (White et al. 2006), issues regarding management and enforcement continue to challenge their success (see Watson 1999). This document reports results of a series of baseline and follow-up surveys of four marine reserves and five proposed reserve sites around the island of Bantayan, northern Cebu. Established marine reserves were of varying ages, from one year old to 11 years old, while the proposed sites were awaiting official declaration via municipal ordinance. The methods employed are described below, followed by site descriptions and results of fish and benthic surveys for each site. Assessments of management efficacy and recommendations for improved management are provided in a separate section at the end of the report.

METHODS

Underwater surveys were conducted by researchers from the University of Guam Marine Lab, using snorkel and SCUBA. Mapping of the corner boundaries of each of the proposed marine reserves and placement of corner marker buoys was accomplished by researchers of the *Batas Kalikasan* Foundation, assisted by *Bantay Dagat* personnel from each barangay. Mapping made use of a hand-held GPS unit; latitude and longitude points were then positioned on a map and the boundaries hand-drawn using Photoshop software. Prior to quantitative SCUBA surveys, all sites were briefly surveyed via snorkel for general characteristics, and to locate areas of coral cover. Four established MPAs (Jojo de la Victoria, Maricaban, Talangnan and Hilantagaan) and three proposed MPAs (Bunakan, Tabagak, Tarong) (Figures 1A and 1B) were surveyed with two objectives: 1) In established MPAs, *to assess the effectiveness of management, as measured by fish community diversity and abundance, benthic composition, coral health and invertebrate abundance;* and 2) in proposed MPAs, *to assess their current biotic communities in a baseline survey against which to measure improvements as a consequence of future management and enforcement of no-take regulations.* For Jojo de la Victoria and Hilantagaan MPAs, comparative surveys using the same methods were also conducted immediately outside the MPA boundaries, with the first transect approximately 50m from the boundary, as a further assessment of the effectiveness of MPA management. Time and equipment constraints prevented similar analyses for the Maricaban and Talangnan MPAs. In addition, two proposed MPAs, Kodia and Poblacion, were snorkel surveyed but time and other constraints prevented quantitative surveys of these sites. Details of methods used are presented below.

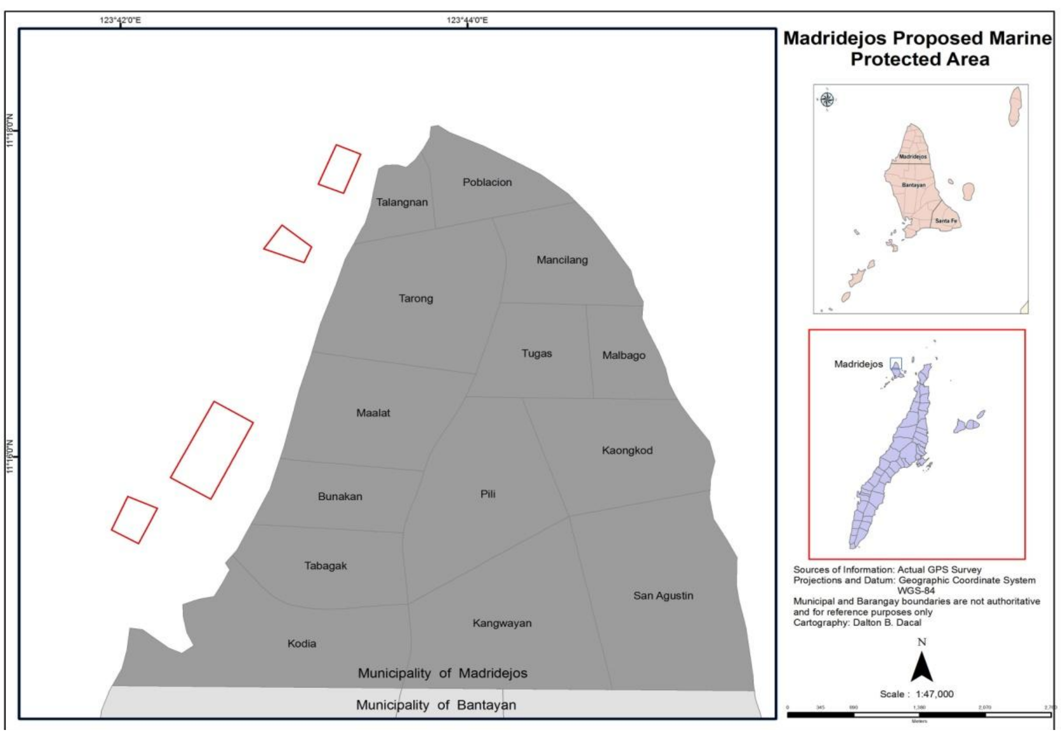


Figure 1A: Sites quantitatively surveyed as either established or proposed MPAs within the municipality of Madridejos, Bantayan Island. Areas outlined in red indicate approximate size, shape and position of protected areas.

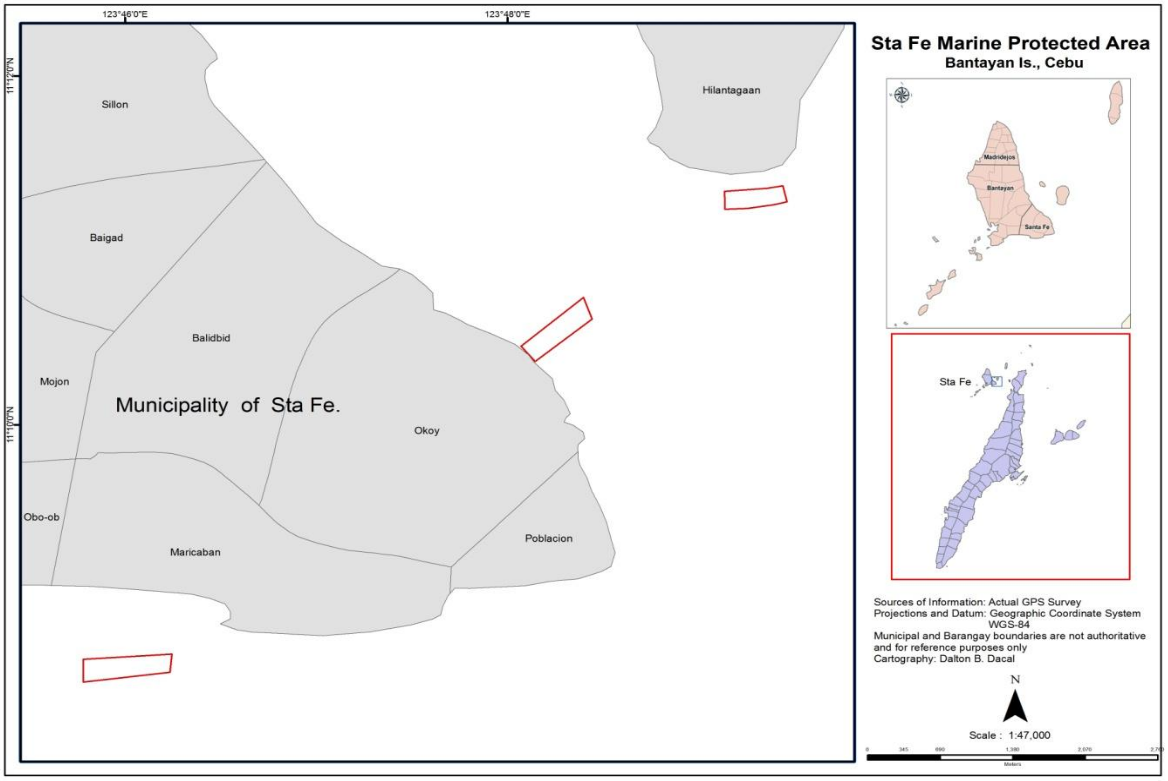


Figure 1B. Santan Fe municipality, Bantayan Island, showing position and size of three established MPAs (Maricaban, Jojo de la Victoria (Okoy), and Hilantagaan) quantitatively surveyed in this project.

FISH COMMUNITY DIVERSITY AND ABUNDANCE

Fish abundance and species richness were quantified using replicate (n=3) 20m x 5m belt transects within which underwater visual census was conducted, following English et al. (1997). All fishes encountered within 2.5 m on either side and above the 20 m transect line were identified to the lowest taxon possible, counted, and their total length estimated to the nearest cm. Fish abundance was presented and classified according to the 19 coral reef fish families/subfamilies recorded on Philippine reefs that are currently used as indicators in coral reef monitoring for management (Uychiaoco *et al*. 2001). Small cryptic and nocturnal species were not included in these surveys due to limited bottom time at each site. Fish families were classified according to broad functional groups (modified from Halpern 2003; Table 1), for between-site comparisons and overall assessment, and we included here Chaetodontids (butterflyfishes) as general indicators of coral reef health. These taxa and their trophic status are summarized in Table 2. Target fishes were counted separately from the other fish species. Target fish are those that are commercially important and primarily targeted by fishermen; these are: Serranidae (groupers), Carangidae (jacks/trevaly), Lethrinidae (emperorfish), Lutjanidae (snappers), Haemilidae (sweetlips), Caesionidae (fusiliers) Scaridae (parrotfish), Siganidae (rabbitfish), Mullidae (goatfish), and >10 cm individuals of Acanthuridae (surgeonfish/unicornfish) (Uychiaoco *et al*. 2001). Fish identification followed that of Allen *et al*. (1997) and FishBase (ver. 06/2011). Mean (+/- SE) fish density was calculated per site, comparing both target and non-target species and trophic categories, and presented graphically. Species richness and density indices used Hilomen et al. (2000; Table 3) for between-site comparisons.

Table 1. Functional group classifications, modified from Halpern (2003)

Herbivores	Planktivores/ Invertebrate Feeders	Carnivores
Kyphosidae	Balistidae	Haemulidae
Pomacentridae	Caesionidae	Lethrinidae
Scaridae	Chaetodontidae	Lutjanidae
Siganidae	Labridae	Serranidae
Zanclidae	Mullidae	
	Nemipteridae	
	Pomacanthidae	

Note: These classifications are natural groupings based on those made in the reviewed literature. Pomacentrids, although herbivores, were excluded from this functional group analyses due to their numerical abundance. Chaetodontids were grouped separately from the other invertebrate feeders in the functional group analysis due to their demand in the live fish trade industry and their ecological importance as coral reef health indicator. However, both groups are included in overall values and analyses.

Table 2. Trophic guilds of Philippine reef fish families and their ecological roles

<table>
<tr><th>Family</th><th>Trophic Group</th><th>Role</th><th>Notes</th></tr>
<tr><td>Surgeonfish (Acanthurids)</td><td rowspan="6">Herbivore</td><td rowspan="5">Maintain coral-algae balance via regulation of algal populations</td><td></td></tr>
<tr><td>Parrotfish (Scarids)</td><td>Heavily targeted by fishers</td></tr>
<tr><td>Rudderfish (Kyphosids)</td><td></td></tr>
<tr><td>Wrasses (Labrids)</td><td>Among the most diverse family on the reef</td></tr>
<tr><td>Damselfish (Pomacentrids)</td><td>Among the most abundant family on the reef</td></tr>
<tr><td>Rabbitfish (Siganids)</td><td>Feeds on seagrass</td><td rowspan="2">Heavily targeted by fishers</td></tr>
<tr><td>Sweetlips (Haemulids)</td><td rowspan="6">Invertebrate Feeder</td><td>Nocturnal predator of crustaceans</td></tr>
<tr><td>Spinecheeks (Nemipterids)</td><td rowspan="2">Feeds on small invertebrates</td><td></td></tr>
<tr><td>Goatfish (Mullids)</td><td>Targeted by fishers</td></tr>
<tr><td>Triggerfish (Balistids)</td><td>Feeds on echinoderms</td><td></td></tr>
<tr><td>Angelfish (Pomacanthids)</td><td rowspan="2">Feeds on sponges, tunicates, and other small invertebrates</td><td rowspan="2">Highly prized by aquarium fish collectors</td></tr>
<tr><td>Moorish Idols (Zanclid)</td></tr>
<tr><td>Fusiliers (Caesionids)</td><td rowspan="2">Planktivore</td><td rowspan="2">Feeds on plankton mid-water along reefs</td><td rowspan="2">Among the most abundant fish families on the reef</td></tr>
<tr><td>Fairy Basslets (Anthids)</td></tr>
<tr><td>Groupers (Serranids)</td><td rowspan="4">Carnivore</td><td rowspan="4">Population control of smaller fish species via predation</td><td rowspan="4">Heavily targeted by fishers</td></tr>
<tr><td>Snapper (Lutjanids)</td></tr>
<tr><td>Emperors (Lethrinids)</td></tr>
<tr><td>Jacks (Carangids)</td></tr>
<tr><td>Butterflyfish (Chaetodontids)</td><td>Coral Health Indicator</td><td>Feed on coral polyps</td><td>Abundance and diversity are used as indicators of good coral cover</td></tr>
</table>

Table 3. Hilomen's species richness and abundance index (Hilomen 2000)

Fish Species Diversity (no. of species/1000m^2)				
Very Poor	Poor	Moderate	High	Very High
0 - 26	27 - 47	48 - 74	76 - 100	>100
Fish Density (no. of fish/1000m^2)				
Very Poor	Poor	Moderate	High	Very High
0 - 201	202 - 676	677 - 2,267	2,268 - 7,592	>7,592

BENTHIC COMPOSITION

Replicate 20 m transects (n=3) were established within patches of reef or coral communities for each site where quantitative data were collected. In general, transects were laid parallel to shoreline, bisecting areas of reef or coral communities at depths ranging from 3 m to 7 m. The Line Intercept method (LIT; English et al. 1997) was used to quantify substrate composition. The following categories were used: live hard coral (LHC), dead or recently killed coral (RKC), coral rubble (RUB), pavement (PVM), sand (SA), soft coral (SC), fleshy macroalgae (FMA), turf algae (TA), and other (OT) for large sessile organisms such as sponges and zooanthids. Percent cover for each substrate type was determined for each transect, and Mean +/- SD were then calculated for each site and graphically represented. Live hard coral was further assessed to the lowest taxon possible; usually to genus level, with the exception of certain corals in the Family Faviidae.

CORAL POPULATION

The coral population at each site was described along the same transects as those established for benthic composition assessment. At five points along each transect (0, 5, 10, 15, and 20 m), a 1 m^2 quadrat was established and all coral colonies whose centers fell within the quadrat boundary were identified to the lowest taxon possible (genus or species), measured, and their health assessed. Recruits were identified as those which were obviously newly settled (i.e., not a product of partial mortality), with intact margins and between 1 and 4cm maximum diameter, based on previous reports by Colgan (1987), Ben-Tzvi et al. (2004), Connell et al. (2004), Ruiz-Zarate and Arias-Gonzales (2004), and Dikou and Van Woesik (2006). Assessments of impacts to health included clearly identifiable signs of predation from Crown-of-Thorns starfish *(Acanthaster planci),* the corallivorous gastropods *Drupella* spp. and *Coralliophila violacea,* or fish; overgrowth or abrasion by algae or sponges, siltation damage, and disease (black band disease, white syndrome, ulcerative white spots, growth anomalies, brown band disease, skeletal eroding band, and endolithic fungal infections).

MOBILE INVERTEBRATE COMMUNITY

Abundance and distribution of diurnal mobile invertebrates were determined at all sites where quantitative surveys were performed, within the same belt transects previously described for benthic and coral composition. Surveys were performed using SCUBA. All individuals of each species observed within a 2m belt were counted and identified *in situ* to the lowest taxon possible. If identification was not possible, photographs were taken for later identification using Dance (1974), Colin and Arneson (1995), Antonius and Riegl (1997), Burdick (2011). Length measurements of all individuals were taken *in situ* using a meterstick. Within all sampled areas, crevices were examined, rocks were overturned, and sea grass was parted to incorporate cryptic species. For organisms that were too abundant to count accurately, the term "TNTC" (Too Numerous To Count) is used in the text. These species are not included in the graphs, though they are indicated in the text.

SUMMARY RESULTS

Here we present our findings for each site visited. Coordinates for the surveyed sites presented in Figures 1A and 1B are summarized in Table 4. Selected summary results we present first, for between-site comparisons. Detailed data for individual sites are presented in succeeding sections.

Table 4. Location and size of surveyed Marine Protected Areas

Barangay	Corner	E Longitude	N Latitude	MPA Size (ha)
Kodia (proposed)	1	123.693	11.254	26.89
	2	123.697	11.253	
	3	123.699	11.257	
	4	123.696	11.259	
Tabagak (proposed)	1	123.699	11.259	14.24
	2	123.702	11.258	
	3	123.703	11.261	
	4	123.701	11.263	
Tarong (proposed)	1	123.714	11.288	10.95
	2	123.718	11.286	
	3	123.718	11.288	
	4	123.715	11.290	
Bunakan (proposed)	1	123.709	11.269	10
	2	123.707	11.264	
	3	123.704	11.266	
	4	123.707	11.270	
Talangnan	1	123.721	11.294	13.53
	2	123.719	11.294	
	3	123.721	11.298	
	4	123.723	11.298	
Maricaban	1	123.763	11.144	17.87
	2	123.771	11.145	
	3	123.770	11.143	
	4	123.763	11.142	
Okoy (JDV)	1	123.807	11.179	16.17
	2	123.807	11.177	
	3	123.802	11.173	
	4	123.801	11.174	
Hilantagaan	1	123.819	11.189	10.8
	2	123.819	11.187	
	3	123.824	11.188	
	4	123.824	11.189	

A list of all fish species and all locations from where they were recorded is presented in Table 5. Two MPAs, Jojo de la Victoria and Hilangtagaan, supported the most diverse fish communities (77 and 70 species, respectively). This is approximately twice the number of species recorded in the initial surveys by Jadloc et al. (2007; 40 and 52 species respectively, from within the MPAs). All other sites showed less diverse fish populations, with species numbers ranging from 34 to 51 per site. Two sites, Kodia and Poblacion, were not quantitatively surveyed, so no data on the fish communities was recorded. Site descriptions for these sites are, however, presented below.

Table 5. Fish species presence (indicated by "1") at each site quantitatively surveyed

SPECIES	SITES						
	JDV	Mari	Buna	Taba	Talan	Hila	Taro
Acanthuridae							
Acanthurus nigrofuscus	1						
Acanthurus nigroris	1						
Acanthurus pyroferus	1						
Ctenochaetus binotatus	1		1	1		1	1
Ctenochaetus striatus	1	1	1	1	1	1	1
Ctenochaetus tominiensis	1	1	1	1	1	1	1
Naso lituratus	1	1		1	1	1	
Naso minor						1	1
Naso vlamingii			1				
Zebrasoma scopas	1	1	1	1	1	1	1
Balistidae							
Balistapus undulatus	1	1		1	1	1	
Balistoides viridescens	1					1	
Chaetodontidae							
Chaetodon auriga	1					1	
Chaetodon baronesa	1	1	1	1	1	1	1
Chaetodon citrinellus	1					1	1
Chaetodon ephippium	1					1	
Chaetodon lunula	1					1	
Chaetodon lunulatus	1	1				1	
Chaetodon octofasciatus	1	1	1	1	1	1	1
Chaetodon trifascialis						1	
Chelmon rostratus		1	1	1	1		
Forcipiger flavissimus	1					1	1
Heniochus chrysostomus	1		1			1	
Caesionidae							
Caesio caerulaurea	1					1	
Pterocaesio pisang		1	1	1	1	1	

Carangidae							
Caranx melampygus	1						
Cirrhitidae							
Cirrhitichthys falco	1	1		1		1	
Paracirrhites arcatus	1		1		1	1	
Diodontidae							
Diodon liturosus	1						
Fistularidae							
Fistularia commersoni	1	1		1	1	1	
Haemulidae							
Plectorhinchus chaetodontoides	1						
Plectorhinchus lineatus						1	
Labridae							
Anampses meleagrides	1						
Anampses twistii	1	1	1	1	1	1	1
Bodianus axillaris	1						
Bodianus mesothorax						1	
Cheilinus fasciatus	1	1				1	1
Choerodon anchorago	1	1				1	
Cirrhilabrus cyanopleura	1	1	1	1	1	1	1
Coris aygula	1	1	1	1	1		
Coris batuensis	1	1	1	1	1	1	1
Coris gaimard	1	1					
Epibulus insidiator	1					1	1
Gomphosus varius	1	1	1	1	1	1	1
Halichoeres hortulanus	1	1				1	1
Halichoeres margaritaceus				1	1		
Halichoeres marginatus		1	1			1	
Halichoeres melanurus	1	1	1	1	1	1	1
Halichoeres richmondi						1	
Hemigymnus melapterus	1					1	
Labroides dimidiatus	1					1	1
Macropharyngodon meleagris	1						
Novaculichthys teaniorus	1						
Oxycheilinus digrammus				1		1	
Oxychelinus unifasciata	1	1			1		1
Stethojulis bandanensis	1	1		1		1	1
Thalassoma hardwicke	1	1	1		1	1	1
Thalassoma lunare	1	1	1	1	1	1	1
Thalassoma quinquivittatus			1	1		1	

Lethrinidae							
Lethrinus harak	1					1	
Lutjanidae							
Aphareus furca						1	
Lutjanus biguttatus						1	
Lutjanus decussatus	1						
Lutjanus fulviflamma	1					1	
Lutjanus fulvus	1						
Monotaxis grandoculis	1						
Monocanthidae							
Aluterus scriptus	1	1		1		1	
Mullidae							
Parupeneus barberinus	1	1				1	
Parupeneus multifasciatus	1	1				1	
Upeneus tragula	1			1		1	
Myripristis							
Myripristis kuntee	1		1		1		
Myripristis pralinia	1			1		1	
Myripristis violacea	1					1	
Neoniphon sammara						1	
Nemipteridae							
Scolopsis bilineatus	1	1	1	1	1	1	
Scolopsis lineatus	1						
Pentapodus aureofasciatus	1					1	
Ostraciidae							
Ostacion cubicus	1	1				1	
Pinguipedidae							
Parapercis clathrata	1	1		1		1	
Pomacanthidae							
Centropyge vroliki	1	1	1	1	1	1	
Chaetodontoplus mesoleucus	1						
Pomacantus imperatur						1	
Pygoplites diacanthus	1	1	1		1	1	
Pomacentridae							
Abudefduf septemfasciatus	1						
Abudefduf sexfasciatus	1					1	
Amphiprion clarkii	1	1		1	1	1	
Amphiprion frenatus	1					1	
Amphiprion ocellaris	1	1					
Chromis atripectoralis						1	
Chromis opercularis						1	

Chromis ternatensis	1	1					
Chromis weberi						1	
Chrysiptera springeri	1						
Chrysiptera traceyi						1	1
Dascyllus aruanus	1	1	1	1	1	1	1
Dascyllus reticulatus	1	1	1	1	1	1	
Dascyllus trimaculatus	1					1	
Plectroglyphidodon lacrymatus	1	1	1	1	1	1	1
Pomacentrus alexanderae			1			1	
Pomacentrus moluccensis	1	1				1	
Pomacentrus stigma	1			1	1		
Pomacentrus vaiuli	1	1				1	1
Pseudochromidae							
Labracinus cyclopthalmus	1	1	1	1	1	1	
Priacanthidae							
Heteropriacanthus cruentatus	1	1		1		1	
Ptereleotridae							
Nemateleotris magnifica	1						
Ptereleotris evides	1		1	1		1	
Scaridae							
Chlororus frontalis						1	
Chlororus sordidus	1	1	1	1	1	1	
Scarus bleekeri	1					1	
Scarus dimidiatus	1						
Scarus forsteni	1						
Scarus frenatus						1	
Scarus globiceps						1	
Scarus rubrioviolaceus	1						
Scarus schlegeli	1					1	
Serranidae/Anthiinae							
Pseudanthias pascalus						1	
Pseudanthias tuka	1					1	
Serranidae/Epinephillinae							
Cephalopholis argus	1					1	
Cephalopholis microprion	1	1				1	
Cephalopholis boenak	1						
Siganidae							
Siganus fuscescens		1	1	1	1		
Synodontidae							
Synodus variegatus	1					1	
Saurida gracilis	1					1	

Tetraodontidae							
Arothron meleagris						1	
Arothron nigropunctatus	1	1					
Canthigaster papua						1	
Canthigaster solandri	1	1	1	1	1	1	
Zanclidae							
Zanclus cornutus	1	1		1		1	
Total	**100**	**51**	**34**	**41**	**34**	**94**	**26**

A measure of fish diversity per site is presented in Table 6, which is a partial summary of Table 5. Labrids (wrasses) and Pomacentrids (damselfishes) were the most well-represented fish families, followed by Chaetondontids (butterflyfishes). Larger target species, such as Scarids (parrot fish), Serranids (groupers), and Lutjanids (snappers) were slightly more diverse within the well-managed MPAs, while Acanthurids (surgeon fish) were fairly common in all sites. Individuals of another important targeted group, the Carangids (jacks), were rare.

Table 6. Number of species per family per site. MPAs and fished reefs combined for Jojo de la Victoria and Hilantagaan sites.

FAMILY	SITES						
	JDV	Mari	Buna	Taba	Talan	Hila	Taro
Acanthuridae	8	4	5	5	4	6	5
Balistidae	2	1	0	1	1	2	0
Chaetodontidae	9	4	4	3	3	10	4
Caesionidae	1	1	1	1	1	2	0
Carangidae	1	0	0	0	0	0	0
Cirrhitidae	2	1	1	1	1	2	0
Diodontidae	1	0	0	0	0	0	0
Fistularidae	1	1	0	1	1	1	0
Haemulidae	1	0	0	0	0	1	0
Labridae	21	15	10	11	10	19	13
Letrinidae	1	0	0	0	0	1	0
Lutjanidae	4	0	0	0	0	3	0
Monocanthidae	1	1	0	1	0	1	0
Mullidae	3	2	0	1	0	3	0
Myripristis	3	0	1	1	1	3	0
Nemipteridae	3	1	1	1	1	2	0
Ostraciidae	1	1	0	0	0	1	0
Pinguipedidae	1	1	0	1	0	1	0
Pomacanthidae	3	2	2	1	2	3	0
Pomacentridae	14	8	4	5	5	14	4
Pseudochromidae	1	1	1	1	1	1	0

Priacanthidae	1	1	0	1	0	1	0
Ptereleotridae	2	0	1	1	0	1	0
Scaridae	6	1	1	1	1	6	0
Serranidae/Anthiinae	1	0	0	0	0	2	0
Serranidae/Epinephillinae	3	1	0	0	0	2	0
Siganidae	0	1	1	1	1	0	0
Synodontidae	2	0	0	0	0	2	0
Tetraodontidae	2	2	1	1	1	3	0
Zanclidae	1	1	0	1	0	1	0
Total	**100**	**51**	**34**	**41**	**34**	**94**	**26**

Figure 2 shows a summary of fish densities for all sites surveyed, though details per site are presented in each succeeding section. It is abundantly clear that the three MPA reported as being effectively managed have much higher fish densities of both all reef species and target reef species; on many of the proposed sites we did not even observe any target species.

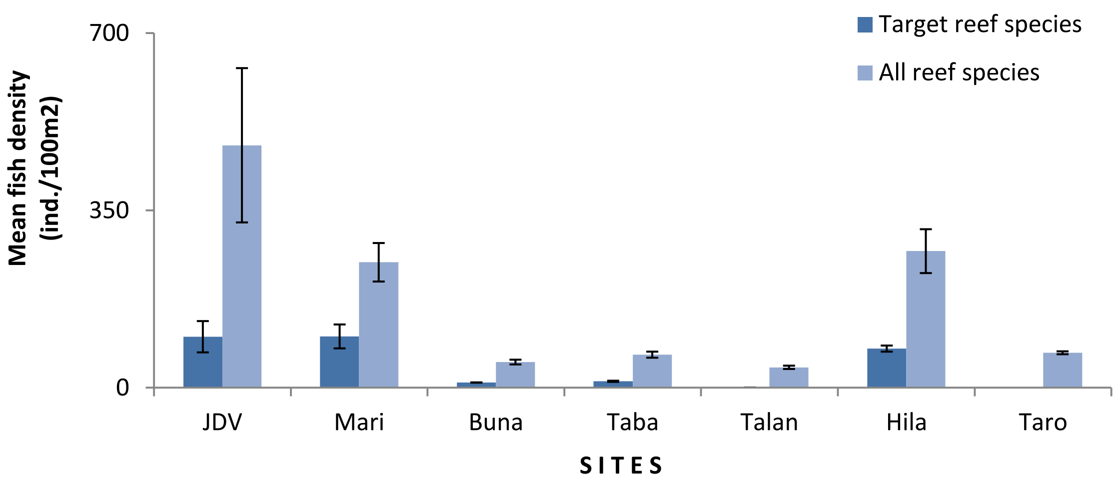


Figure 2. Comparative fish densities of all reef species and target reef species among surveyed sites. JDV= Jojo de la Victoria inside and outside MPA combined; Mari=Maricaban MPA; Buna=Bunakan; Taba=Tabagak; Talan=Talangnan; Hila=Hilantagaan inside and outside MPA combined; Taro=Tarong. Mean +/- SE.

A comparative summary of benthic composition among all quantitatively surveyed sites is presented in Figure 3; details per site are presented in succeeding sections. As our surveys focused on areas dominated by coral, these descriptions to do necessarily reflect the average benthic composition of the areas as a whole. Hilantagaan MPA had, by far, the highest coral cover (73%), followed by the Maricaban MPA (37%). Jojo de la Victoria (both MPA and fished reef) and Talangnan showed very low coral cover (3.8-4.9%) and correspondingly higher amounts of either dead coral or rubble. This suggests past or current impacts to coral that resulted in mortality with little recovery. Interestingly, both Hilantagaan (MPA and fished) and JDV MPAs contained almost no fleshy macroalgae within coral-dominated areas, suggesting high rates of herbivory and a healthy and viable herbivore population.

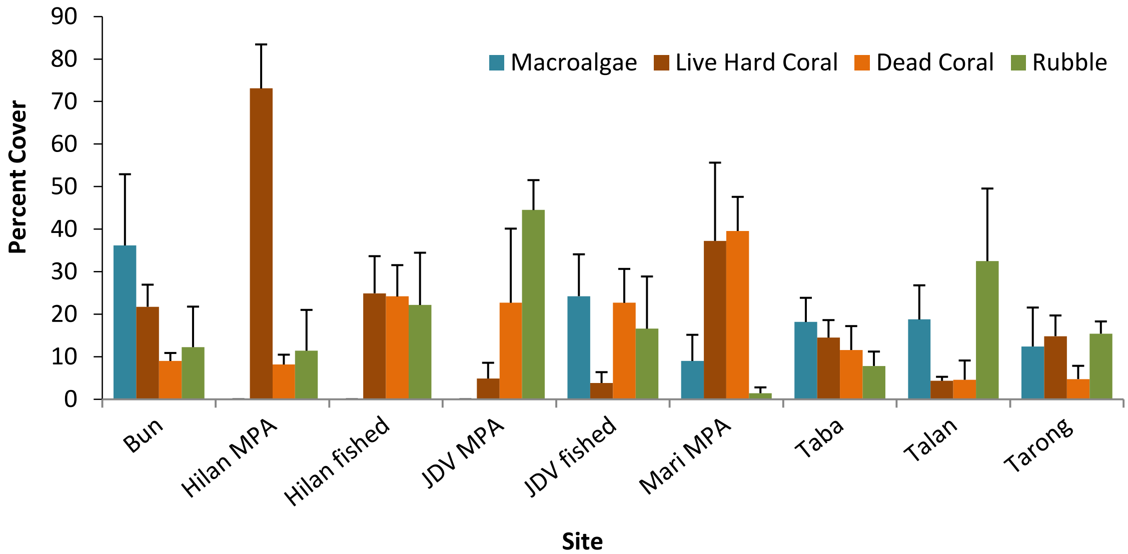


Figure 3. Comparison of benthic composition in all surveyed sites detailing prevalent substrate categories (i.e. macroalgae, live hard coral, dead coral, and rubble). Mean ± SD

Coral communities were generally limited within the demarcated MPA zones, with the exception of Hilantagaan and Maricaban, where snorkel surveys indicated dominance by hard coral throughout the MPAs. All other sites were dominated by either large areas of soft-bottom sand/rubble or seagrass, with coral communities limited to a narrow, shallow zone. The number of taxa observed within our transects varied from a low of 17 in Talangnan MPA to a high of 43 in the JD Victoria MPA. Colony density likewise varied similarly; corals were the most sparse in Talangnan and more dense in JD Victoria. Density of new coral recruits (colonies 1 - 6cm diameter) was low in most sites, though high coral cover (Maricaban and Hilantagaan) made it difficult to locate recruits and these figures are undoubtedly underestimates. More detailed information about individual coral communities is presented in each site description, below.

Table 7. Descriptive statistics on coral communities at each site quantitatively surveyed.

Site	Mean Colony Density/m^2	Total Taxa No.	Mean Recruit No./m^2
JD Victoria MPA	25.0 +/-7.2	43	2.2+/-1.2
JD Victoria fished	23.8+/-5.9	36	0.8+/-0.5
Maricaban MPA	17.6+/-5.2	23	0.4+/-0.2
Hilantagaan MPA	19.1+/-4.0	14	0.2+/-0.3
Hilantagaan fished	15.4+/-4.7	22	1.7+/-1.2
Tabagak	13.1+/-1.2	19	0.7+/-0.1
Bunakan	16.4+/-7.3	30	0.9+/-0.5
Tarong	9.7+/-1.2	27	1.3+/-0.3
Talangnan MPA	1.5+/-0.2	17	0.3+/-0.3

Two of the most important mobile invertebrates, the corallivorous starfish Crown-of-Thorns (COTS; *Acanthaster planci)* and the harvestable giant clams (*Tridacna* spp) fairly rare at most sites, and absent from our transects on several (Figure 4; see Appendix for photo identification). Only one site, Maricaban MPA, showed a potential problem with COTS; 25 individuals were counted along our three transects. This could indicate an outbreak is developing or has occurred; 30 individuals/ha is considered an outbreak (Englehardt et al. 1999). However, the area we surveyed was a small portion of the entire reefal area and manta tow surveys would reveal a more accurate density count over a larger area. *Tridacna* were general rare to absent, though small individuals were more common within both Jojo de la Victoria and Maricaban MPAs, suggesting successful recruitment and early survival of juveniles within these sites. Monitoring of their survival to larger size classes would reveal whether or not they are getting poached as they get larger.

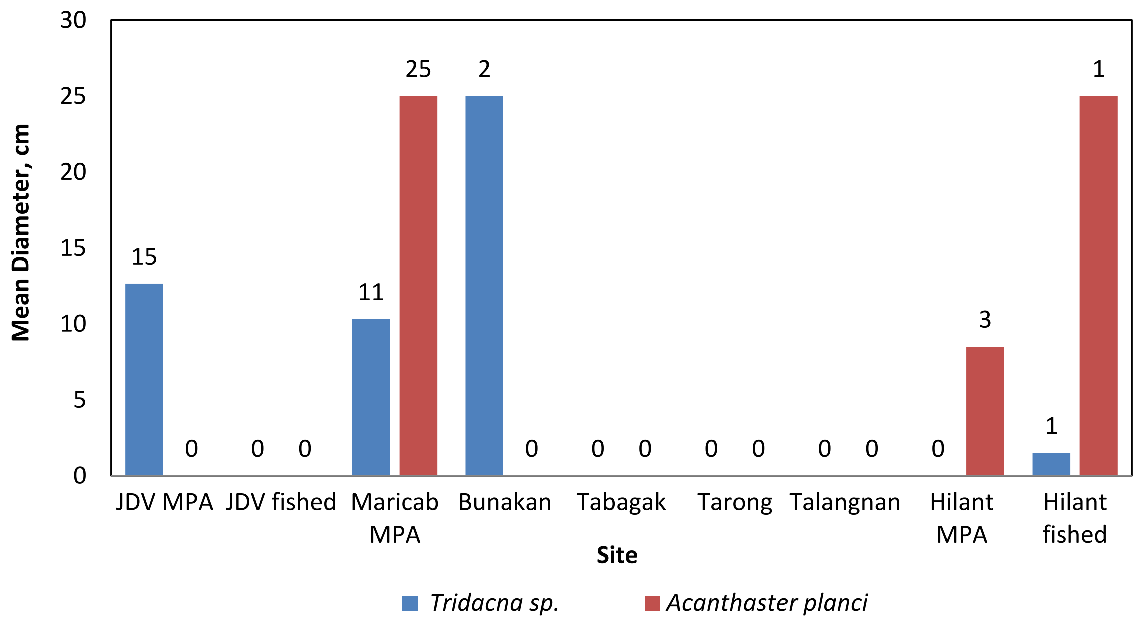
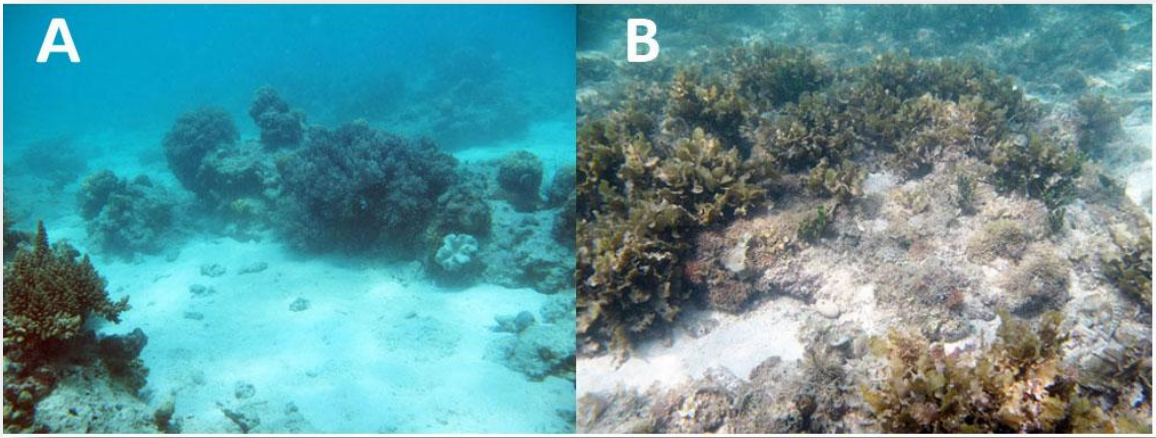


Figure 4: Average size of *Tridacna* sp. and *Acanthaster planci* per site surveyed. Values above the bars represent the total number of individuals recorded at each survey site.

JOJO DE LA VICTORIA (JDV) DEMONSTRATION MARINE RESERVE AND ADJACENT FISHED REEF, OCOY, STA. FE MUNICIPALITY



Jojo de la Victoria Marine Reserve: (A) typical coral-dominated community within the reserve boundary; (B) typical fleshy macroalgae-dominated community outside the reserve boundary

This reserve was established in 2004 as a demonstration reserve of the Law of Nature *(Batas Kalikasan)* Foundation. It lies within the Barangay of Ocoy, in the Santa Fe municipality, and encompasses a 16.2-ha area from the intertidal zone to offshore (see Figure 1B and Table 4). This nearshore reserve lies on a gentle slope dominated by a sandy substrate. A mixed seagrass zone dominated by *Thalassia hemprichii* existed close to the upper subtidal limit, approximately 40m wide. Seaward to this zone was an area—at least 50m wide--of extensive coral rubble suggestive of past thicket-forming *Acropora*. The historical events resulting in this rubble field are not known, but either a major storm or dynamite fishing could cause such damage. Seaward to the rubble field, coral growth was limited by predominantly sand substrate that prevented the development of a consolidated reef structure. A patchy coral garden had developed, dominated by small massive colonies of low relief.

Surveys adjacent to the marine reserve (southeast border) were accomplished immediately after, at the same distance offshore. The area was dominated by the rubble and the macroalga *Sargassum,* and coral cover was sparse.

The initial surveys accomplished in 2007 noted a *Sargassum* zone immediately seaward of this seagrass bed (Jadloc 2007). *Sargassum* was not present within the reserve during our surveys, though it was abundant immediately outside (see Benthic Composition below), suggesting its absence was not due to seasonality. It is possible that increased herbivory within the reserve prevented the establishment of the thick *Sargassum* beds characteristic of nearshore environments with low herbivory.

FISH COMMUNITY

Species Richness

The MPA was characterized by "very high" fish species diversity, using Hilomen's classification (Table 3). A total of 77 fish species were recorded inside JDV MPA and 13 were recorded outside (100 species, total; Table 6). Of these, Labrids (wrasses) were the most diverse family, with 22 species recorded, followed by the Pomacentrids (damselfish) with 15 species. There were nine species of Chaetodontids (butterflyfish) recorded inside and outside the MPA.

Fish Abundance

The mean fish density inside JDV MPA was ranked as "high", with 479 ind/100m^2 of which 101 ind/100m^2 were target fishes (Fig. 5), which suggests continual effective enforcement of no-take regulations. Outside the MPA, mean fish densities for both all reef and target reef species were five times lower than inside; 76 ind/100m^2 and 20 ind/100m^2, respectively. Encouragingly, these figures have increased greatly from the 2007 surveys. Within the MPA, fish densities have risen almost an order of magnitude from the 2007 survey (all reef fish: 255 ind/500m^2, or 51 ind/100m^2; target species: 19 ind/500m^2 or 4 ind/100m^2; Jadloc et al. 2007). Likewise, densities have also increased within the fished reef; six times higher for all reef fish and ten times higher (an order of magnitude) higher for target species (111 ind/500m^2 and 11 ind/500m^2, or 22 ind/100m^2 and 2.2 ind/100m^2). Inside the MPA, herbivores were the most abundant trophic group with 77.7±11.6 ind/100m^2, followed by invertebrate feeders (43±11.7 ind./100m^2). While these results are encouraging, carnivorous fish were only observed within the MPA and high fishing pressure was still very obvious outside its boundaries (Fig. 6).

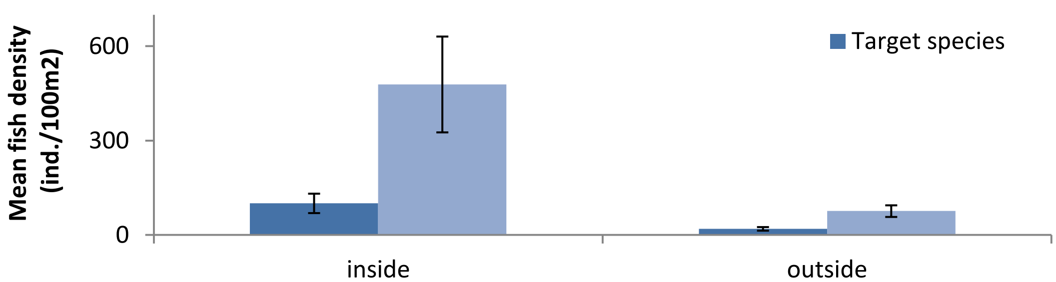


Figure 5. Comparison of mean fish density of species targeted for harvest vs. all total reef species, inside the Jojo de la Victoria MPA and in fishing grounds immediately adjacent to the MPA. Mean +/-SE

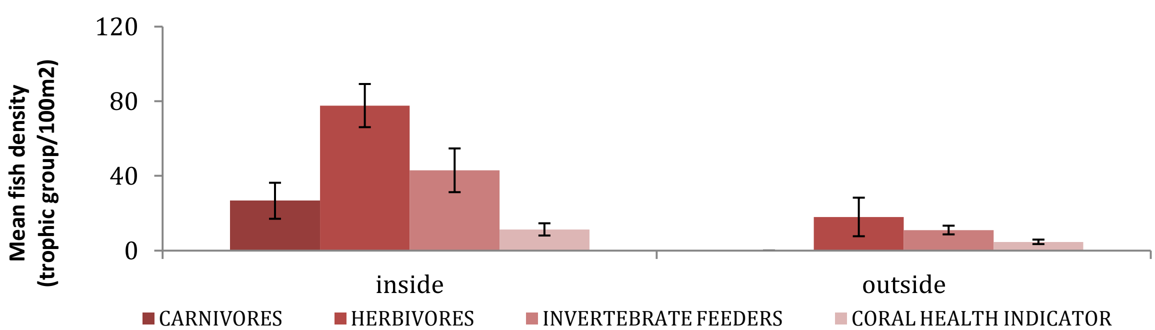


Figure 6. Comparison of abundance of fish occupying different trophic groups inside the Jojo de la Victoria MPA and in the fishing grounds immediately adjacent to the MPA. Mean +/- SE

BENTHIC COMPOSITION

Inside the MPA, patchy and low coral cover (4.9%) was observed while the majority of benthic composition consisted of loose coral rubble (44.5%). Pavement and dead/recently killed coral was also a substantial component of substrate cover. Outside the MPA, coral cover was similar to inside the MPA (3.8%), with the exception of fleshy macroalgae, which dominated the benthic composition. These values may suggest a lack of herbivorous grazing outside the MPA, as macroalgae was not recorded along the transect inside the MPA. Coral cover reported in this study is much lower than that reported by Jadloc et al. in 2007 (11.3% inside and 9.3% outside). This apparent loss of coral--a decline of greater than 50% over 4 years--should be cause for concern, as it suggests impacts to coral even within the MPA. However, since coral cover is patchy and we did not replicate the exact location of the 2007 surveys, establishment and monitoring of permanent transects is recommended.

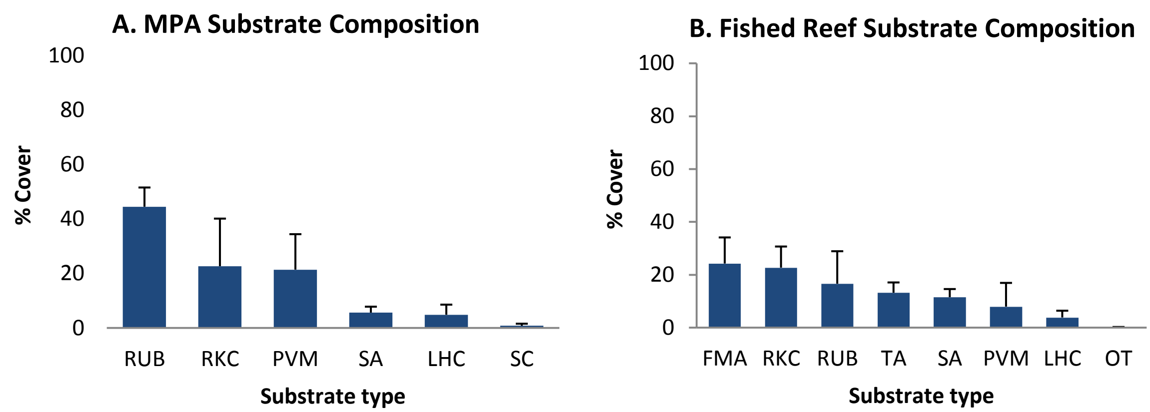


Figure 7. A: Substrate composition within the JD Victoria MPA; B: substrate composition within the fished reef adjacent to the MPA. RUB=rubble; RKC=recently killed coral; PVM=pavement; SA=sand; LHC=live hard coral; SC=soft coral; FMA=fleshy macroalgae; TA=turf algae; OT=sponges, etc. Mean +/- SD

CORAL COMMUNITY

Although Favids were collectively the most abundant family, *Acropora spp*. and *Porites spp.* were the most commonly observed genus of corals within the MPA. Outside the MPA *Acropora* spp. dominated coral cover and *Favites* spp. was the second most abundant genus observed (Figure 8A & B). Coral population size structure in both sites was dominated by

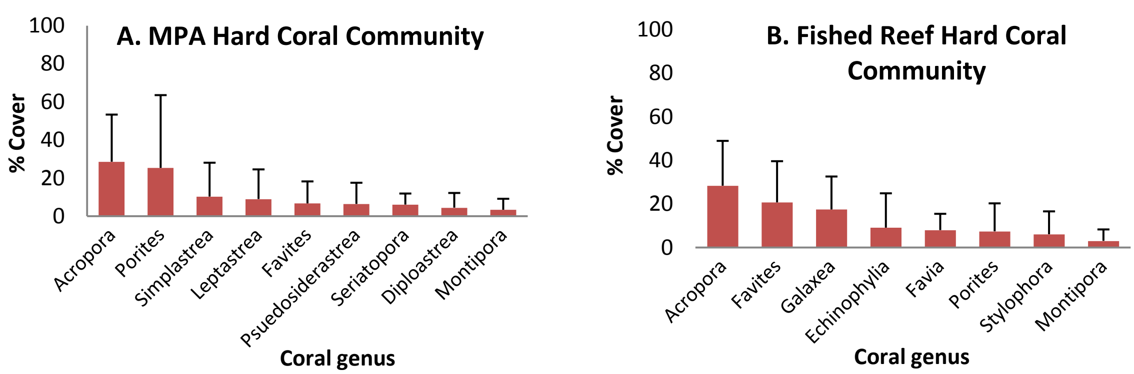


Figure 8. A: Generic composition of hard coral community within the MPA; **B:** Generic composition within the fished reef adjacent to the MPA. Mean +/-SD

small colonies less than 30cm in diameter, though the MPA contained a larger proportion of larger colonies (Figure 9). This small colony size, coupled with low colony density, explains the low cover by live hard coral. However, the MPA supported the largest recruit population, double that of all other sites (Table 7) which will serve to replenish and repopulate this reef as long as protection continues. In contrast, the adjacent fished reef contained fewer than ½ the density of recruits, as the high density of fleshy macroalgae is known to outcompete with coral recruits via shading and abrasion.

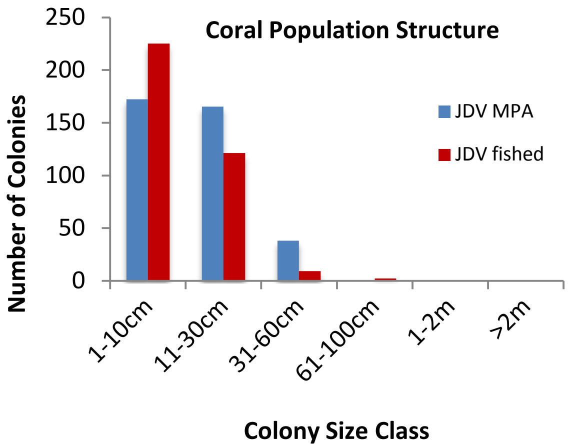


Figure 9. Population size structure of the hard coral populations within the MPA and in the adjacent fished reef. Total colony counts, combining n=3 transects.

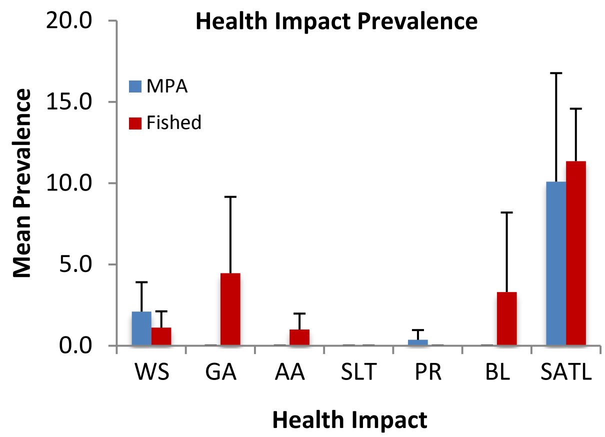


Figure 10. Prevalence of impacts to coral health within and outside the JDV MPA. WS=white syndrome; GA=growth anomalies; AA=algal abrasion; SLT=silt abrasion; PR= pigmentation response; BL=bleaching; SATL=subacute tissue loss. Mean+/-SD

Impacts to health are summarized in Figure 10. Overall prevalence of corals displaying some form of health impact was 12.5+/-9.3% within the MPA and 12.6+/-2.1% in the fished reef. Total prevalence of >10% is generally considered fairly high (Ruiz-Moreno et al. in review), so both sites displayed high prevalence of impacts in spite of low coral host density (see Lafferty 2004). Subacute tissue loss (i.e., older tissue loss where the cause cannot be determined) was by far the most common health impact in both sites. Silt abrasion damage was absent, indicating that siltation is not a problem along this area of coastline. Corals in the fished reef displayed three conditions: growth anomalies, algal abrasion and bleaching that were not observed within the MPA.

MOBILE INVERTEBRATE COMMUNITY

Thirteen genera distributed among four phyla were recorded within the 120 sampled area of the managed JoJo De La Victoria Marine Sanctuary (Figure 11A). Sea urchins dominated the community, but mollusks were also common. This site held the highest abundance of individual *Tridacna sp.* for all sites surveyed. *Tridacna sp.* are of the subfamily Tridacninae (the giant clams) and are a commercially important genera. The long-spined sea urchin *Diadema* sp. were also abundant here, many of which were found clustered in what appeared to be spawning aggregations. The only *Pearsonothuria graeffei* (see Appendix) found throughout our surveys was also spotted at this location.

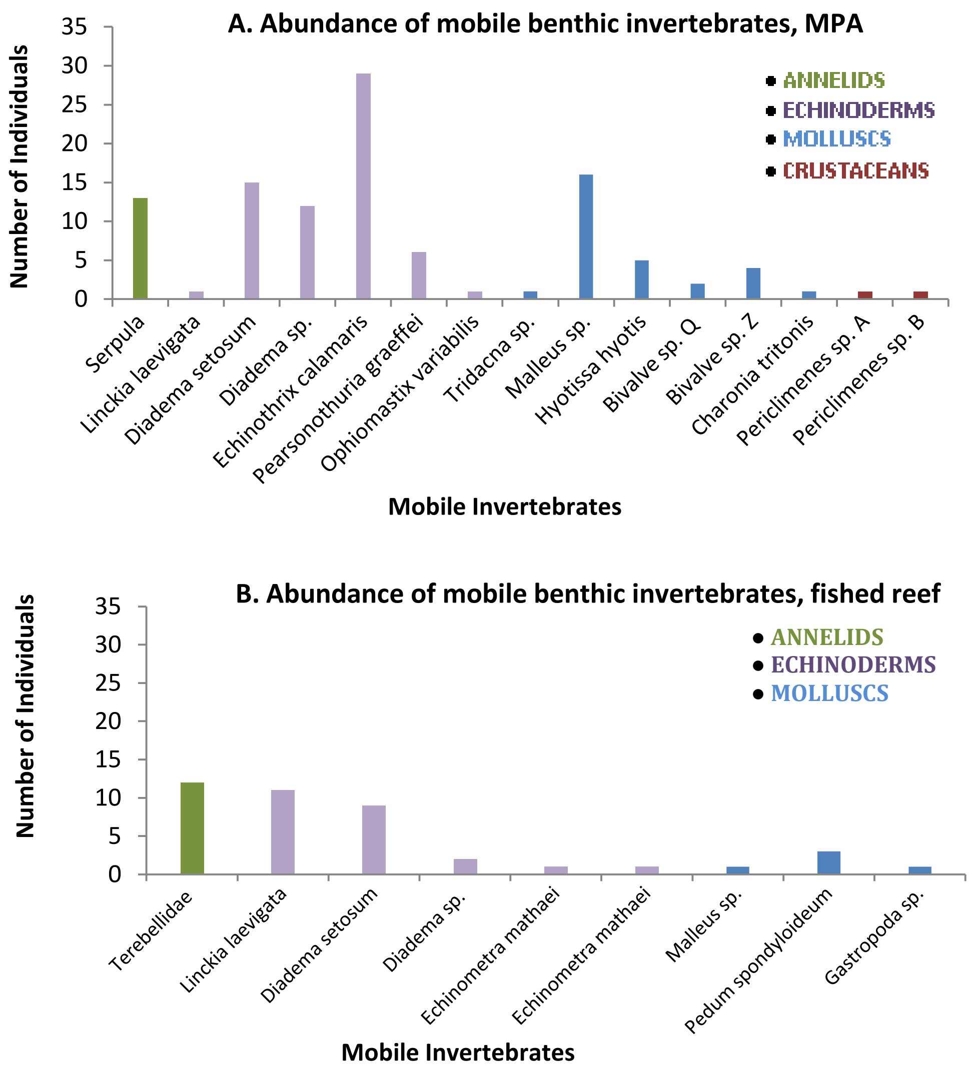


Figure 11. A: Total counts and types of mobile benthic invertebrates found within the MPA; **B:** Total counts and types found within the fished reef.

In contrast, within the 120 sampled area outside of the managed marine sanctuary, 7 genera within three phyla were recorded, and abundance of these species were considerably lower (Figure 11B). Sea urchins were still dominant, though lower in abundance. Both *Tridacna sp.* and holothuroids (sea cucumbers) were absent at these transects and there was noticeably fewer *Diadema sp.* There was a single commercially valuable *Trochus niloticus* found off transect at this site as well. Similar abundance patterns were observed in the 2007 surveys (Jadloc et al. 2007), though mollusks were, by far, the most dominant macroinvertebrate both inside and outside the MPA. JD Victoria MPA was also noted as having the highest *Tridacna* density of the sites surveyed as well.

MARICABAN MARINE RESERVE, STA. FE MUNICIPALITY

Maricaban Marine Reserve, showing dominance of massive *Porites* and high coral cover.

This reserve, established the previous year in 2010, is 10.5 ha in size and located offshore. It displayed very high coral cover, dominated by massive *Porites* colonies (see photo above and Fig. 15). Snorkel surveys revealed extensive coral cover throughout much of the area of the reserve. The massive coral morphology does not provide high topographic relief and abundant fish habitat, but cover was very high, no doubt influencing the decision to establish this site as a reserve. Herbivory was evidently high, as very little macroalgae was present. No outside comparisons were made, due to time limitations.

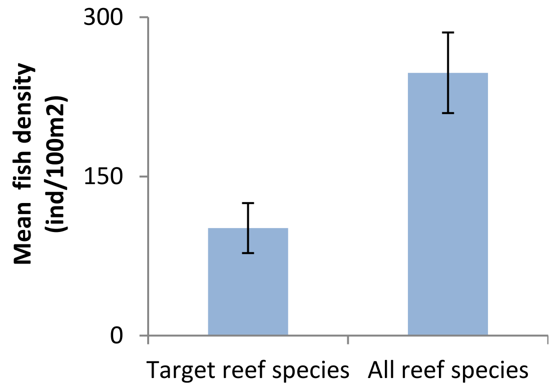
FISH COMMUNITY

Species Richness

Species diversity in Maricaban MPA appeared to be "very high", with a total of 51 species observed (Tables 5 & 6). The most diverse family were the Labrids (wrasses), represented by 15 species followed by the Pomacentrids (damselfish) with 8 species. Only 4 species of Chaetodontids (butterflyfish) were observed in the area (Table 5). Target species were very depauperate, which is characteristic of newly-established MPAs, but which may be expected to favorably change over time, assuming that poaching is not allowed and no-take enforcement regulations are upheld.

Fish Abundance

Mean fish abundance for all reef species in Maricaban MPA appeared to be "very high" (Table 3), with 248 ind/100m^2 (2,480 ind/1000m^2), of which 51 ind/100m^2 were target fishes (Fig. 12). The most dominant trophic group was the herbivores, with 152 ind/100m^2 (Figure 13). This group was comprised mainly of small grazing rabbitfish. Again, it is characteristic of newly-established MPAs that herbivores recover quickly; large carnivores may take up to 15 years to recover in abundance to pre-fished abundances (Russ and Alcala 2004), which is consistent with our observations.



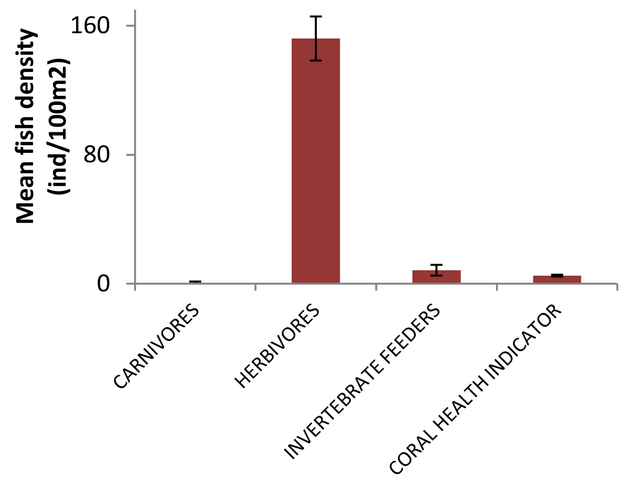


Figure 12. Mean fish density of targeted fish species and all reef fish species within the Maricaban MPA. Mean +/- SE

BENTHIC COMPOSITION

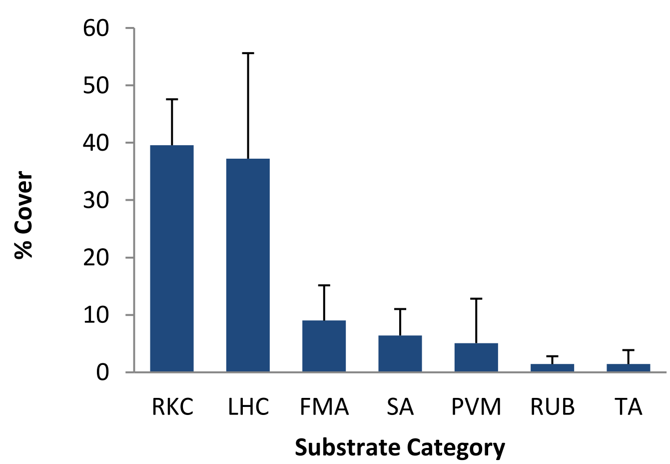


Figure 14. Benthic composition within the Maricaban MPA. RKC=recently-killed coral; LHC=live hard coral; FMA=fleshy macroalgae; SA=sand; PVM=pavement; RUB=rubble; TA=turf algae. Mean +/-SD.

Although there was slightly more dead/recently killed coral (39.6%) than live hard coral, live hard coral was the second highest recorded (37.3%) among all surveyed sites. Fleshy macroalgae was present, but at relatively low frequencies (9.0%) (Figure 14). This indicates a high degree of herbivory within this MPA, suggesting that the herbivorous fish population has responded favorably to protection, and is corroborated by the data on herbivore abundances previously reported.

CORAL COMMUNITY

Massive *Porites* spp dominated the live hard coral community within the MPA (93.7%; Figure 15). All other genera were uniformly very low in abundance and dominated by massive growth forms. This results in a reef of very low topographic complexity. Recent recruits of other coral genera were noted across the three transects. However, as Figure 17 shows, there was a larger number of large, older colonies, 1m and greater in diameter. The shallow depth and high density at this offshore site may limit the size these colonies can grow. Recruit abundance was quite low (Table 7; most of the colonies falling within the smallest size category (Figure 16) are juveniles estimated to be >1 year old, or fragmented from larger colonies.

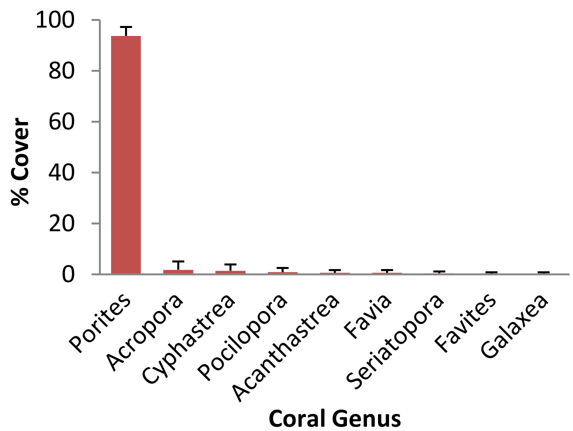


Figure 15. Hard coral community composition within the Maricaban MPA, showing dominance by the genus *Porites*. Mean +/- SD.

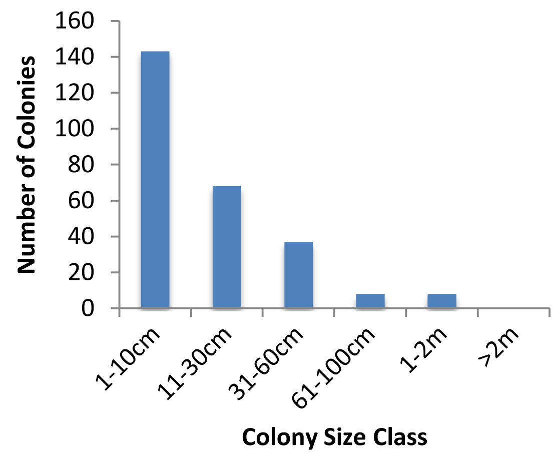


Figure 16. Colony size distribution of the coral community in Maricaban MPA. Total counts, combining n=3 transects.

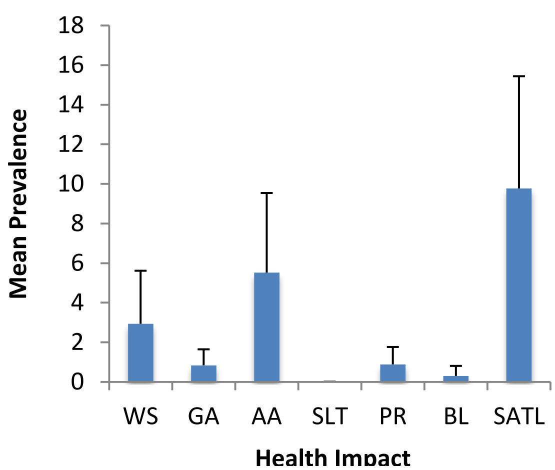


Figure 17. Prevalence of impacts to coral health within the Maricaban MPA. WS=white syndrome; GA=growth anomalies; AA=algal abrasion; SLT=silt abrasion; PR= pigmentation response; BL=bleaching; SATL=subacute tissue loss. Mean+/-SD

Disease and other health impacts were quite high at this site (20% +/- 4%; Figure 17). Two infectious syndromes commonly affecting massive *Porites* throughout the Indo-Pacific were observed: white syndrome and growth anomalies, as well as the non-infectious pigmentation response. Algal abrasion from fleshy macroalgae *(Sargassum, Turbinaria)* accounted for approximately 5% of lesions we observed, but subacute tissue loss comprised approximately 50% of the impacts we saw. As Maricaban had the highest densities of Crown-of-Thorns starfish (*Acanthaster planci;* Figure 3), old lesions from COTS predation may responsible for many of these observations. Because of the high prevalence of these lesions and the high density of COTS observed, monitoring is advised, to determine whether or not COTS removal may be warranted as a management option.

MOBILE INVERTEBRATE COMMUNITY

The Maricaban MPA supported the greatest abundance of Echinoidea (sea urchins) and Malleidae (mollusks). This was mainly attributed to one echinoid species and one genus of Malleidae. A total of 187 *Echinometra mathaei* and 103 *Malleus* spp. were found within the 120 surveyed area, along with four other mollusk species and one annelid species (Figure 18). In addition, abundant *Serpula* sp. (TNTC) (see Appendix) were recorded within the surveyed area. As was previously stated, Maricaban contained the highest number of COTS among all of our surveyed areas (25 individuals observed within our survey area) and the second largest abundance of *Tridacna* spp. (11 individuals).

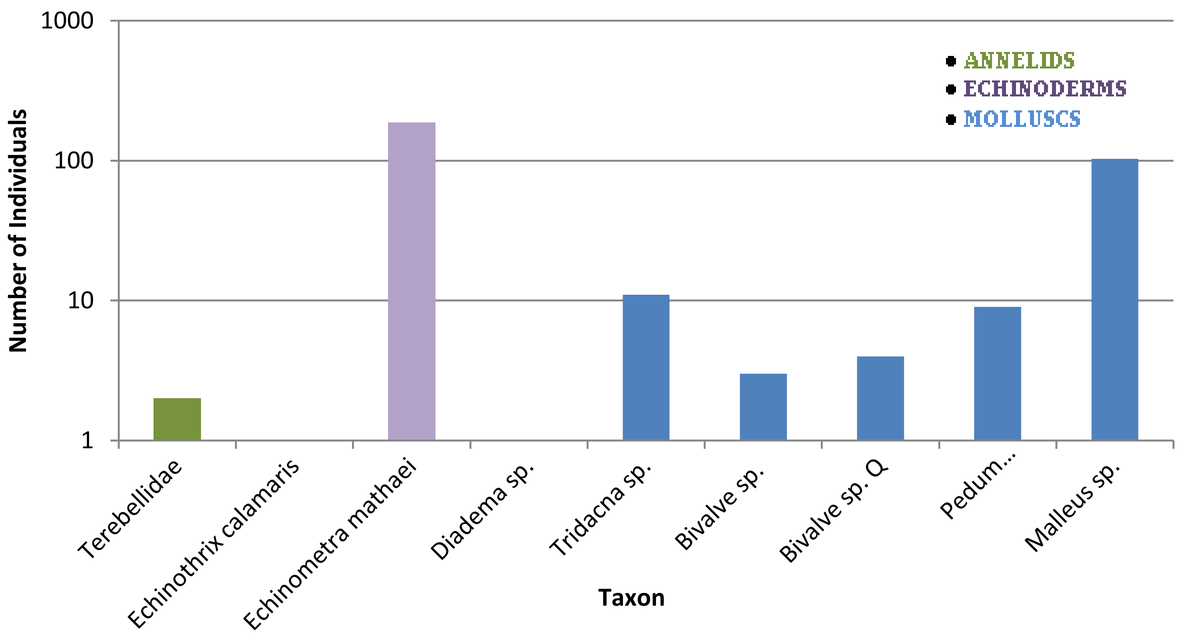
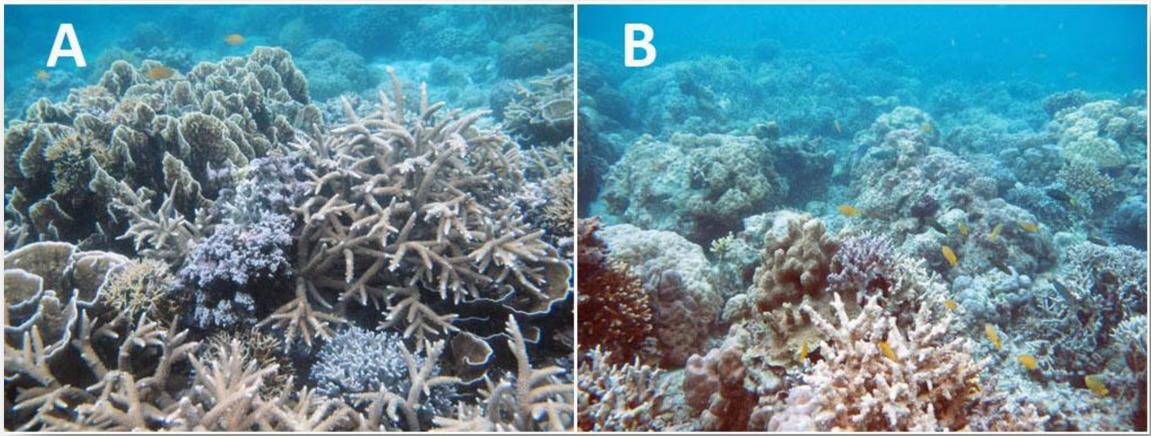


Figure 18. Abundances and taxonomic distribution of mobile invertebrates found within the Maricaban MPA. Note that abundances presented on the Y axis are on a log scale, to allow for large differences in abundance.

HILANTAGAAN MARINE RESERVE, HILANTAGAAN ISLAND



Hilantagaan Marine Reserve (A) inside the reserve, showing dominance by fragile branching Acroporids; and (B) immediately outside the reserve, showing dominance by massive forms.

This 10-year-old reserve, established in 2001, covers a 10-ha area of well-developed reef and extends to the shoreline in front of the village. Coral condition was excellent, and cover and diversity of live hard coral was very high. Furthermore, dominance of the coral community by branching and staghorn *Acropora*, which are known to be very sensitive to water quality and physical damage, demonstrates that management efforts to protect both water quality and the coral community continue to be successful.

Live hard coral cover outside the reserve was also quite high, though dominated by massive growth forms. This suggests two points: 1) that the condition of this reef when the reserve was first established was good and coral cover was high; and 2) that this good condition has been reasonably maintained over time within the fished reef, though the more fragile growth forms have died out and been replaced by more robust forms. Harvesting activities, even if not obviously destructive, can result in physical damage to corals which can reduce or eliminate fragile species over time.

FISH COMMUNITY

Species Richness

Species diversity in Hilantagaan MPA was "very high", with a total of 70 species observed inside the MPA and 24 outside. Labridae (wrasses) were the most abundant family, represented by 19 species, followed by the Pomacentrids (damselfish) with 14 species. A total of 10 species of Chaetodontids (butterflyfish) were also observed (Tables 5 and 6). These figures are almost double what was reported from within this reserve in 2007 (Jadloc et al. 2007), suggesting further recovery of the MPA and continual, effective enforcement.

Fish Abundance

Mean fish abundance for all reef species in Hilantagaan MPA was "high", with 270 ± 43 ind/100m^2. However, only 77 ± 6 ind/100m^2 were target fishes. Outside, the figure was considerably lower and more variable between transects: 180 +/-64 ind/100m^2 (all reef species) and 33 +/- 18 ind/100m^2 (target species; Fig. 19). These figures compare favorably with those from 2007, and show marked improvement in the fish community overall: 322 ind/500m^2 or 64 ind/100m^2 were recorded from within the MPA and 241 ind/500m^2 or 48 ind/100m^2 outside (roughly, a four-fold increase both within and outside the MPA).

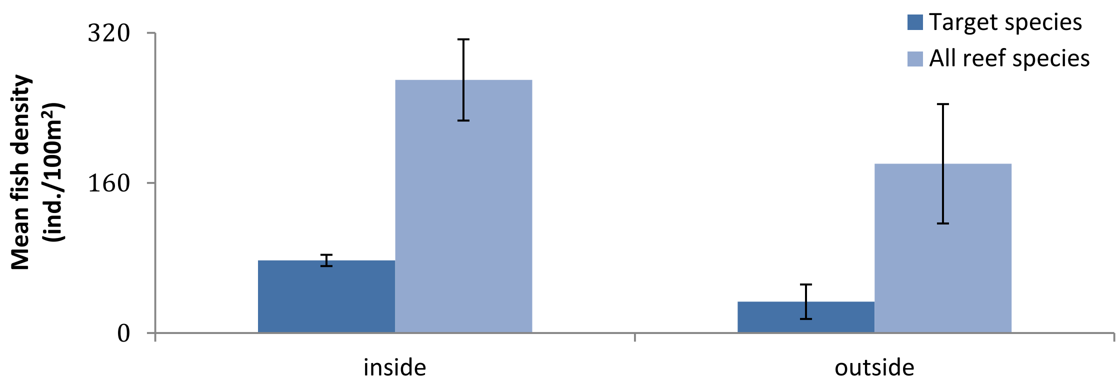


Figure 19. Comparison of abundances (Mean +/-SE) of fish representing different trophic groups within and outside the Hilantagaan MPA. Mean +/- SE

The most dominant trophic group were the herbivores with 64 ± 6 ind /100m^2 (Fig. 20), followed closely by the invertebrate feeders (57 ± 13 ind/100m^2). Few carnivores were observed in the area, though there were slightly more within the MPA, but they were all medium sizes (TL=10-30 cm); no larger, older individuals were seen. Given the age of the MPA and the length of time of protection, this is not what would be predicted. Older individuals of certain target species would be expected to be present.

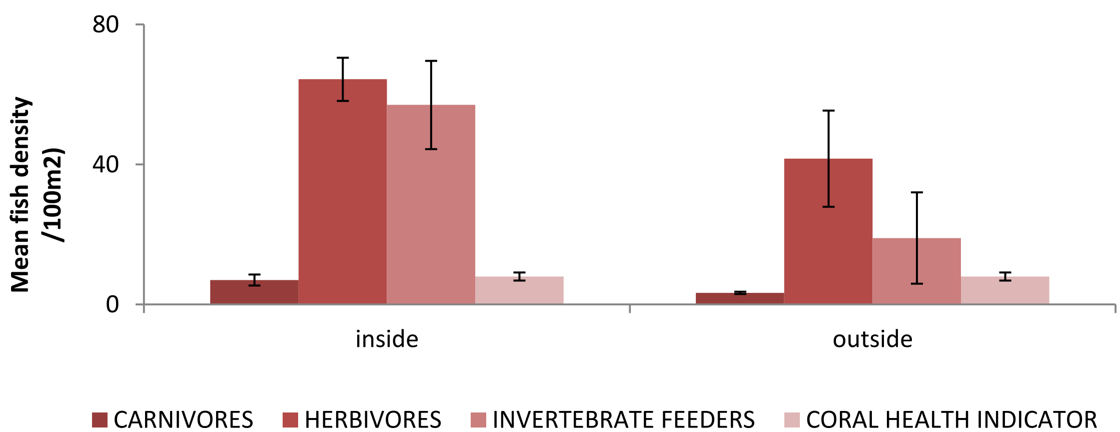


Figure 20. Comparison of densities of fish functional groups inside and outside of Hilantagaan MPA. Mean +/- SE

BENTHIC COMPOSITION

Inside the MPA boundary, live hard coral cover dominated (Figure 21). Loose rubble and dead/recently killed coral were recorded in low percentages and fleshy macroalgae was not observed within ourtransects, within the MPA. Noticeable differences were observed between the inside and outside MPA comparisons at this site. The adjacent fished reef contained >50% less live hard coral, 11% more coral rubble, 16% more dead coral, and 23% more pavement than the MPA. In comparing findings from 2007 (Jadloc et al. 2007), live hard coral increased from 54% to 73% inside the MPA but decreased outside, from 38% to 25% (Fig. 21).

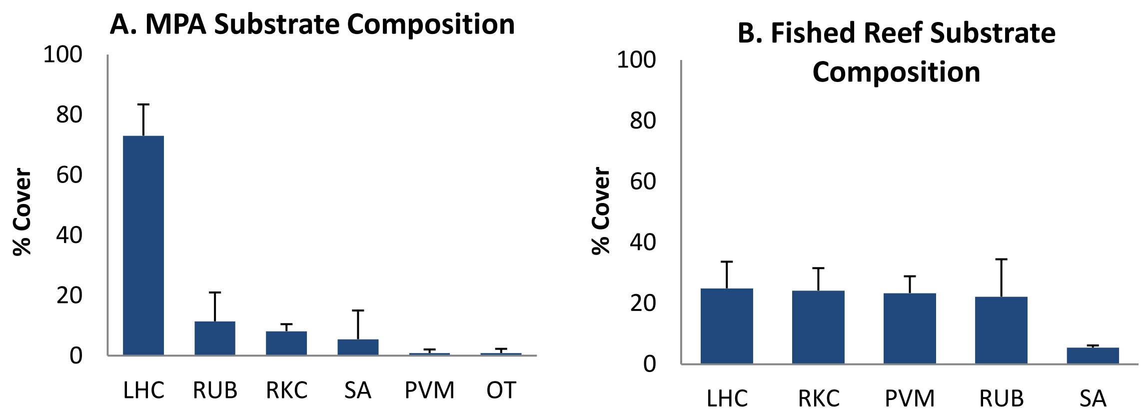


Figure 21. A: Substrate composition within the Hilantagaan MPA; B: substrate composition within the fished reef adjacent to the MPA. LHC=live hard coral; RUB=rubble; RKC=recently killed coral; PVM=pavement; SA=sand; OT=sponges, etc. Mean +/- SD.

CORAL COMMUNITY

The MPA had the highest live hard coral cover among all the surveyed sites (Fig. 3). *Porites* spp. and branching *Acropora* spp. dominated live hard coral cover (Fig. 22A). The predominance of fragile growth forms and those sensitive to poor water quality (staghorn *Acropora, Seriatopora*) indicates effective protection against physical damage such as that caused by repeated anchor drops. Further, visibility was very high and there were no indications of chronic silt problems. Outside the MPA, coral cover and generic diversity were lower (Fig. 22A vs. B), though the number of species within genera was higher than within the MPA (Table 7). *Porites* spp. and *Acropora* spp. dominated this site as well, though there were fewer colonies of the more fragile growth forms.

Colony sizes were generally larger within the MPA than in the adjacent fished reef (Fig. 23), and this is reflected in the lower colony density values seen (Table 7). Overall, colony densities were lower than in the JDV MPA though coral cover was much higher, and this can

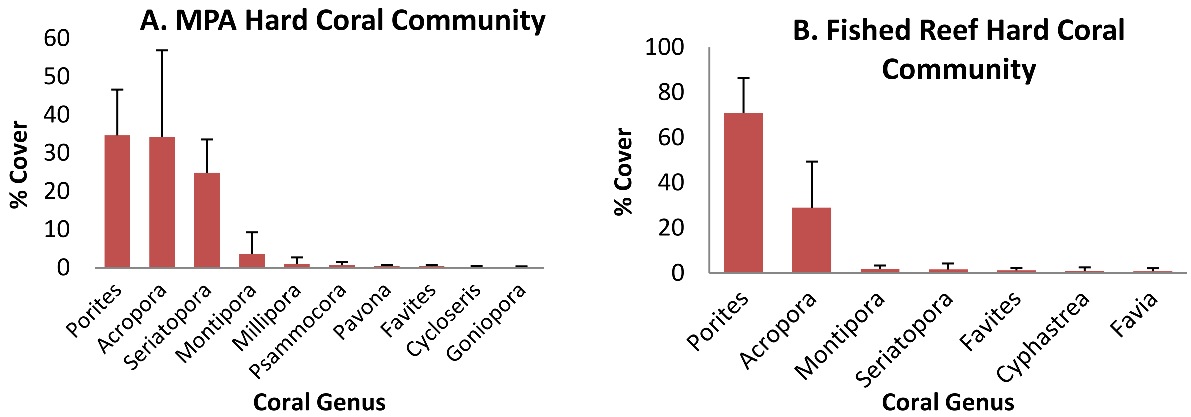


Figure 22. Generic composition of the hard coral community (A) within the MPA and (B) within the fished reef adjacent to the MPA. Mean +/- SD.

be explained by the greater number of large colonies within Hilantagaan. Larger colonies sizes would be expected in reefs that have not undergone major disturbance resulting in coral mortality for an extended period of time.

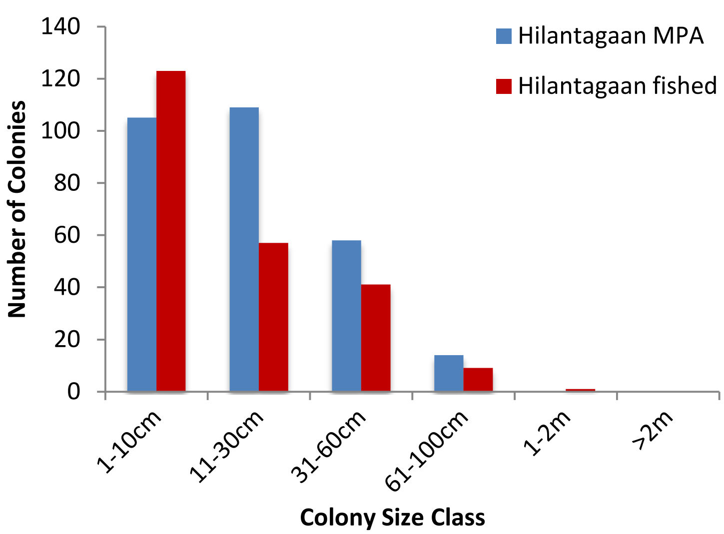


Figure 23. Hard coral community colony size distribution inside the Hilantagaan MPA and in the adjacent fished reef. Total colony counts from n=3 transects.

Recruit density within the MPA was quite low (0.2 individuals/m^2; Table 7), but this may partly be a sampling artifact as the high rugosity and coral cover made it difficult to observe cryptic recruits. Substrate suitable for recruitment (i.e., pavement) was approximately four times greater outside the MPA and this area showed the highest density of recruits of all sites (1.7 individuals/m^2; Table 7). An abundant supply of recruits is associated with high resilience and is a favorable attribute for an MPA.

Disease prevalence was high within this site, but lower within the MPA (16.7 +/-7%) than in the adjacent fished reef (32.1+/-17.8%; Fig. 24). This is consistent with other sites in the region that have shown significantly less disease within an MPA than in the fished reef immediately adjacent and within the same reef system (Raymundo et al. 2009).

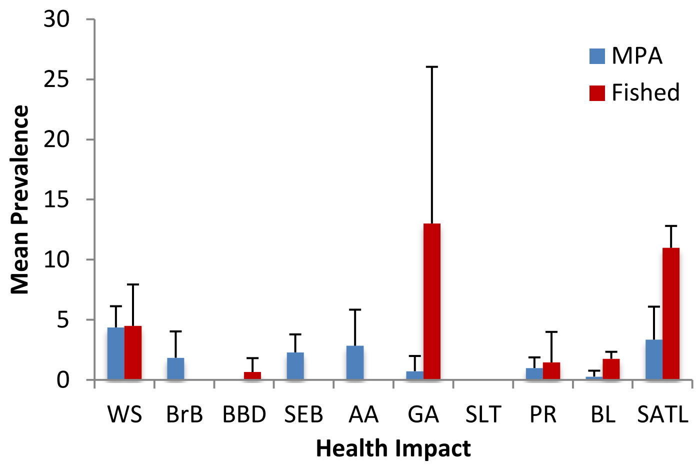


Figure 24. Health impacts to corals within and adjacent to the Hilantagaan MPA. WS=white syndrome; BrB=brown band; BBD=black band disease; SEB=skeletal eroding band; AA=algal abrasion; GA=growth anomaly; SLT=silt damage; PR= pigmentation response; BL=bleaching; SATL=subacute tissue loss. Mean +/- SE

This suggests an additional role of MPAs in maintaining coral health. A cluster of colonies of massive *Porites* displaying growth anomalies outside the MPA was responsible for the high prevalence of that syndrome, and subacute tissue loss (cause of tissue death unknown) was also high outside the MPA. So, while several syndromes were observed within the MPA, their individual prevalence values were low. The overall high value was undoubtedly linked to high coral cover, as this is often found to be a driver of high disease prevalence even when water quality is high (Bruno et al. 2007).

MOBILE INVERTEBRATE COMMUNITY

The greatest invertebrate community diversity was found inside the Hilantagaan MPA. Two annelid species, 12 echinoderm species, 8 mollusc species and one crustacean species were recorded at this site (Figure 25). Echinoid abundance was high, though more diverse than that of Maricaban; five genera were observed within the Hilantagaan MPA. *Serpula* sp. (TNTC) were abundant amongst the many healthy coral heads, and the only cowrie species observed throughout our surveys (*Cypraea tigris*) was noted here. The greatest diversity of

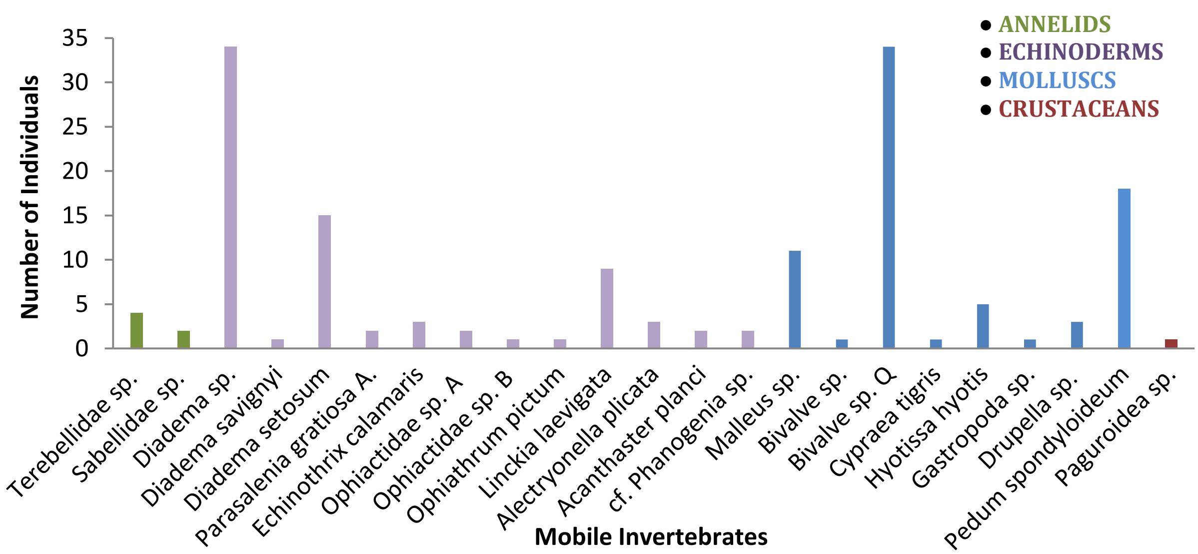


Figure 25. Abundance and taxonomic distribution of mobile invertebrates found within the Hilantagaan MPA.

echinoderms was recorded here as well, including 66 *Echinometra* sp. A (not included in Fig. 25) and two *Acanthaster planci* (both of which were < 10 cm and considered juveniles).

Outside the MPA, diversity remained high (the second highest number of taxa out of all the sites surveyed). One annelid species, 5 echinoderm species, 10 mollusc species, and two crustacean species were recorded here (Figure 26). The number of Mollusca species increased outside the sanctuary while the number of echinoderms decreased. A similar number of *Echinometra* sp. A (64 individuals, not listed in Figure 25) was also observed. The corallivorous starfish *Culcita novaeguineae* and *Acanthaster planci* (>25 cm adult; see Appendix for photodocumentation of both species), and a crinoid were observed off transect at this site (and so not included in Fig. 25). *Serpula* sp. were also highly abundant (TNTC), though visual estimates were lower than that within the MPA.

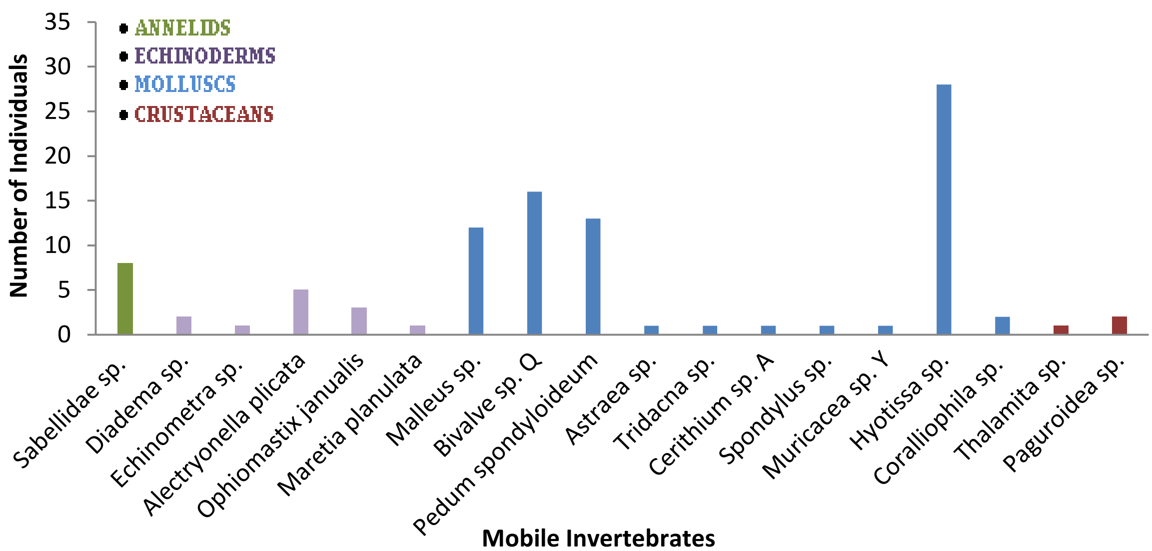


Figure 26. Abundance and taxonomic distribution of mobile invertebrates found within the Hilantagaan adjacent fished reef.

There were signs of disturbance from human activity within this site despite its protected status and the good condition of the coral community. An abandoned fish net was found within the reserve, fouling a number of coral heads. While it is not direct evidence of poaching within the reserve as it could have drifted in from outside, fishing gear fouling marine organisms can cause their death, and it should be removed. An intact empty giant clam shell was also observed inside the MPA. The intact condition of the shell suggested death either via disease or harvesting. In addition, outside the reserve an overturned coral head was observed.

TALANGNAN MARINE RESERVE, MADREDEJOS MUNICIPALITY

Talangnan Marine Reserve, showing abundant *Sargassum* (at red arrow), a fleshy macroalga that competes with corals, and small scattered coral colonies of massive growth forms.

This marine reserve was established eleven years ago and is 14 ha in area. However, no enforcement has been present since its establishment and this is obvious in the low coral cover and diversity, high fleshy macroalgae abundance, and very low fish abundance. Snorkel surveys beyond our transect area revealed an extensive area of mixed fleshy macroalgae and small massive corals and a much smaller seagrass zone than many of the other sites surveyed. It is clear that this site would benefit greatly from enhanced management and enforcement of no-take regulations. Improved enforcement is predicted to increase coral cover and decrease algal abundance and, over time, would result in increased fish diversity and abundance. Herbivorous fish would respond rapidly and have a positive influence in reducing algal abundance and allowing coral recovery via enhanced survival of recruits and adult colonies (Mumby et al. 2006).

FISH COMMUNITY

Species Richness

Species diversity in Talangnan Proposed MPA was classified as in a "poor" condition, with a total of 34 species observed (Tables 3 & 5). The most diverse family were the Labrids (wrasses) represented by 10 species, followed by the Pomacentrids (damselfish) with 5 species. Only 3 species of Chaetodontids (butterflyfish) were observed within our transects.

Fish Abundance

Mean fish abundance for all reef species in Talangnan Proposed MPA appeared to be in "poor" condition as well, with 40±3 ind/100m^2, and with no target fish observed within our transects (Figure 27). This suggests very high fishing pressure in the area. Likewise, only 2 trophic groups were observed: herbivores and coral health indicators. Both groups were in very low abundance, represented by 10±1 ind/100m^2 and 5±0.6 ind/100m^2, respectively (Fig. 28). All fishes observed were in the small size class category (TL=1-10 cm).

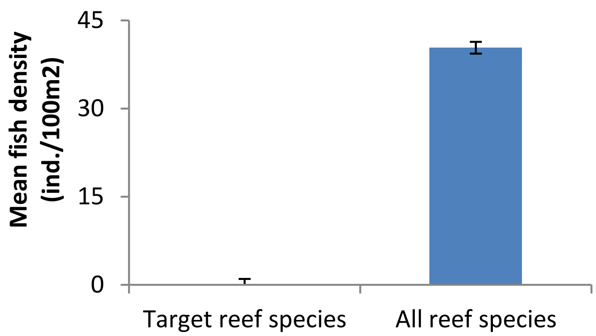


Figure 27. Abundance of both target fish species and all reef species within the Talangnan MPA. Mean +/- SE

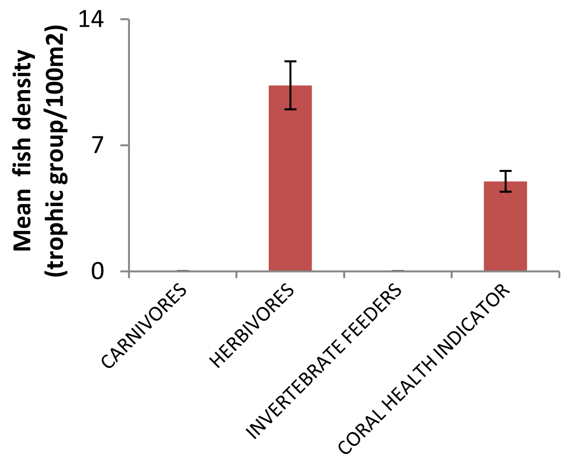


Figure 28. Abundance of fishes within the different trophic groups in the Talangnan MPA. Mean +/- SE

BENTHIC COMPOSITION

Low coral cover (4.3%), extensive rubble fields (33.8%), and fleshy macroalgae of the genera *Sargassum* and *Turbinaria* (18.8%) characterized the benthic composition of this site (Fig. 29). The abundance of thick algal turf mats (12.1%) was the second highest recorded between the surveyed sites. Heavy siltation was also observed and the water was very turbid. The predominance of rubble fields and dead coral ("RKC"; 4.6%) indicates past presence of branching corals, though cause of such extensive mortality cannot be ascertained as the rubble was highly weathered.

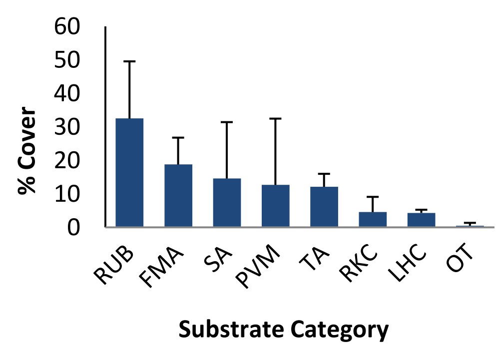


Figure 29. Benthic composition within the Talangnan MPA. RUB=rubble; FMA=fleshy macroalgae; SA= sand; PVM=pavement; TA=turf algae ; RKC=recently-killed coral; LHC=live hard coral. Mean +/-SD

CORAL COMMUNITY

Coral diversity and abundance was low and live hard coral cover was dominated by massive forms from poritids and faviids (Fig. 30). Unlike at other sites, the entire 20m X 2m belt transect was evaluated, as coral cover was so low. Colonies were generally very small (Fig. 31), though this does not represent high recruit abundance, as that was also very low (0.3 ind/m^2; Table 7). Health impacts were generally not from infectious diseases: algal abrasion and silt damage accounted for a high percentage of the observed impacts (Fig. 32). Total prevalence of impacts was the highest among the sites surveyed: 34.4.+/-4.1% of corals were affected by one or more health impacts. White syndrome was the only disease noted, with a prevalence of 8.5% of corals surveyed. This is very high considering the low density of corals and suggests environmental impacts which may be affecting the coral population's ability to defend itself against health threats. These impacts, coupled with low recruitment and small colony size, suggest this coral population has little ability to recover from stressors and would greatly benefit from improved water quality and reduction in algal cover.

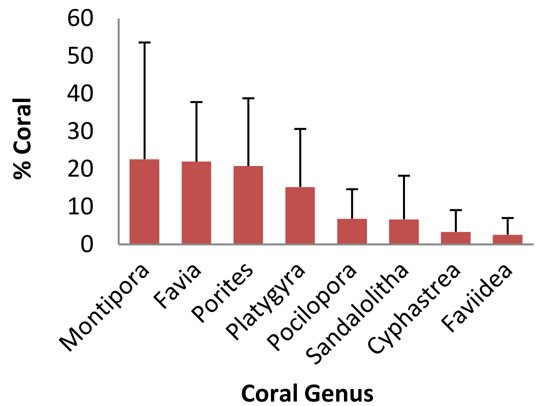


Figure 30. Generic composition of the hard coral community within the Talangnan MPA. Mean +/- SD.

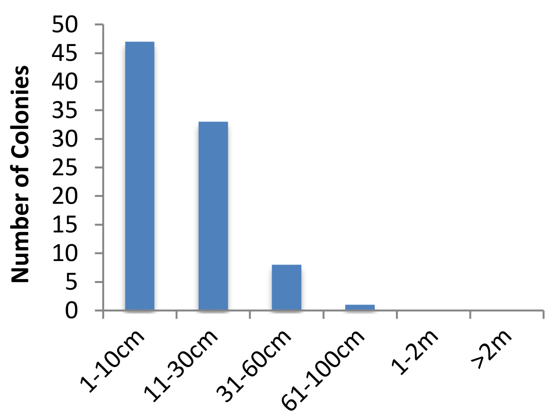


Figure 32. Health impacts to corals within the Talangnan MPA. WS=white syndrome; GA= growth anomaly; AA=algal abrasion; SLT=silt damage; PR= pigmentation response; BL= bleaching; SATL=subacute tissue loss. Mean +/- SD

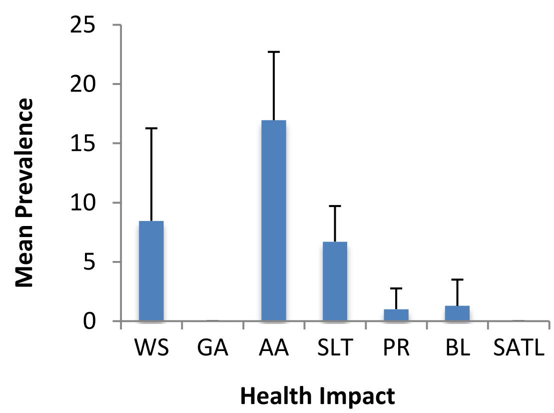


Figure 31. Size class distribution of the hard coral community within the Talangnan MPA. Total colony counts from n=3 transects.

MOBILE INVERTEBRATE COMMUNITY

The Talangnan MPA displayed a very low abundance of mobile benthic invertebrates; the lowest, in fact, of all of our sites. Three species of echinoderms, four species of molluscs, and one crustacean species were recorded here (Figure 33). One *Protoreaster nodosus* starfish (family Oreasterida; see Appendix) was also found off-transect at this site.

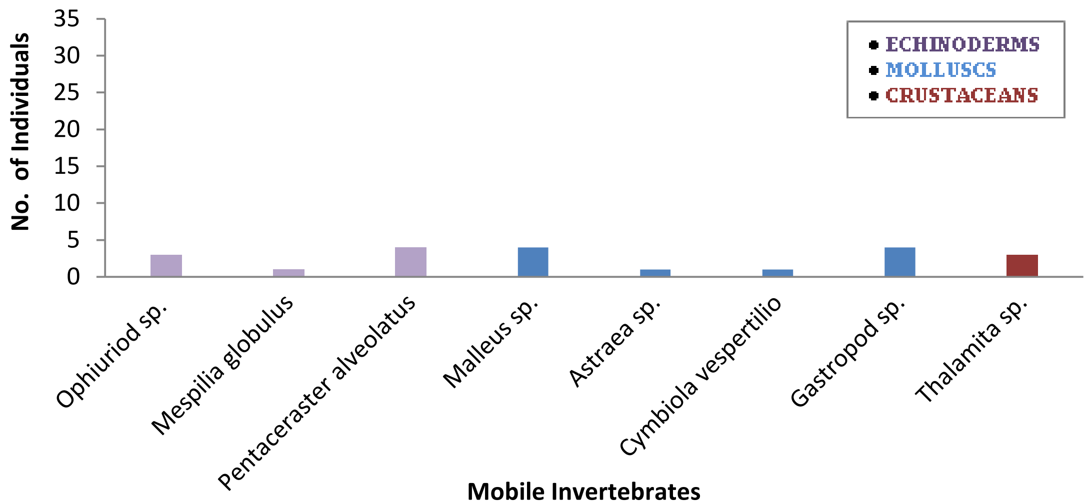


Figure 33. Abundance and taxonomic distribution of mobile benthic invertebrates found within the Talangnan MPA.

KODIA PROPOSED MARINE RESERVE, MADREDEJOS MUNICIPALITY

The proposed reserve encompasses an offshore area of 26.9 ha, averaging 7m in depth, which is predominantly a seagrass bed. No quantitative surveys were completed at this site because no actual reef community was observed. A snorkel survey was conducted which bisected the reserve area, and scattered coral heads were observed within the seagrass bed. The water was quite turbid and visibility was poor. The source of turbidity appeared to be silt. There was a large fish pen along one side of the reserve boundary and numerous fishing boats were anchored along the seaward border.

While seagrass beds are important as nursery and feeding grounds for a number of fish species, the lack of a discrete coral community with diverse fish habitat that can support a reef fish community may hinder the improvement of fish stocks within the reserve.

BUNAKAN PROPOSED MARINE RESERVE, MADREDEJOS MUNICIPALITY

Proposed site of the Bunakan Marine Reserve, showing representative coral community. Red arrow: bare substrate covered with fine silt layer; Green arrow: abundant fleshy macroalgae *(Sargassum),* a known competitor of hard corals.

This proposed MPA, 10 ha in area, was dominated by an extensive seagrass bed, similar to other sites along the Madredejos coast. A small reef patch of high relief was found centrally located within the proposed MPA at a depth range of 6m to 2m. It was within this reef patch that we conducted our surveys. The reef patch was characterized by high relief structure, but the water was very turbid; both silt and fleshy macroalgae dominated and dead coral heads were common (Fig. 34).

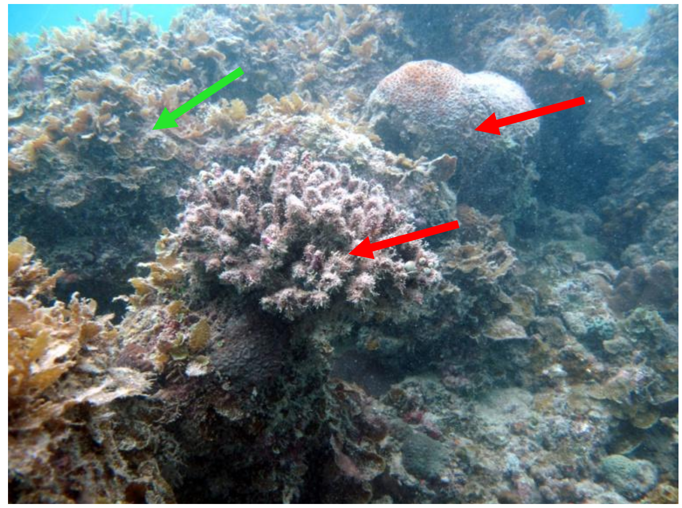


Figure 34. Appearance of reef within the Bunakan proposed MPA, showing silted, dead coral heads (red arrows) and predominance of fleshy macroalgae (green arrow).

FISH COMMUNITY

Species Richness

Species diversity in Bunakan Proposed MPA was classified as “poor”, with a total of 34 species counted (Table 3). The most diverse family were the Labrids (wrasses), represented by 10 species, followed by the Acanthurids (surgeonfish), with 5 species. Only 4 species of Chaetodontids (butterflyfish) were observed in the area (Table 5).

Fish Abundance

Mean fish abundance for all reef species in Bunakan Proposed MPA appeared to be in “poor” condition with only 51±5 ind/100m^2, of which 10±0.3 ind/100m^2 represented target fish species (Table 3; Fig. 35). Herbivores were the most abundant trophic group, with 15±2 ind/100m^2, followed by invertebrate feeders, with 7±2 ind/100m^2 (Fig. 36).

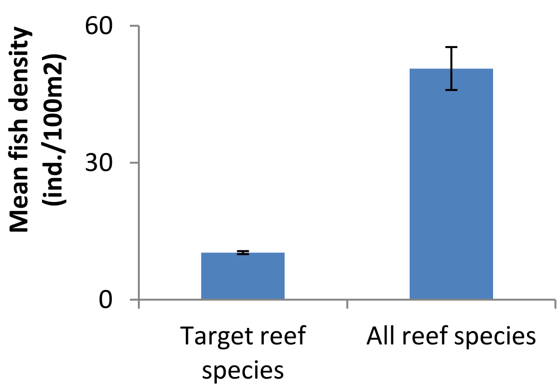


Figure 35. Density of fish target species and all reef species found within the coral zone of the proposed Bunakan MPA. Mean +/- SE

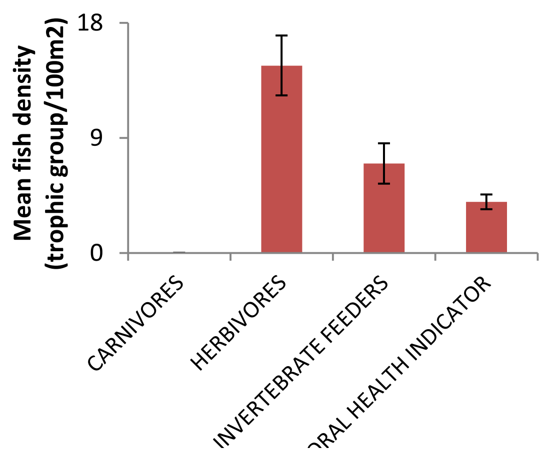


Figure 36. Density of the major fish functional groups found with the coral zone of the proposed Bunakan MPA. Mean +/- SE

BENTHIC COMPOSITION

Benthic composition within the coral zone of the proposed MPA site was dominated by was fleshy macroalgae (36.2%), followed by live hard coral (21.8%) and sand/silt (20.3%) (Fig. 37). The highest abundance of macroalgae was recorded within this site, suggesting very low herbivory. *Sargassum* was very common, as was a *Peysonellia*-like calcareous alga.

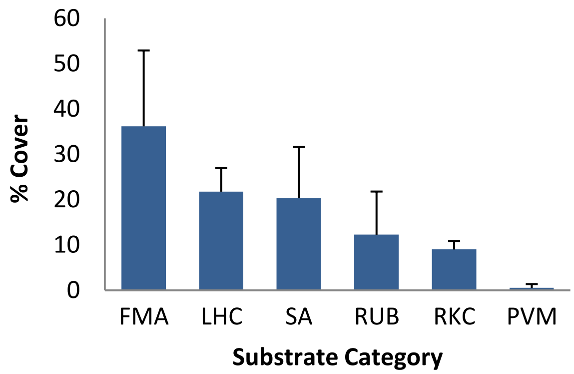


Figure 37. Benthic composition within the Bunakan proposed MPA. RUB=rubble; FMA=fleshy macroalgae; SA= sand; PVM=pavement; TA=turf algae ; RKC= recently-killed coral; LHC=live hard coral. Mean +/-SD

CORAL COMMUNITY

The coral community was characterized by low diversity and abundance, and dominated by silt-tolerant, hardy species. Massive *Porites* was, by far, the most dominant form, comprising 59.5% of the recorded live hard coral. All other genera were much less common, with the exception of large plates of *Turbinaria* sp., comprising 14.6% of the coral observed at this site (Fig. 38). Colonies were uniformly small, though relatively abundant, the majority of colonies limited to the two smallest size categories (Fig. 39). Recruit density was moderately high (0.9 ind/m^2; Table 7), but it is unlikely that recruits survive long, given the amount of silt that appears to be chronically deposited on this reef and covered all surfaces (Fig. 34).

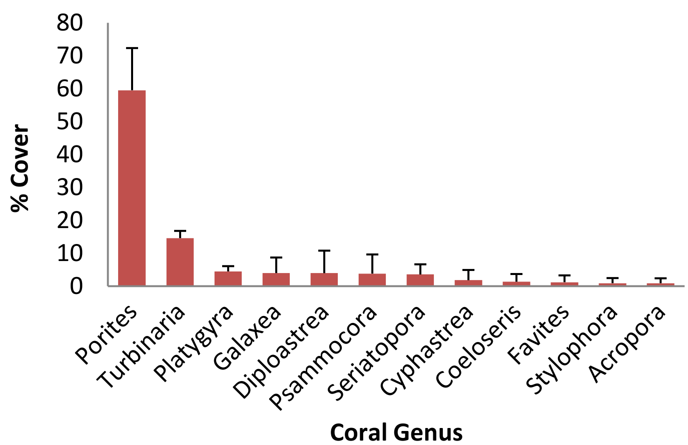


Figure 38. Abundance and taxonomic distribution of hard coral genera within the proposed Bunakan MPA. Mean +/- SD

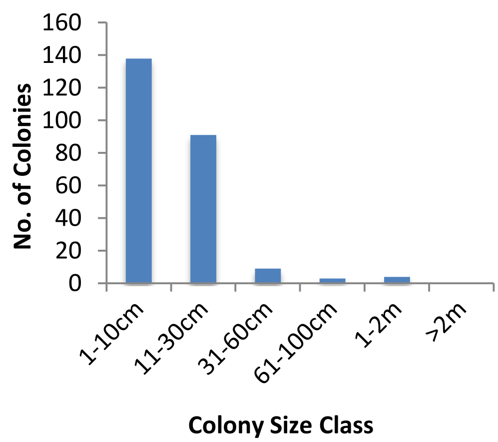


Figure 39. Colony size distribution of the hard coral population within the proposed Bunakan MPA. Total colony counts from n=3 transects.

Bunakan corals were exposed to a variety of health impacts. *Drupella* was most common at this site, both on and off our transects. *Drupella* is a genus of small corallivorus sea snails that can reach very high numbers and cause considerable tissue loss and whole colony mortality. In the Red Sea, the snail has been implicated in coral disease (Antonius & Riegl, 1997). Total health impacts prevalence was 13.9+/-9%, with subacute (old) tissue loss being the most common category (Fig. 40). White syndrome and growth anomalies were the two diseases noted, but silt smothering, algal abrasion and bleaching were also observed. The high prevalence of subacute tissue loss indicates that coral mortality has been high for quite some time and will likely to continue in the future unless water quality is improved.

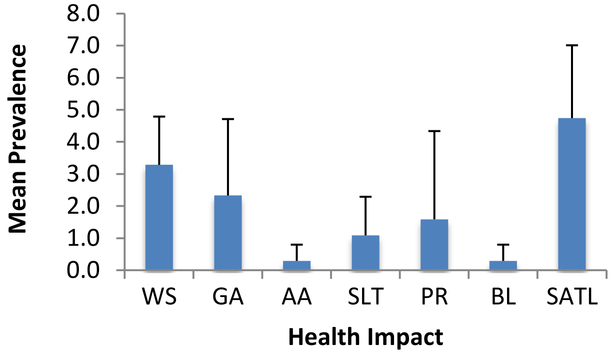


Figure 40. Health impacts to corals within the Talangnan MPA. WS=white syndrome; GA=growth anomaly; AA=algal abrasion; SLT=silt damage; PR= pigmentation response; BL=bleaching; SATL=subacute tissue loss. Mean +/- SD

MOBILE INVERTEBRATE COMMUNITY

The invertebrate community was represented by four phyla, but dominated by species within the phylum Mollusca, One annelid, one echinoderm, 9 mollusc, and one curstaean species were recorded at this site (Figure 41). Relative to the other surveyed sites, a higher abundance of the carnivorous snails *Drupella* sp. (See Appendix) and *Coralliophila violacea* was particularly noticeable at this site. The large predatory snail *Cymbiola vespertilio* was also seen off transect.

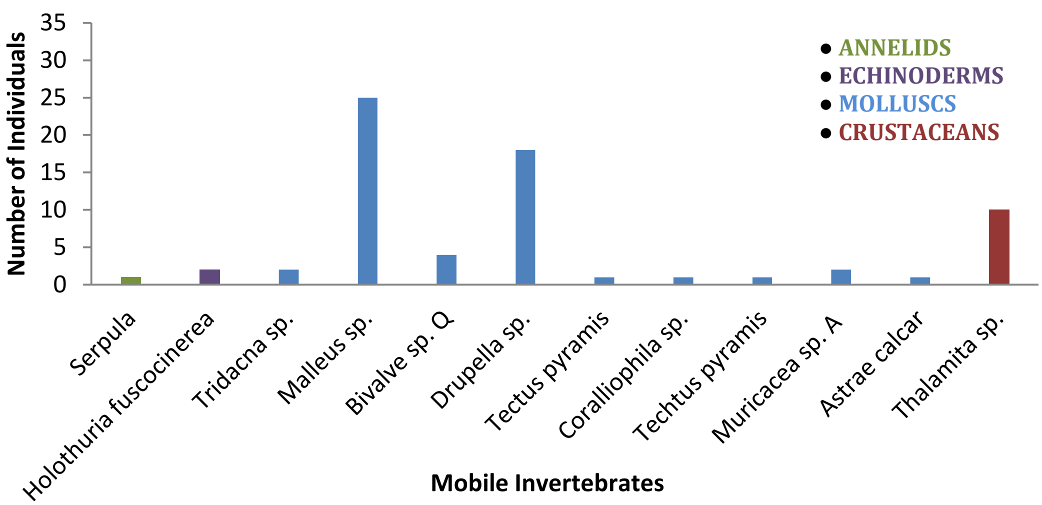
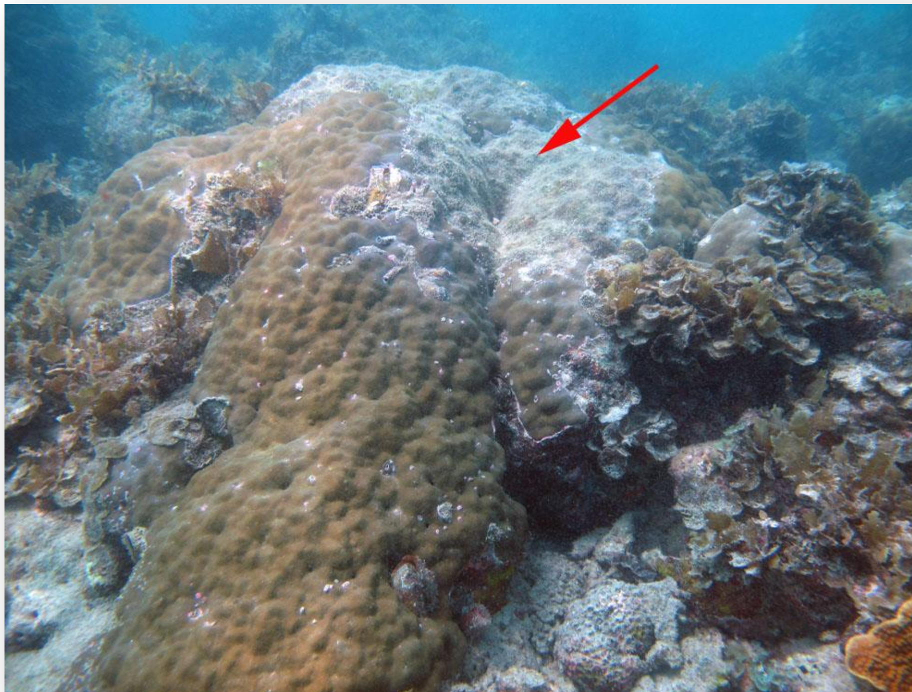


Figure 41. Abundances and taxonomic distribution of the mobile benthic invertebrate community within the Bunakan MPA coral zone.

TABAGAK PROPOSED MARINE RESERVE, MADREDEJOS MUNICIPALITY



The coral community within the proposed Marine Reserve in Tabagak. The community was characterized by siltation and high algal abundance, causing extensive damage to many coral colonies (red arrow)

This 14.2-ha proposed reserve was dominated by an extensive seagrass bed, with a small patchy coral reef area at 5m depth, which we surveyed. Turbidity was high, and the reef was very silted and of similar composition to other areas surveyed along this Madredejos coast. The reef showed signs of human impact, such as the overturned coral shown in Figure 42, as well as much algal overgrowth and abrasion of coral and tissue loss on corals due to silt smothering.

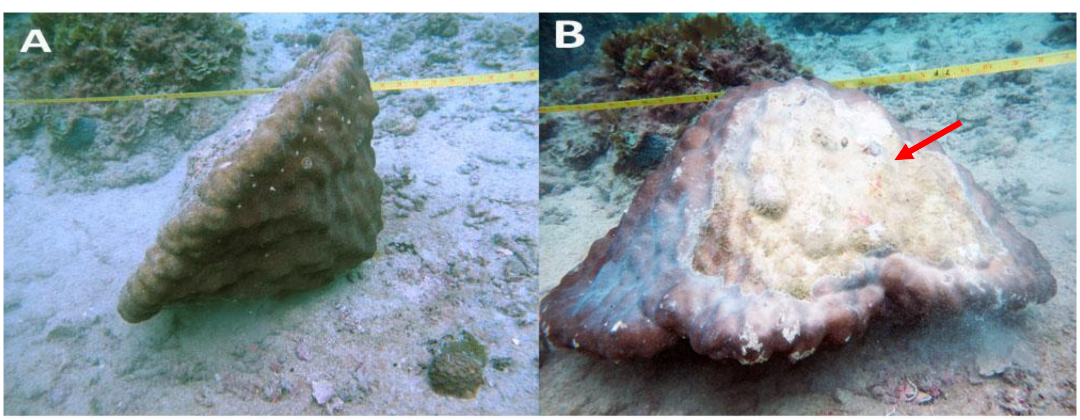


Figure 42. An overturned colony of *Porites* sp., showing the position of the colony along our transect (A) and the tissue loss (B; red arrow) which resulted from the colony being overturned. This may have been caused by an anchor.

FISH COMMUNITY

Species Richness

Species diversity in Tabagak Proposed MPA was classified as "poor", with a total of 41 species observed (Table 3). The most diverse family were the Labrids (wrasses) represented by 11 species, followed by Acanthurids (surgeonfish) and Pomacentrids, both with 5 species. Only 3 species of Chaetodontids (butterflyfish) were observed within the surveyed area.

Fish Abundance

Mean fish abundance for all reef species in Tabagak Proposed MPA appeared to be in "poor" condition with only 65±6 ind/100m^2, of which 13±1 ind/100m^2 were target fish species (Fig. 43). Herbivores were, by far, the most abundant trophic group, with an average of 30±5 ind/100m^2, followed by invertebrate feeders with 6±0.6 ind/100m^2 (Fig. 44). No carnivorous species were observed within our transects.

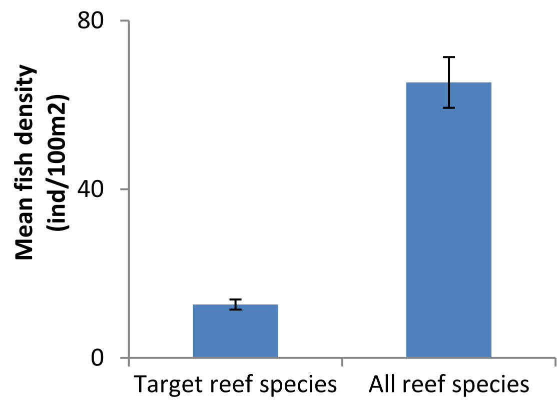


Figure 43. Density of target fish species and all reef fish species within the coral zone of the proposed Tabagak MPA. Mean +/-SE

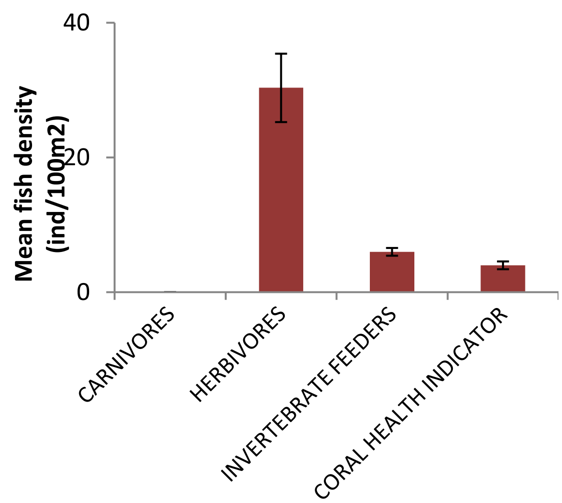


Figure 44. Density of the major fish functional groups found with the coral zone of the proposed Tabagak MPA. Mean +/-SE

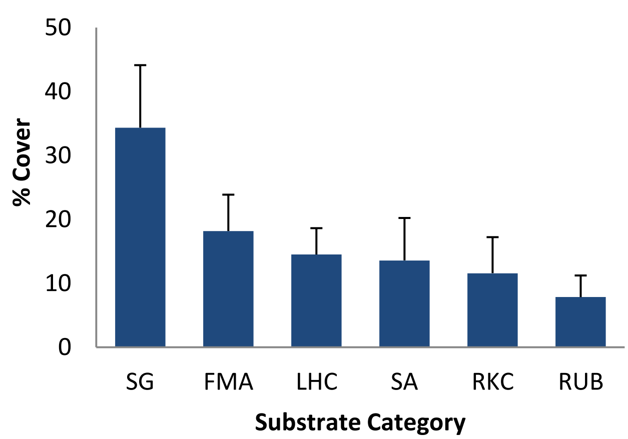


Figure 45. Benthic composition within the Tabagak proposed MPA. SG=seagrass; FMA=fleshy macroalgae; LHC=live hard coral; SA= sand; RKC=recently-killed coral; RUB=rubble; Mean +/-SD

BENTHIC COMPOSITION

Seagrass dominated the proposed MPA, even within the zone where coral was found (34.3%) (Fig. 45). Fleshy macroalgae (18.8%) was also very common, indicating a low abundance of herbivores; indeed, it was more abundant than live hard coral (14.5%) and was implicated in health impacts to corals (see below). Dead coral (RKC) and rubble (RUB) comprised approximately 20% of the substrate, suggesting that coral loss had been happening for some time.

CORAL COMMUNITY

Live hard coral cover was low and dominated by morphologies and species resistant to siltation. Massive *Porites* was clearly the dominant coral (40%; Fig. 46) and a small number of older, large colonies were present (Fig. 47). All other genera were less common. Colony density, taxonomic richness and recruit abundance were all moderate, compared with other sites surveyed (Table 7). The coral population was dominated by corals in the smallest size categories, although there were a limited number of larger colonies, up to 2m in diameter (Fig. 47). These colonies, mostly massive *Porites* and frondose *Turbinaria,* were considerably older than the other colonies and indicate that a coral community has existed within this site for a considerable amount of time. Unfortunately, the abundance of fleshy macroalgae and land-based silt are currently the major causes of tissue loss (Fig. 48) and are negatively impacting these larger, older colonies.

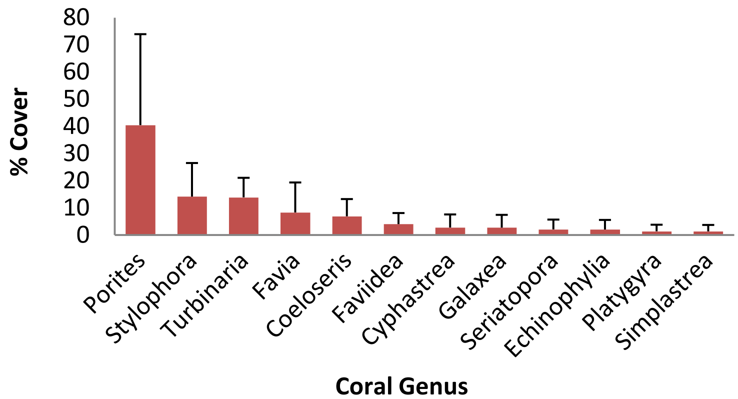


Figure 46. Abundance and taxonomic distribution of hard coral genera within the proposed Tabagak MPA. Mean +/- SD

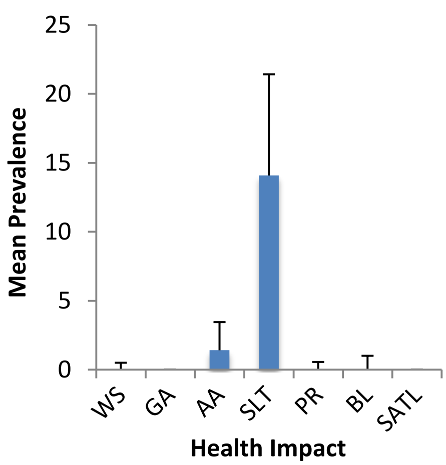


Figure 48. Health impacts to corals within the Talangnan MPA. WS=white syndrome; GA=growth anomaly; AA= algal abrasion; SLT=silt damage; PR= pigmentation response; BL=bleaching; SATL=subacute tissue loss. Mean +/- SD

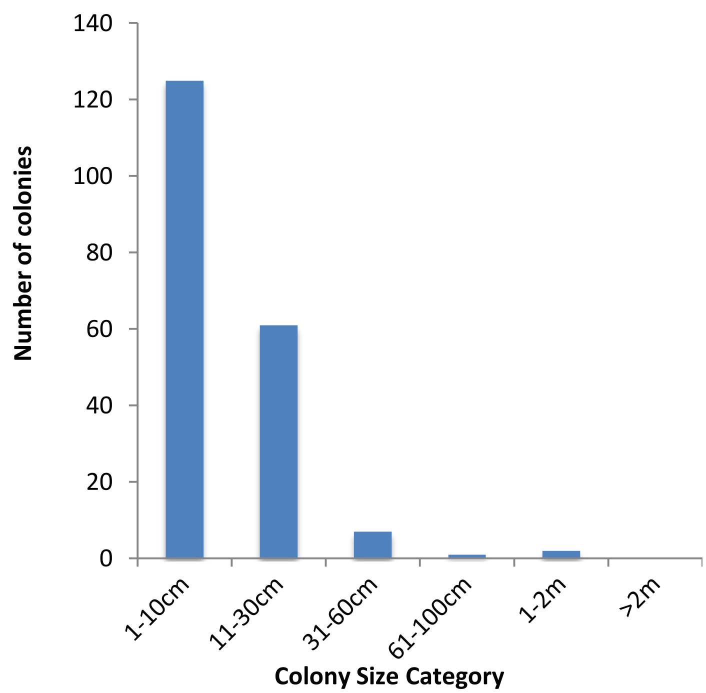


Figure 47. Population size structure of the hard coral populations within the proposed Talangnan MPA. Total colony counts, combining n=3 transects.

MOBILE INVERTEBRATE COMMUNITY

The mobile invertebrate community at the Tabagak Marine Sanctuary was of very low diversity and dominated by species within the family Mollusca. One echinoderm species, 8 mollusc species, and two crustacean species were recorded within the 120 transect area (Fig. 49). *Malleus* sp. (see Appendix) and *Serpula* sp. (TNTC) dominated at this location.

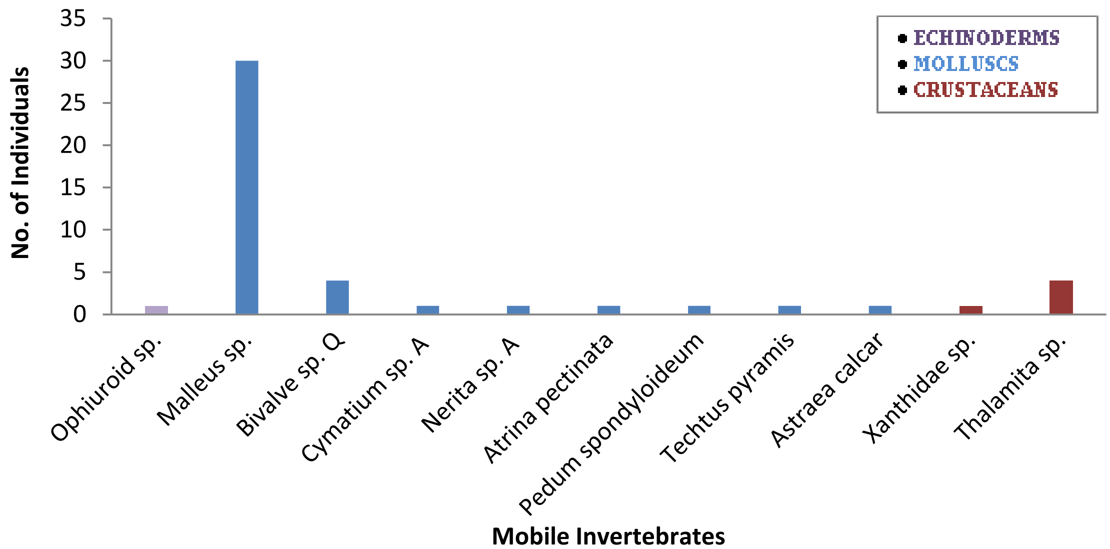


Figure 49. Abundance and taxonomic distribution of mobile benthic invertebrates within the coral zone of the proposed Tabagak MPA.

TARONG PROPOSED MARINE RESERVE, MADREDEJOS MUNICIPALITY

The coral community within the proposed Tarong Marine Reserve. Note abundance of fleshy macroalgae and scattered coral patches.

The proposed Tarong Marine Reserve is a 10.95 ha offshore area dominated by seagrass. Within this delineated area is a small zone of patchy coral at 5m depth where we conducted our surveys. Similar with other proposed sites along the Madredejos coast, the coral zone was marked by high turbidity, silt deposition and abundant fleshy macroalgae.

FISH COMMUNITY

Species Richness

Species diversity in Tarong Proposed MPA was classified as "very poor", with a total of 26 species observed (Tables 3 & 5). The most diverse family were the Labrids (wrasses) represented by 13 species, followed by the Acanthurids (surgeonfish) with 5 species. Only 4 species of Chaetodontids (butterflyfish) were observed within our transects.

Fish Abundance

Mean fish abundance for all reef species in Tarong Proposed MPA appeared to be "moderate", with 69±3 ind/100m^2. No target fish were observed within our transects (Figure 50). This suggests very high fishing pressure in the area. Likewise, only two trophic groups were observed: invertebrate feeders and coral health indicators. Both groups were in very low abundance, represented by 10±1 ind/100m^2 and 5±0.6 ind/100m^2, respectively (Fig. 51). All fishes observed were in the small size class category (TL=1-10 cm). Carnivorous and herbivorous species were totally absent from our counts.

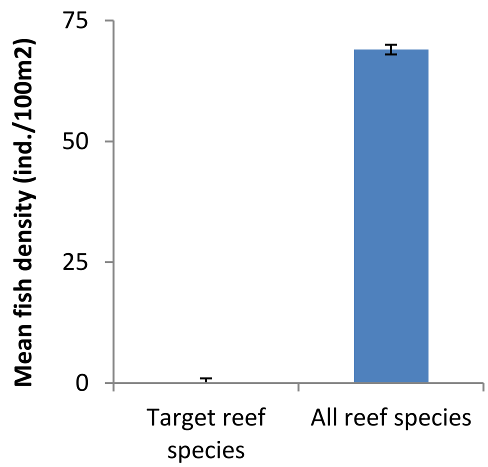


Figure 50. Abundance of both target fish species and all reef species within the proposed Tarong MPA. Mean +/- SE

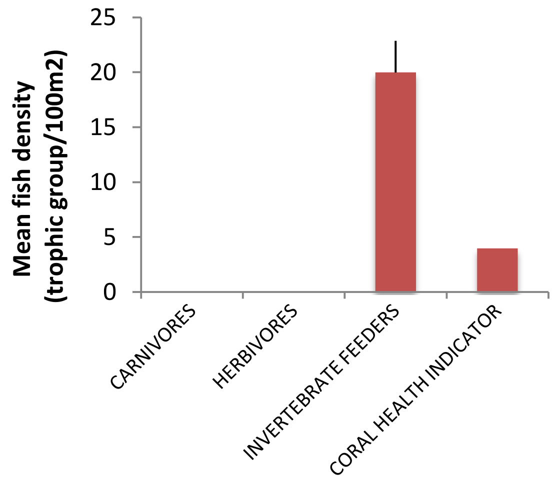


Figure 51. Density of the major fish functional groups found with the coral zone of the proposed Tarong MPA. Mean +/- SE

BENTHIC COMPOSITION

The reef community within the proposed Tarong MPA was dominated by pavement (44.3%) which is a favorable substrate for recruitment of new corals. Loose rubble (15.4%) and live hard coral (14.8%) were the next most abundant substrate categories (Fig. 52). The abundance of rubble is indicative of branching species, though there were few such colonies in the current survey, suggesting past mortality and replacement by silt-tolerant massive species.

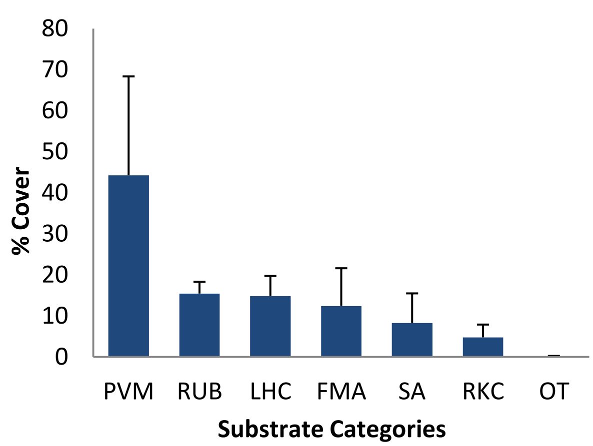


Figure 52. Benthic composition within the Tarong proposed MPA. PVM=pavement; RUB=rubble; LHC=live hard coral; FMA=fleshy macroalgae; SA= sand; RKC=recently-killed coral; OT=other cover, such as encrusting sponges. Mean +/-SD

CORAL COMMUNITY

Live hard coral cover was dominated by two silt-tolerant genera, *Porites* spp. (34.2%) and *Turbinaria* sp. (30.5%). As with other sites, massive and silt-tolerant growth forms dominated (Fig. 53). Consistent with what we observed in terms of benthic composition (i.e., a high percentage of bare pavement), coral density was low (Table 7, Fig. 53), and recruits were more abundant than at most other sites (Table 7). However, the large amount of silt covering all surfaces has a detrimental effect on survival and growth of these recruits, so it is unlikely that coral cover will increase over time unless this problem is addressed. As in other sites, there were a small number of large coral colonies (Fig. 55), indicating that coral has existed in this site for some time, though current water quality issues are resulting in an overall loss of corals. Silt smothering was the leading cause of tissue loss (Fig. 56) that we observed and growth anomalies on massive *Porites* was the only disease assessed at this site (Fig. 55).

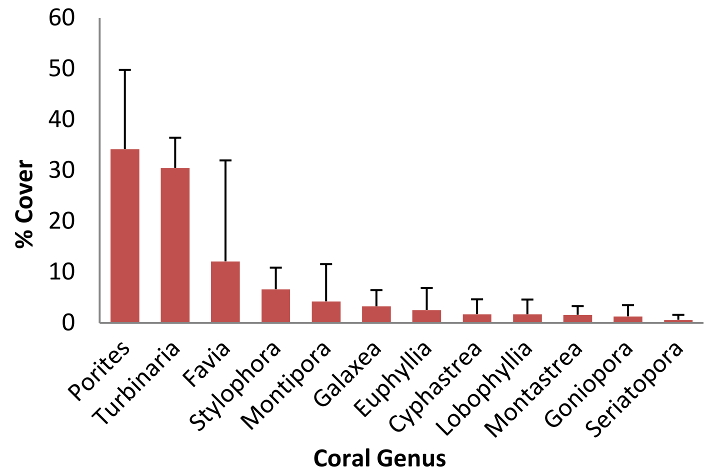


Figure 53. Abundance and taxonomic distribution of hard coral within the proposed Tarong MPA. Mean +/- SD

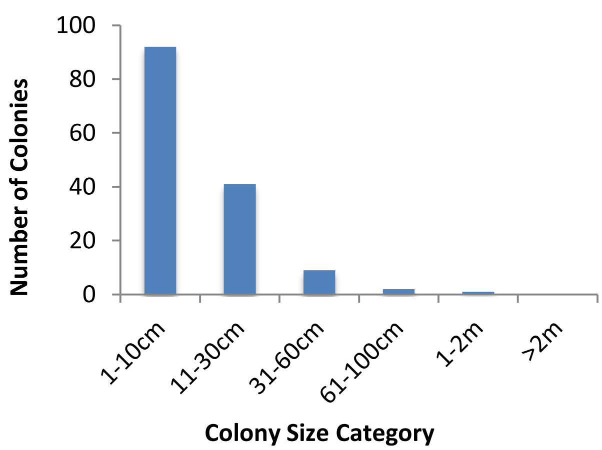


Figure 54. Population size structure of the hard coral populations within the proposed Tarong MPA. Total colony counts, combining n=3 transects.

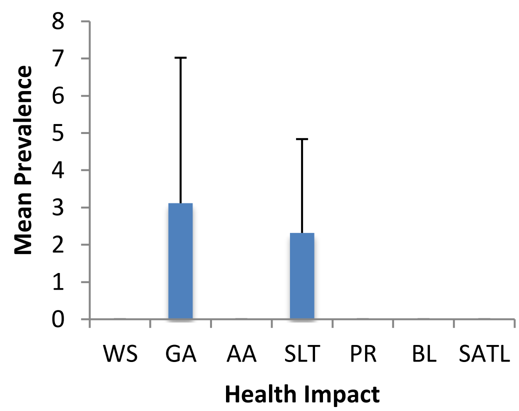


Figure 55. Health impacts to corals within the proposed Tarong MPA. WS=white syndrome; GA=growth anomaly; AA=algal abrasion; SLT=silt damage; PR= pigmentation response; BL=bleaching; SATL=subacute tissue loss. Mean +/- SD

MOBILE INVERTEBRATE COMMUNITY

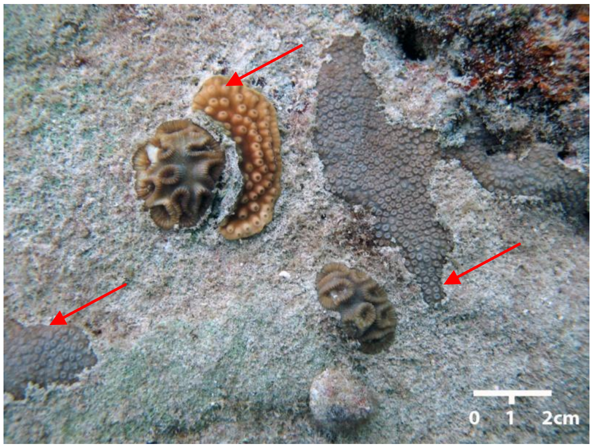


Figure 56. New coral recruits (yellow arrows) on silted dead coral substrate, showing remnants of original colony (red arrows) within the Tarong proposed MPA

The molluscan diversity at the Tarong Proposed Marine Sanctuary was found to be the highest out of all the sites surveyed. However, only mollusks and crustaceans were present on our transects, indicating very low diversity of all other groups. Two crustacean species and 13 mollusc species were recorded in the sanctuary (Fig. 57). *Serpula sp.* (TNTC) were noticeably abundant at this site and one *Holothuria fucocinerea* sea cucumber was observed outside the 120 sampled area.

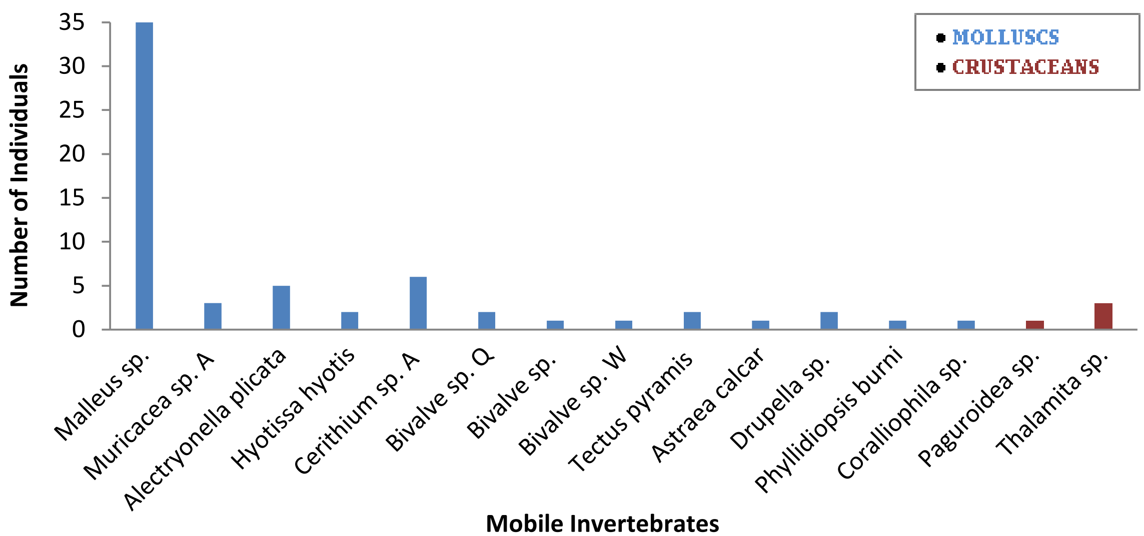


Figure 57. Abundance and taxonomic distribution of mobile benthic invertebrates within the coral zone of the proposed Tarong MPA.

POBLACION PROPOSED MARINE RESERVE, MADREDEJOS MUNICIPALITY

This site was briefly visited and brief snorkel surveys were conducted at two locations within the site in front of the area of Kota Park. Unfortunately, the current was very strong at both sites and a dive survey was deemed impossible. The snorkel surveys revealed extensive seagrass beds and patches of scattered, low relief coral areas dominated by small massive colonies. It is possible that there were areas of greater coral cover elsewhere, but we did not observe them and could not locate them. Because this area has high recreational use, it was proposed for protection. However, without further surveys it is not known whether there is any high-value reef which could be developed as a dive destination.

CONCLUSIONS AND RECOMMENDATIONS

- The JDV MPA rubble field could be a demonstration site for rubble stabilization techniques. This may increase fish habitat, as coral development is likely to remain limited within this reserve due to dominance by sandy substrate. Increasing habitat complexity using structures that could act as recruitment surfaces may be possible within this site, as it appears reasonably protected from strong storm surge.

- At present, fish diversity and abundance are uniformly low (“very poor” to “poor”) in all proposed MPA sites. Carnivorous species, of which several are target species, were very rare or completely absent. If protection is established and maintained at these sites, these species would be expected to recover very slowly, due to their life history. Furthermore, the area of coral reef habitat within these sites is quite small, so increases in fish biomass will be limited by the lack of reef habitat. Seagrass beds are much more extensive, so species which use this as habitat would show steady increases under protection. While seagrass beds are very important nursery and feeding grounds for a host of nearshore marine species, they do not provide the habitat complexity of coral reefs. Protecting a mix of reef and seagrass beds is an optimum situation, but most of the sites surveyed were clearly dominated by seagrass, with very limited reef area.

- Many of the proposed MPA sites had very little coral cover, and that which was there was dominated by massive growth forms and species that are large-polyped and relatively silt-tolerant (Fig. 56). Turbidity was high and silt was visible and a cause of mortality on many coral colonies. Because silt also creates poor recruitment substrates for many species of corals, possibilities of recovery via recruitment are also limited. The silt appeared to be terrigenous in origin (i.e., land-based) and suggests that land use practices which result in high soil erosion are a major cause of coral loss along the Madredejos coastline. Efforts by local politicians to address these issues and reduce siltation into nearshore waters are urgently needed. Otherwise, recovery of these patch reefs is likely to be very minimal.

- It is important that the local stakeholders be a part of the management planning of the proposed MPA to increase the success of the initiatives. Consultations with the community regarding the establishment and goals of the proposed MPAs and their agreed upon location and size should be undertaken if they have not already occurred. Furthermore, realistic expectations of rate and extent of recovery of fish and coral should be discussed by managers in meetings with stakeholders. If expectations are unrealistic, enthusiasm for continued management will lessen over time.

- Establishing and promoting the legal aspects of the initiative can provide support and a concrete basis for the protection of the area, and may also be able to provide limited funding support from government budgets. If barangay resolutions establishing these protected areas in the proposed sites have not yet been endorsed to the municipal council, then this should be a priority.

- Efforts were made by *Bantay Dagat* fishers, with the help of Batas Kalikasan Foundation, to establish boundaries of all proposed sites. The installed marker buoys on the corners of the proposed MPA, as well as existing MPAs should be maintained at all times. Furthermore, fishers and other stakeholders, as well as the community as a whole, should be informed of the presence of these markers so they understand what they demarcate.

- Creation and/or strengthening of MPA management bodies should be undertaken at all existing and proposed sites. It is essential for the success of the MPA to have a multi-stakeholder management body to oversee the management of the MPA and undertake regular monitoring and feed-back of the results to the community and government. This body should consist of policy makers, resource managers and users, law enforcers and representation from any other stakeholder group.

ACKNOWLEDGEMENTS

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APPENDIX

MOLLUSCA

Tridacna spp.

Cymbiola vespertilio

Drupella sp.

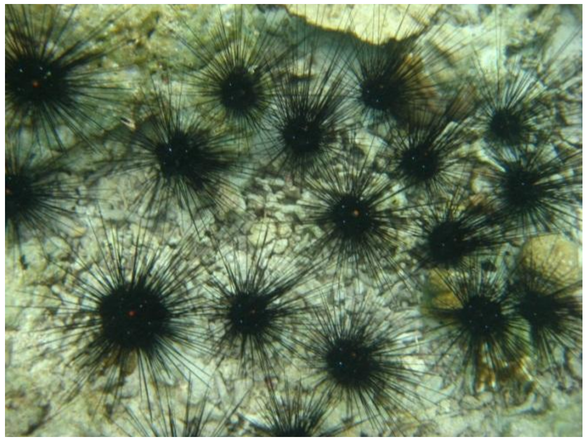
Malleus sp.

ANNELIDA

Sabellidae sp.

ECHINODERMATA

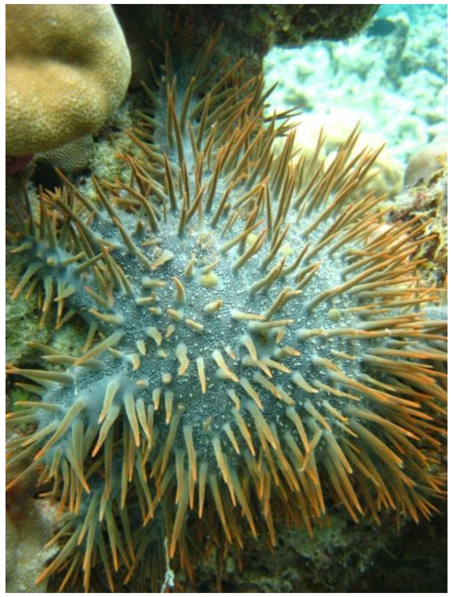
Echinometra sp. A (Kerr & Burdick)



Diadema sp.

Pearsonothuria graeffei

Holothuria fucocinerea



Acanthaster planci (adult)

Acanthaster planci (juvenile)

Culcita novaeguineae

Oreasteridae