

A Survey of Coral Disease Prevalence in Marine Protected Areas and Fished Reefs of the Central Visayas, Philippines, 2006



Laurie J. Raymundo, Aileen P. Maypa, Kathryn B. Rosell,
Pablina L. Cadiz, and Pablo T. Rojas, Jr.

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A Report to the Municipalities of Negros Oriental, Cebu and Bohol, local *Bantay Dagat* groups, Coastal Conservation & Education Foundation, Inc., and Silliman University-Angelo King Center for Research and Environmental Management

Submitted by:

Laurie J. Raymundo¹, Aileen P. Maypa², Kathryn B. Rosell³,
Pablina L. Cadiz⁴, and Pablo T. Rojas, Jr. ^{1,2}

¹University of Guam Marine Laboratory, Mangilao, GU 96923, ²Coastal Conservation and Education Foundation, Inc., Banilad, Cebu City, Cebu 6000, ³Silliman University Biology Department, Dumaguete City, Negros Oriental 6200, ⁴Silliman University-Angelo King Center for Research and Environmental Management, Bantayan Beach, Dumaguete City, Negros Oriental 6200

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Introduction

This survey was designed to test the hypothesis that coral reefs protected from fishing and other harvesting activities would show lower disease prevalence than those which are similar in structure but are harvested. This idea relates to the concept that marine protected areas (MPAs), when well-managed, have more complete communities, and may be healthier due to fewer impacts from human activities. The Central Philippines was selected for this study, due to the presence of numerous MPAs with well-documented management histories, as well as the presence of reefs in close proximity to the MPAs which showed a range of fishing pressure from light to severe.

Surveys were accomplished between May 21 and June 16, 2006. A total of 12 MPAs and 12 fished reefs were surveyed (see Figure 1) by a team of five divers, with L. J. Raymundo as Principal Investigator. A. Maypa accomplished fish visual census, L. Raymundo and K. Rosell accomplished coral disease and taxonomic surveys, P. Cadiz completed benthic composition surveys, and P. Rojas collected data quantifying disease severity. This report summarizes preliminary data, and provides descriptions of each site visited, the diseases observed, and total disease prevalence.

Survey Methods

At each selected site, three 20m x 2m belt transects were laid along the reef crest, or in the area of highest coral cover. The Line Intercept Transect method was used to quantify and describe benthic composition. All coral colonies within the 2m belt on either side of the transect were counted and identified to genus. All diseased colonies were field diagnosed, using a hand-held magnifying lens when necessary, counted, and sampled if diagnoses were unclear. These samples were placed in bags with fresh seawater, and taken to land, where they were further examined with a field dissecting microscope. Other categories used in determining coral health included: predation (predators were identified and counted), bleaching, and compromised health (i.e., when coral colonies were clearly not healthy, but where no specific diagnosis of cause could be made). In addition, severity of one disease, *Porites* Ulcerative White Spot Disease (PUWS), was quantified per reef, by determining the density of lesions on five colonies per transect.

The fish community was assessed using the underwater Fish Visual Census technique on three 50m x 10m belt transects per reef. All fish were counted, identified to species, and sizes of known target species were estimated. Additional descriptive data on each surveyed reef are currently being collected, which will assist in our assessment of the level of management and human impacts each reef receives. These data include: distance to nearest population center, population size,

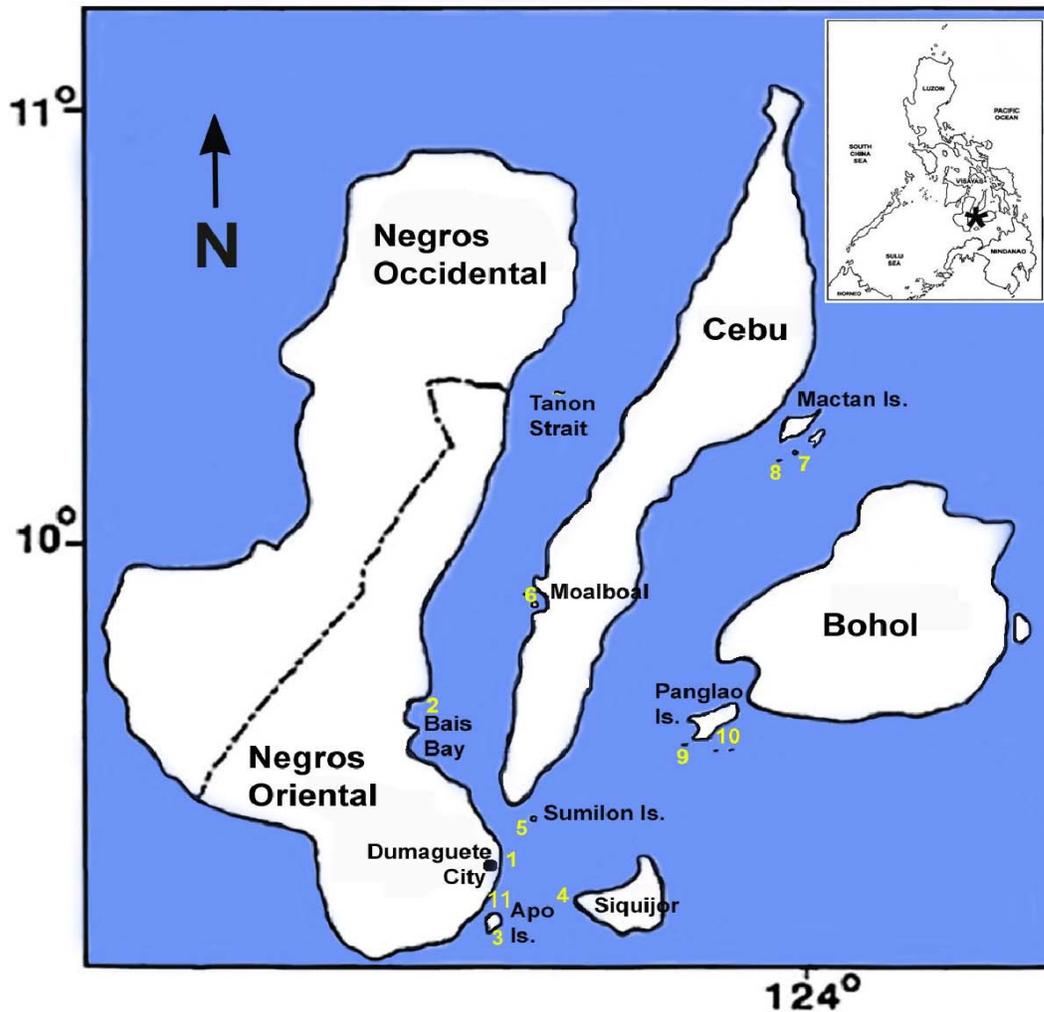


Figure 1. Map of the Central Visayas, showing survey sites, in yellow numbers. 1: Bantayan reef and Agan-an MPA; 2: North Bais Bay; 3: Apo Island MPA and Can-uran, Apo; 4: Cang-alwang, Siquijor; 5: Sumilon Island; 6: Basdiot, Saavedra and Zaragosa MPAs; 7: Hilutungan MPA; 8: Nalusu-an MPA; 9: Balicasag MPA; 10: Calipayan, Panglao Island; and 11: Poblacion MPA, Masaplod Norte MPA, and Masaplod Sur MPA.

size of fisher population, number of years of protection of MPAs, size of the MPA, frequency of known poaching incidents, density of tourists visiting the site, and any other obvious impacts (such as proximity to known point sources of pollution). These data will be analyzed using multiple regression statistics, to determine which of the factors we obtained information for have direct associations (either positive or negative) with disease prevalence and overall coral health (including compromised health and predation).

Preliminary Results

This report will present a brief description of each site visited, a list of all diseases and predators seen, and a preliminary calculation of disease prevalence. Other data are still being transcribed and collated, and the overall analysis will be presented in a peer-reviewed publication. Table 1 presents descriptions of all health impacts observed during our surveys; these descriptions will be referred to in the discussions below. Figure 2A presents photographs of each disease we observed, while Figure 2B presents examples of other categories of ill-health (predation and compromised health).

Table 1. Summary of categories of poor health in corals observed in 2006 Central Visayas surveys

Diseased States	Descriptions
<i>Porites</i> Ulcerative White Spot Disease	discrete, focused white lesions, ~5mm diameter. Affects mostly <i>Porites</i> , but other genera appear to have developed infections as well.
Growth Anomalies (i.e., tumors)	hyperplasias or neoplasias; unusual skeletal deposition, may be accompanied by different pigmentation, disorganized corallites, few zooxanthellae
Black Band Disease	black to reddish filamentous band between dead skeleton and healthy tissue. Band contains cyanobacteria, is fairly dense, may contain mobile ciliates
Skeletal Eroding Band	concentrations of boring ciliates, may be scattered throughout dead skeleton, or concentrated in a cluster or band near border of living tissue
White Syndrome	irregular patches of recently-killed, exposed skeleton. Border with living tissue may be necrotic, with mucous secretion. No obvious predators in immediate vicinity
Brown Band Disease	on branching <i>Acropora</i> ; newly-exposed skeleton bordered by brownish band (which may be diffuse in some cases). Band contains mobile ciliates
<i>Drupella cornus</i> gastropod predation	recently killed, exposed skeleton, with clear, finite edge between skeleton and living tissue. Shells usually visible, predated border may be scalloped.
<i>Corallophyllia violacea</i> gastropod predation	shells visible, and tightly attached to coral; only seen on <i>Porites</i> spp. Shells don't migrate, but leave a white lesion with an irregular edge, same diameter as shell. Usually in cracks or crevices on colonies.
<i>Acanthaster planci</i> starfish predation	presence of individuals in the area; usually underneath coral heads during the day. Large areas of newly exposed skeleton, no scalloping, no necrosis; sharp edge between healthy tissue and dead skeleton
overgrowth	algae, sponges (<i>Terpios</i>), ascidians--overgrowing living coral, leaving dead skeleton underneath. Some algae cause loss of color, but not outright death
compromised health	ill-defined signs of poor health, with no specific disease diagnosable: pale coloration, old lesions of unknown cause, pigmentation response (<i>Porites</i>), patchy bleaching, patchy necrosis

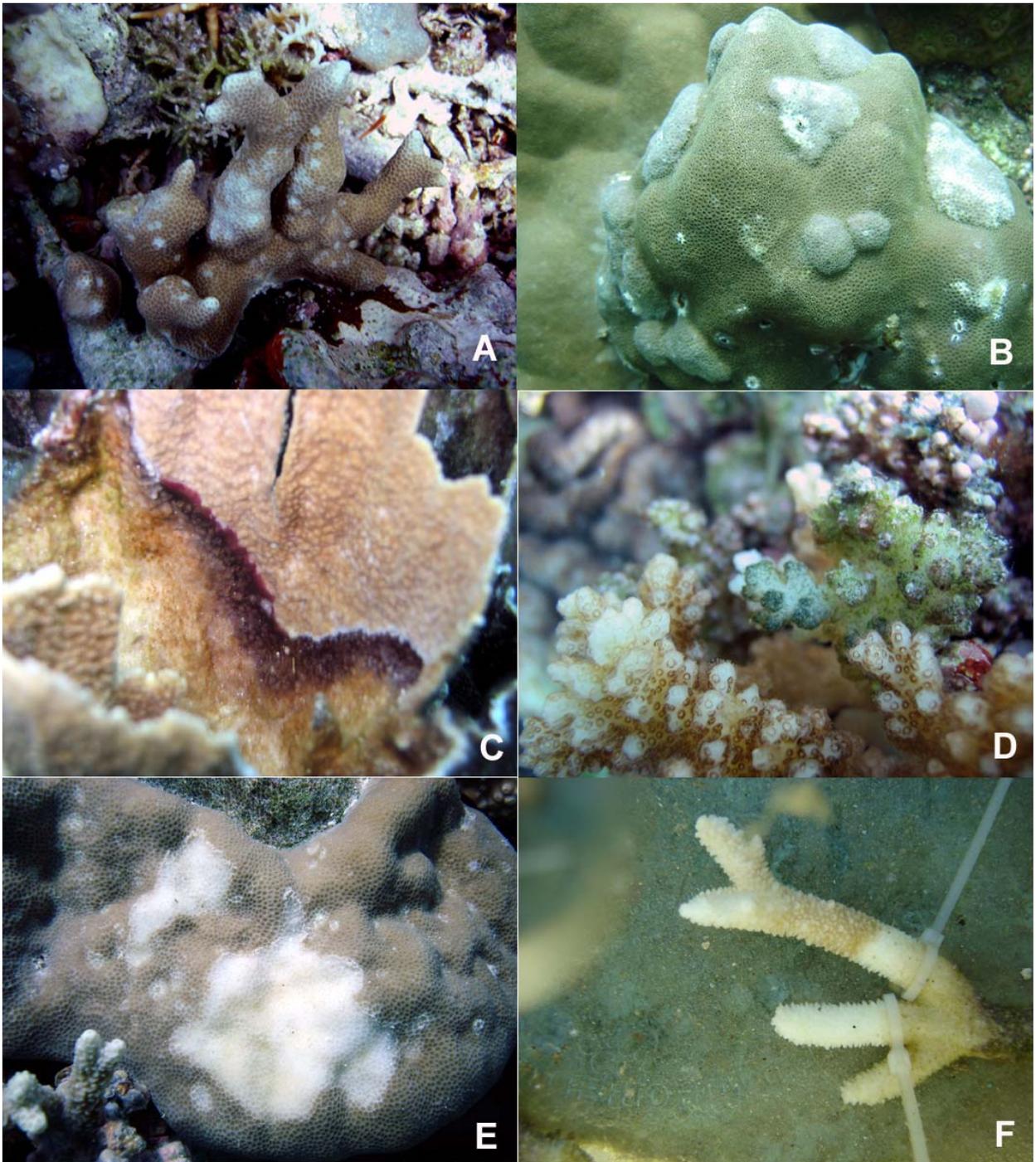


Figure 2A. Diseases observed on 2006 Central Visayas surveys. A=*Porites* Ulcerative White Spot Disease; B=Growth anomaly (i.e., tumor); C=Black Band Disease; D=Skeletal Eroding Band Disease; E=White Syndrome; and F=Brown Band Disease.

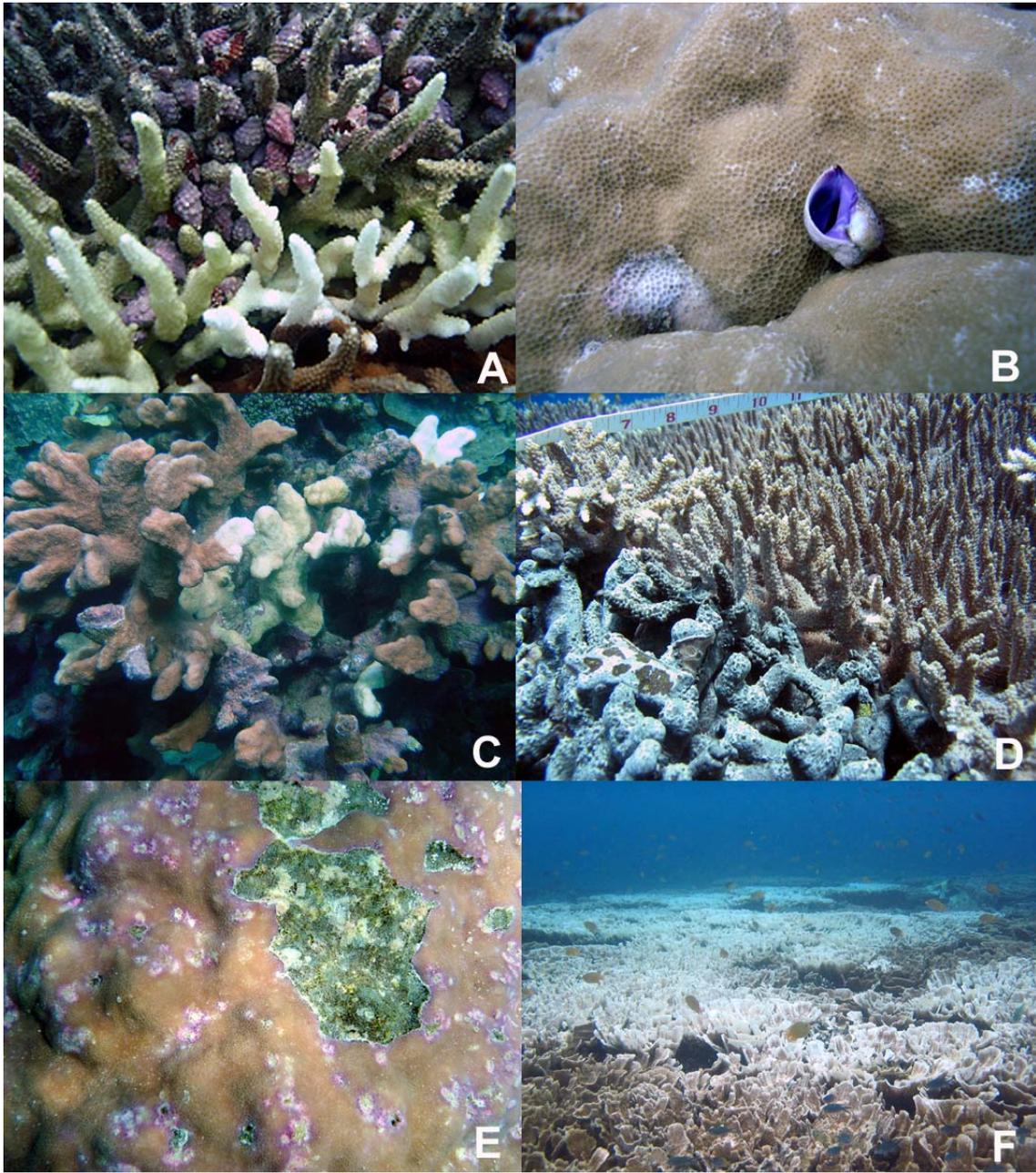


Figure 2B. Examples of other impacts to corals observed during 2006 Central Visayas surveys. A=*Drupella* predation; B=*Corallophyllia* predation; C=*Acanthaster planci* (Crown-of-Thorns starfish) predation; D=*Terpios* sponge overgrowth; E=pigmentation response and lesions of unknown origin; and F=coral patchy bleaching

Dumaguete City, Negros Oriental: Bantayan Reef and Agan-an Marine Protected Area

These nearshore reefs are located slightly to the north of the city of Dumaguete (population ~100,000; 2000 census). Our sampling sites were located in adjacent sections within a contiguous band of fringe reef that begins slightly to the north of the Agan-an MPA and continues southward toward the city pier. Reefs show patchy coral cover, interspersed with sand and seagrass (live hard coral cover: 28% in Agan-an and 45% in Bantayan reef). No reef crest exists; rather, the reef slopes gently to an extensive seagrass bed. Evidence of good management is seen in the abundance of target species within the Agan-an MPA. Both reefs are highly impacted by untreated sewage, siltation, and agricultural runoff from this city. In addition, fishing pressure is intense, as population growth in the city is high. Both reefs are impacted by Crown-of-Thorns starfish and the gastropod predator *Drupella* (Figure 3). In addition, PUWS, growth anomalies and White Syndrome were observed. Total disease prevalence for these reefs was calculated as 7.7% for Agan-an MPA and 7.9% for Bantayan reef.



Figure 3. A *Drupella* infestation on a large *Porites* colony, Bantayan Reef.
(Photo: L. Raymundo)

Cang-alwang reef, Siquijor

This reef, located at the southwestern tip of Siquijor, consists of a very wide reef flat (>2km, extending from shore), which ends in a steep wall. Currents around this wall can be strong. Coral cover is patchy within the reef flat (live hard coral

cover: 28.8%), becoming denser toward the crest. Fishing pressure is intense, and there is no MPA in this area. The reef was fished using dynamite in the past, but it has, apparently, been stopped. There is no large population center nearby, though the reef may be slightly impacted by agricultural runoff. Two diseases, PUWS (Figure 4) and White Syndrome, were seen on this reef, but very few incidents of predation were observed. Total disease prevalence was 4.6%.



Figure 4. *Porites* Ulcerative White Spot disease on a massive *Porites* colony along the reef crest of Cang-alwang reef. (Photo: L. Raymundo)

Bais Bay, Negros Oriental

Bais Bay is a large bay into which five rivers drain, facing the Tañon Strait. These rivers flow through extensive agricultural land and a medium-sized city, Bais City (population: 68,000; 2000 census). The barrier reef enclosing the bay, therefore, receives agricultural and sewage runoff, and is heavily fished. Coral cover is high on the outer slope and crest (50.9%), though standing dead coral colonies are abundant. Diseases observed included: White Syndrome, Black Band Disease, Skeletal Eroding Band (Figure 5), Growth anomalies, and PUWS. In addition,

Drupella predation is evident and can be very dense on certain host colonies. Total disease prevalence was 10.84%.

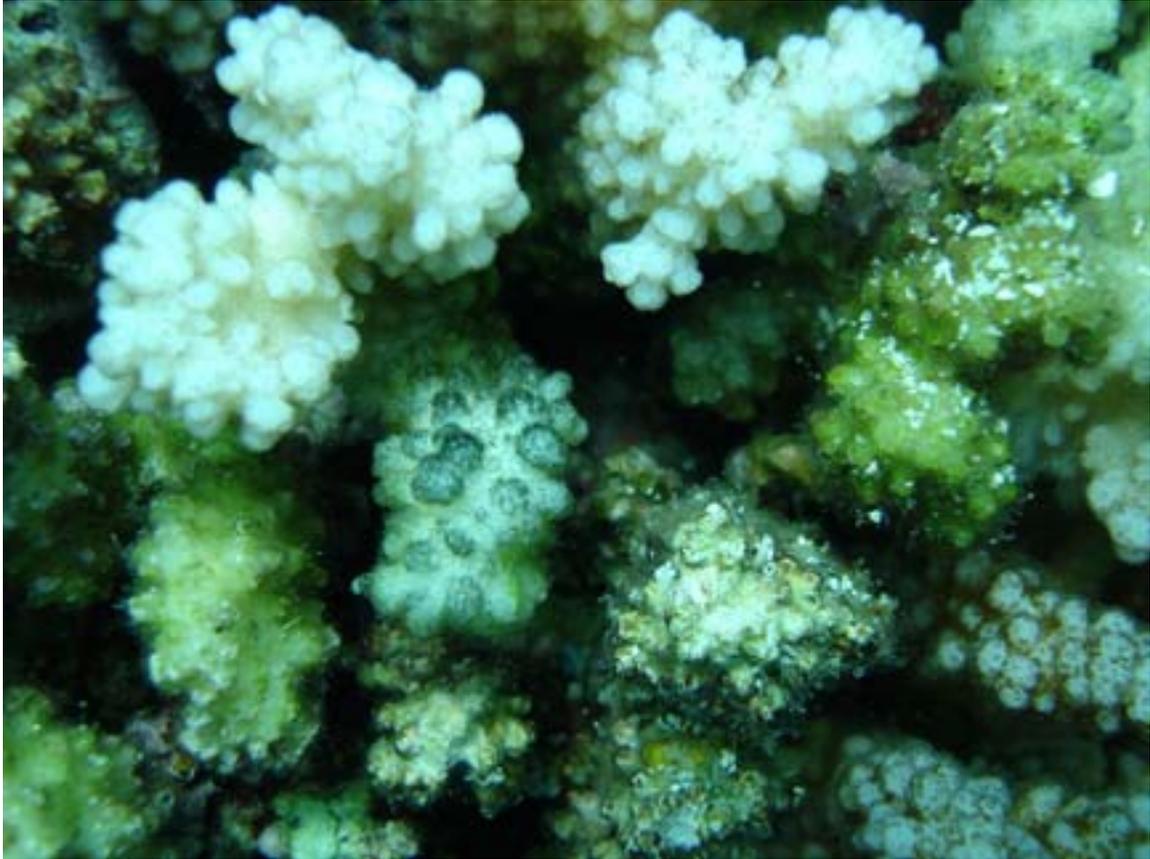


Figure 5. Skeletal Eroding Band affecting a colony of *Pocillopora verrucosa* in Bais Bay.
(Photo: K. B. Rosell)

Dauin, Negros Oriental: Poblacion Marine Protected Area, Masaplod Norte Marine Protected Area and Masaplod Sur Marine Protected Area

The municipality of Dauin, Negros Oriental is one of the best-managed reef systems in the region. Reefs in this area are small and patchy; sand flats and seagrass beds dominate the substrate. Therefore, most patch reefs are fully enclosed within marine reserves, and are surrounded by extensive sandy areas. Three MPAs were surveyed: Poblacion, Masaplod Norte and Masaplod Sur. Coral cover within these MPAs is limited to small patches, though cover is high within these patches (live hard coral cover: 79.35%; 41.9%, 49.2%, Poblacion, Masaplod Norte, and Masaplod Sur, respectively). All three are frequented by tourist divers, though diver density is controlled. No-take rules appear to be strictly enforced, though a fish trap was observed within the Masaplod Norte MPA, adjacent to a patch reef

(Figure 6). Diseases observed were: growth anomalies, White Syndrome and PUWS. Few incidents of predation were documented. Total disease prevalence was 6.2%, 0.5%, and 4.7% for Poblacion, Masaplod Norte, and Masaplod Sur, respectively. Masaplod Norte exhibited one of the lowest levels of disease prevalence observed on our surveys.



Figure 6. An abandoned fish trap observed within the Masaplod Norte MPA.
(Photo: L. Raymundo)

Apo Island, Dauin Municipality, Negros Oriental

The Apo Island reef consists of a dense fringing reef surrounding the island. The reef flat is generally narrow, with dense coral cover that increases toward the crest, followed by a steep slope or drop-off. We surveyed within the MPA (live hard coral cover: 40%) and on the Can-uran reef, adjacent to the MPA (live hard coral cover: 72%). Fishing is allowed on the Can-uran reef, though fisher density is limited to inhabitants of the island (population: 700; 2000 census) and non-destructive fishing methods. Tourism diving takes place on most reefs around the island; this poses the greatest impact to reef damage, and though the number of divers allowed per day is controlled, the MPA receives one of the highest densities of tourist divers per day in the province. Few other impacts are present: the

community is located away from the MPA, there is no freshwater input onto the reef, and little agriculture. Diseases observed included: Black Band Disease, PUWS, Skeletal Eroding Band, and growth anomalies. It is interesting to note, however, that a suspected outbreak of Black Band Disease was beginning within the Apo

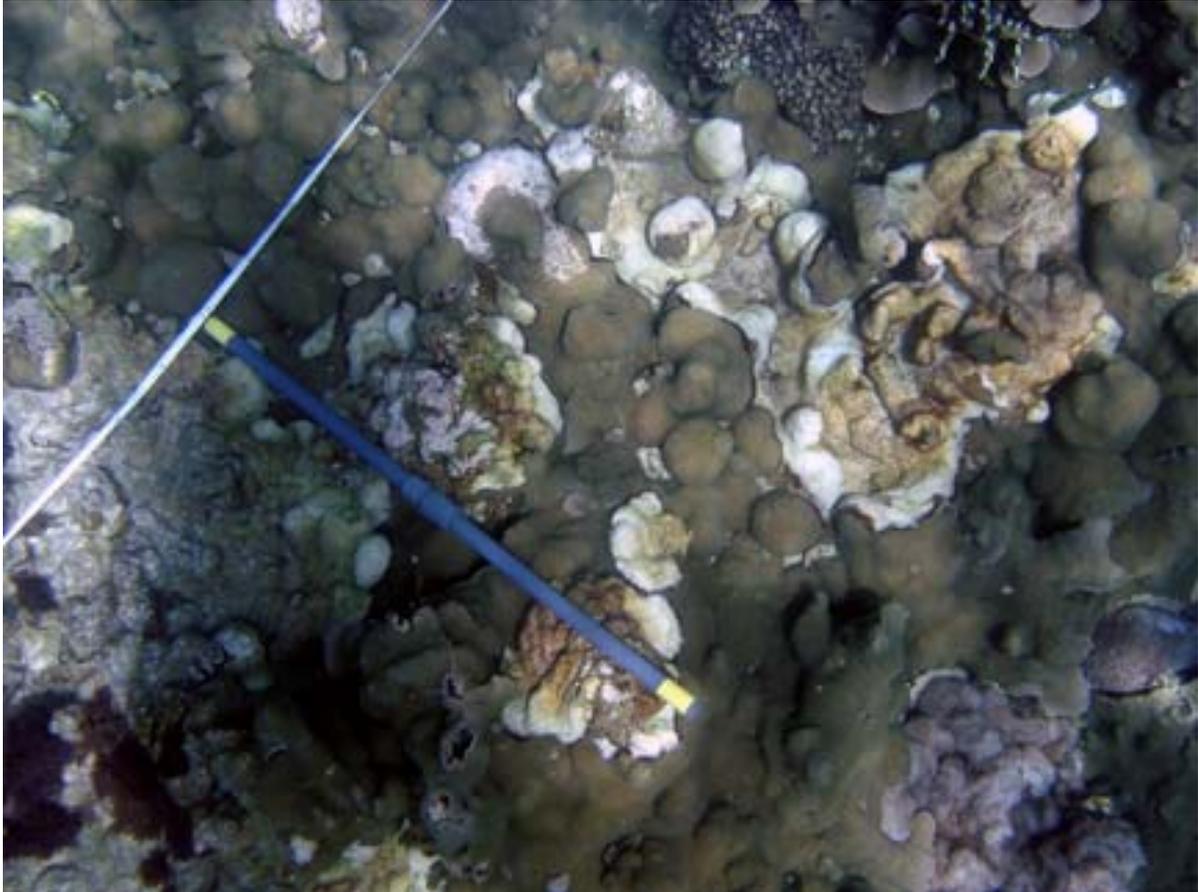


Figure 7. A colony of the coral *Echinopora lamellosa* showing several progressing fronts of Black Band Disease, within the Apo Island MPA. The spread of this disease is currently being monitored. (Photo: L. Raymundo)

MPA on *Echinopora lamellosa* (Figure 7). This outbreak is currently being monitored, for its rate of spread to adjacent colonies. A few incidents of *Drupella* predation were noted. Disease prevalence continues to be low within the MPA (3.1%), and was slightly higher on Can-uran reef (5.6%).

Moalboal, Cebu: Saavedra Marine Protected Area and Basdiot Marine Protected Area

The Saavedra reef is a fringing reef in good condition and contains a well-managed MPA. Surveys were completed within the MPA, and immediately outside its boundaries, in the adjacent fished reef. Coral cover is high in both areas (live

hard coral cover: 75% within the MPA; 60% outside the MPA), and density and body sizes of target fish species were noticeably higher within the MPA, indicating minimal to no poaching. The reef appeared to be far from significant sources of pollution, and tourist diving appeared to be moderate. At a slightly deeper depth than that where our transects were laid, Crown-of-Thorns starfish populations had caused some damage to *Acropora* table corals (Figure 8). Diseases observed were: PUWS, Brown Band, growth anomalies, Skeletal Eroding Band, White Syndrome and Black Band. Disease prevalence was lower inside the MPA (3.8%) than outside (7.8%).

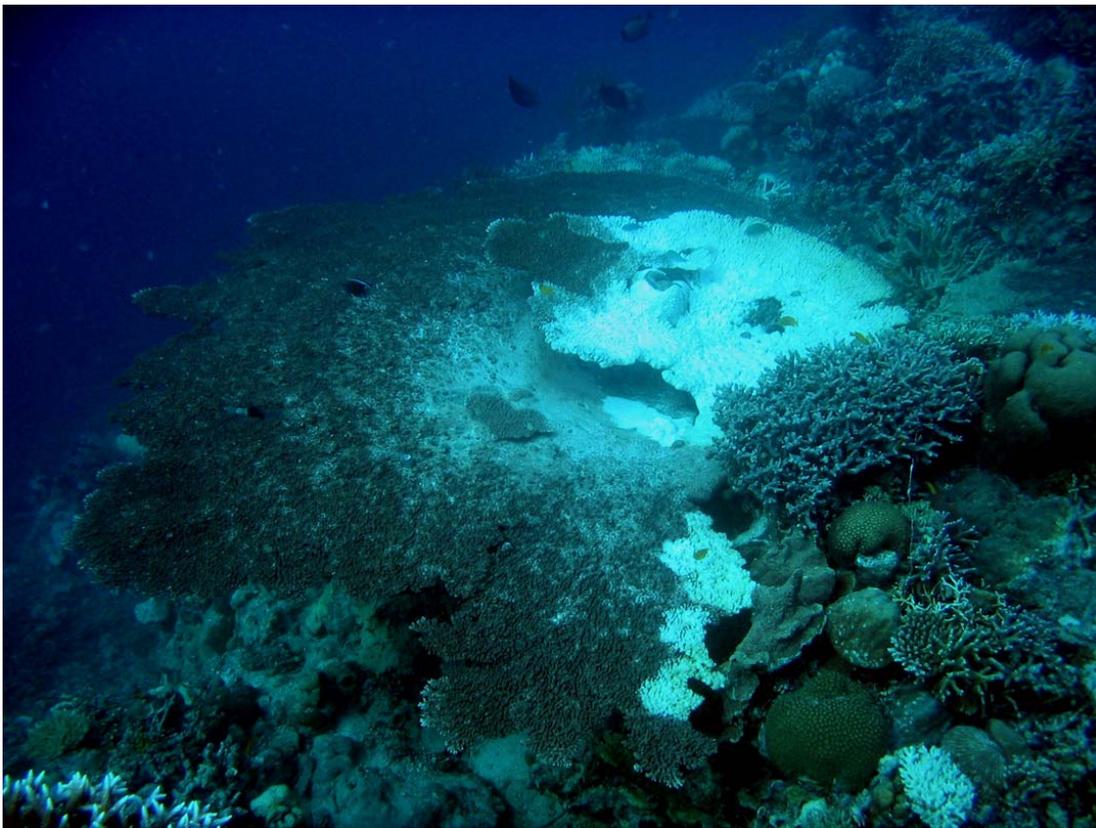


Figure 8. Predation by Crown-of-Thorns starfish on a table *Acropora*, Saavedra Marine Protected Area. (Photo: K.B. Rosell)

Basdiot MPA is a much smaller protected area than that of Saavedra, and target fish density and body sizes suggested that some poaching may occur. Tourist diving appears to be moderate, and no land-based pollution sources were apparent. Surveys were accomplished within the MPA, and immediately adjacent to it. Coral cover is high (data are still being collated; Figure 9). *Drupella* was present in very high densities, though patchily distributed. Diseases present were: Black Band, Brown Band, PUWS and White Syndrome. Total disease prevalence was 2.75% within the MPA and was slightly higher outside: 5.8%.



Figure 9. High hard coral cover within the Basdiot Marine Protected Area. (Photo: K.B. Rosell)

Badian, Cebu: Zaragosa Marine Protected Area

The Zaragosa MPA and adjacent reef is a fringing reef surrounding the island of Zaragosa, a small island off the town of Badian, Cebu. Coral cover is patchy within the reef flat, becoming denser toward the reef crest, and dropping steeply after the crest. The reef does not appear to receive any direct land-based pollution, and is not located near a population center. Surveys were done both within the MPA and within the adjacent fished reef. Although the PO managing the reef was very proactive and visible, target fish densities and body sizes indicated that poaching occurs, probably at night, since the PO did not appear to be aware of this. Tourist diving was forbidden within the reserve. Coral cover was very high along the crest where our transects were laid (live hard coral cover: 73.9% inside the MPA and 64.9%, outside). Diseases included White Syndrome, PUWS, Skeletal Eroding Band, and growth anomalies. *Drupella* were also present, though in low densities. Total disease prevalence was very low: 1.7% within the MPA and 3.0% outside the MPA.

Gilutungan Marine Protected Area, Eastern Cebu

Gilutungan Island is a small island off the eastern coast of Cebu, several kilometers from the island of Mactan. It is a popular tourist destination, and receives a large number of divers and snorkelers on a daily basis. The reef consists of a wide seagrass bed with patch reefs, and coral density increases toward the reef crest. Although tourists are not allowed within the MPA, boats tie up to anchor buoys along the reef crest, and this area receives heavy use. There did not appear to be other significant sources of impacts, though the area may receive pollutants from nearby Cebu City (population 719,000; 2000 census), depending on current patterns. The PO managing the MPA was well-organized and proactive, and this showed in the good condition of the reef and target fish species, as compared to conditions immediately adjacent to the MPA. Live coral cover within the MPA was 64% (Figure 10); outside it was 11%. Diseases present included White Syndrome, Black Band Disease, PUWS, and Skeletal Eroding Band, and total disease prevalence was very low: 0.4% both inside and outside the MPA.



Figure 10. High coral cover and abundant fish within the Gilutungan MPA. (Photo: K.B. Rosell)

Nalusu-an Marine Protected Area, Eastern Cebu

Nalusu-an Marine Protected Area is located within the fringing reef surrounding Nalusu-an Island, off the eastern coast of Cebu, and south of Gilutungan. The reef flat is wide, with patchy coral cover, sloping gently to depth. Coral is healthy (38% live hard coral cover; Figure 11), and fish are abundant. There is some apparent controversy regarding the management of this MPA; it is currently managed by a resort on the island, and the local fishing community has not been given the opportunity to be involved in management. The MPA appeared to be receiving adequate protection from harvesting, though inputs of waste and other pollutants from the island's resort are unknown. In addition, the resort maintains captive sea turtles, which is against the law; these animals are protected by CITES and should be returned to the wild. Diseases observed included: Skeletal Eroding Band and grown anomalies, and overall disease prevalence was very low: 0.72%.

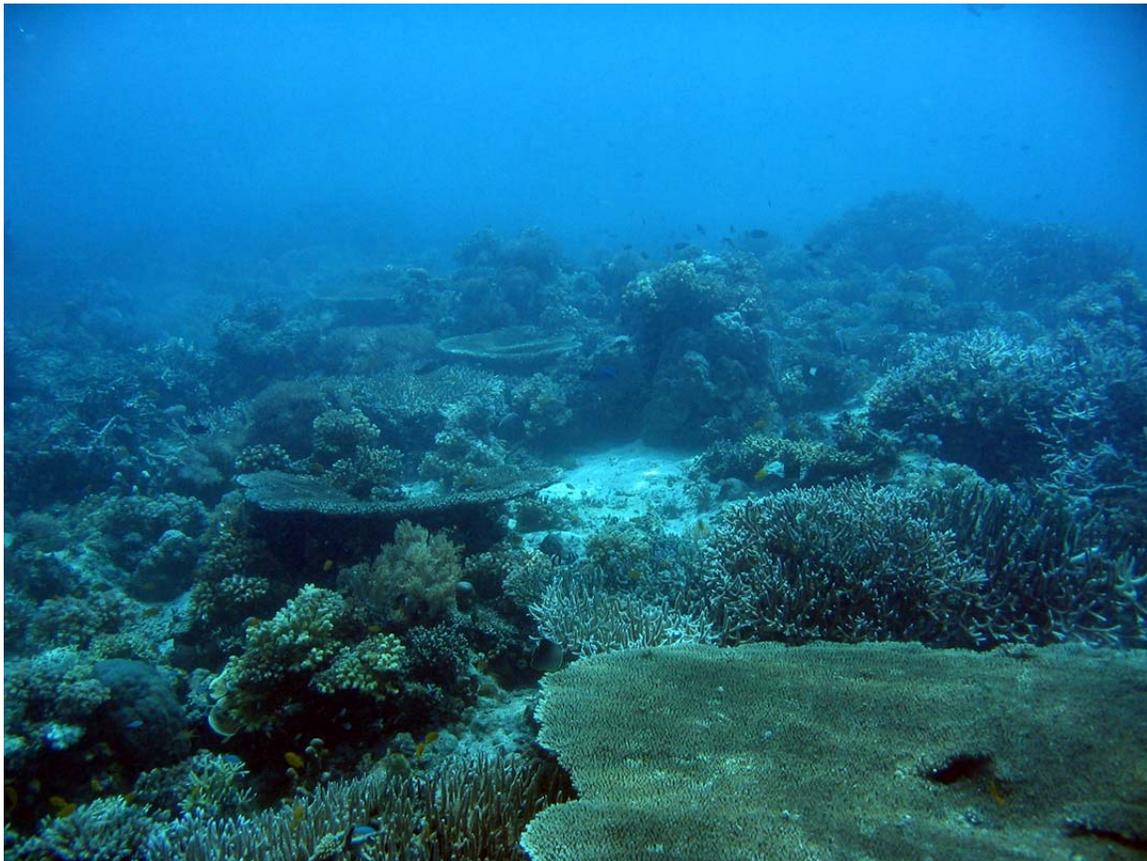


Figure 11. Abundant and diverse coral cover within the Nalusu-an MPA. (Photo: K.B. Rosell)

Balicasag Is. Marine Protected Area, Southwestern Bohol

Balicasag Island lies off the larger island of Panglao, off the southwestern corner of Bohol. Both Balicasag and Panglao have been developed for tourism, and receive large numbers of tourists daily. We surveyed both within the Balicasag MPA and immediately outside, along the adjacent fished portion of the reef. The Balicasag reef is known for its steep wall, and coral cover on the reef itself is very sparse and patchy (live hard coral cover: 11% inside the MPA; 25% outside). This may be partially due to a previous infestation with the coral-killing sponge *Terpios* (Figure 12) several years prior to our surveys; evidence of past coral mortality was visible in standing dead coral skeletons, and *Terpios* was still present at slightly deeper depths. Disease counts were few, and limited to PUWS and Skeletal Eroding Band; prevalence was the lowest in our surveys: 0.24% inside the MPA and 0.27% outside.

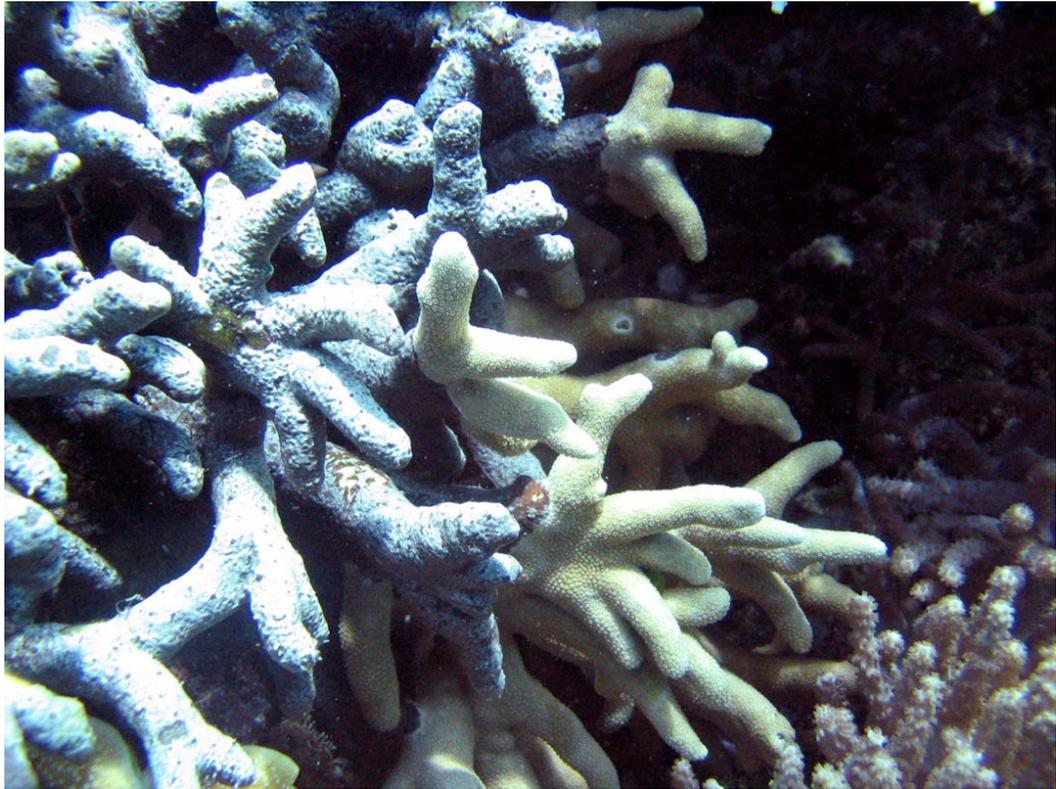


Figure 12. The coral-killing sponge, *Terpios*, overgrowth healthy tissue of the coral *Porites cylindrica*. (Photo: K.B. Rosell)

Kalipayan Reef, Panglao Island, Bohol

This is a fringing reef off the island of Panglao, southwestern Bohol. The reef flat was wide, with patchy coral and a distinct reef crest shoreward of a steep drop-off. The reef appeared to have been severely damaged in the recent past, possibly by coral predators and *Terpios*; there was a high percentage of dead standing coral and rubble, and low live coral (19%). Diseases present included PUWS, Skeletal Eroding Band and White Syndrome, and *Drupella* infestations were also present. Disease prevalence, however, was quite low: 1.29%.

Summary

This report provides preliminary information on the status of disease prevalence in the Central Visayas region. In general, marine protected areas showed lower disease prevalence, as well lower prevalence of compromised health. However, whether this difference is statistically significant remains to be tested (see Figure 13). In addition, reefs closest to larger population centers appeared to be more impacted by disease and predation, though, again, this requires further data analysis.

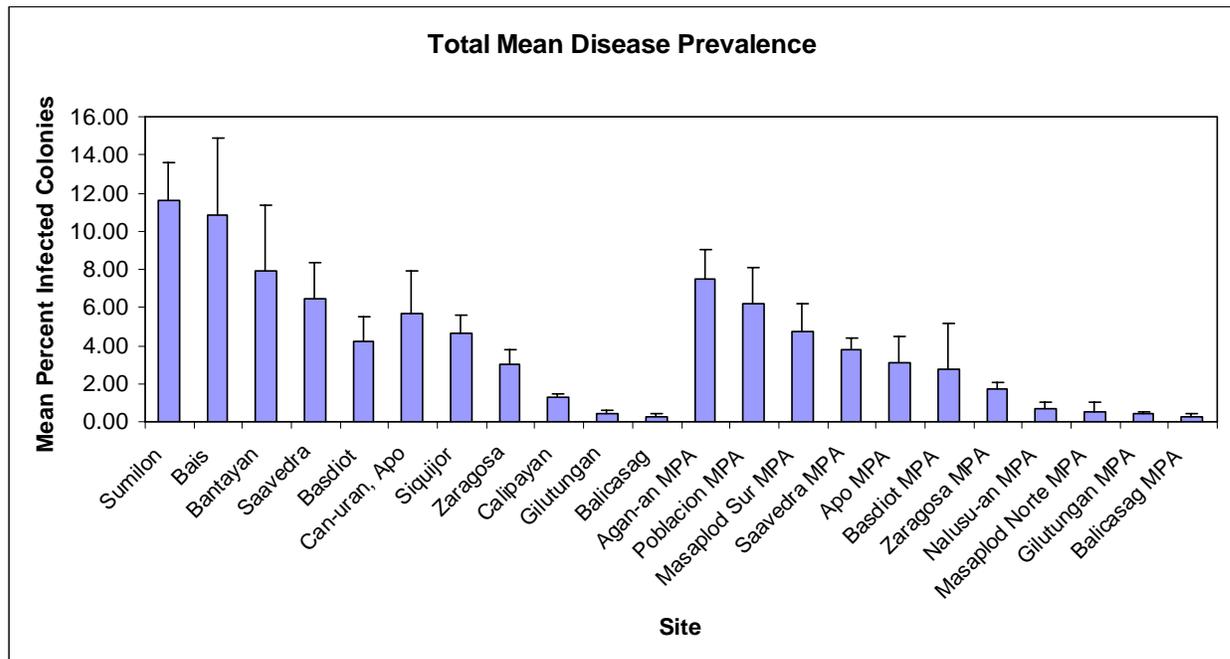


Figure 13. Preliminary estimates of total disease prevalence per site, Central Visayas 2006 surveys.

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