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Status of Benthos and Reef Fish Communities in Pujada Bay, Davao Oriental, Mindanao

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Abstract

Coral reef resources, particularly corals, macrobenthos and reef fish in Pujada Bay in the southeastern coast of Mindanao were assessed in 2002 to determine their status. A one-shot standard survey methods of corals and their associate fish was conducted in the reef sites of Guang-guang, Manguihay, Lawigan, Mamali and Macambol. Soft-bottom macrobenthos in these reef sites were monitored for one year. Hard coral cover in Pujada Bay was in a poor to fair category. Reef fish had low diversity and indicator species were low in abundance - the conditions indicative of a degraded reef. Reef fishes were dominated by low-valued species and high-value species had low incidence - a profile symptomatic of overfishing. The preponderance of herbivore fish species in some reef areas bespeaks of the important role of vegetation in supporting the productivity of the reef. The reef sites supported a diverse group of macrobenthos largely, mollusks. Reefs in Macambol showed a good coral-reef fish condition while that in Mamali was in a poor state. Despite the latter, the reef supported a good number of macrobenthos and reef fish. Protective, enhancement and rehabilitation activities are needed to stop if not reverse the dismal situation of the Bay. Good management of land-based activities must also be pursued alongside reef ecosystem management.

Keywords: benthos communities, reef fishes, status of reef resources, puja bay

Introduction

Coral reef is among the world's most important ecosystems because it performs a wide range of function, providing home, feeding and nursery ground to countless sea life, and sheltering land from storms and erosion. It also provides food, aesthetic pleasure, recreation, minerals and medicine through the resources it harbors (ENR Atlas of the Philippines, 1998). By preying others and being preyed upon, coral reef organisms help in the transfer of energy within the system and keep in check other population, hence maintaining the system's stability and functionality. Some mollusks, crustaceans, annelids, and echinoderms, by their consumption of dead organic matter, help recycle the nutrients back into the system (Gomez and Chavez, 1987; Vincx and

Coomans, 1998).

Coral reef occupies only an estimated 1% of the earth's surface, yet it gives a significant contribution to the economic stability and upliftment to the social condition of human populace. In the Philippines, coral reef occupies around 10% of the country's total land area (Gomez et al., 1994) yet contributes around $6,000/ha/year of goods and services (Costanza, 1997 as cited by Hilomen, 1998) and around 10-15% of total fisheries catch (Alcala and Russ, in press). In Southeast Asia, 90% of its five million people employed in fisheries consist of small-scale fishers whose traditional fishing methods confined them to coral reef areas. It is also a favorite tourist destination giving additional income to the area. Records in 1993 from marine protected areas in the Caribbean earned US $8.9 billion and employed 350,000 people. Phuket, Thailand earned from tourism revenues US $167.5 million in 1989 and US $847.5 million in 1995. Apo and Balicasag Islands in Central Philippines have annual incomes of about US $100,000 from the same venture (Alcala and Russ, in press). Some coral reef resources are exploited for their omamental value. Among such are mollusks that formed an important basis for cottage industries; mollusk and echinoderms have been exploited as well for their medicinal importance (Gomez and Chavez, 1987; Schoppe, 2000).

In Mati, around 70% of the municipality's population largely depends on the resources of the sea (CEP Primer, undated). Pujada Bay is the more important source of income for the local populace. It does not only provide fishing ground but also utilized for recreation, research, education as well as for tourism activities.

The great value derived from coral reefs is also the very reason of their present degraded status. Coral reefs in Southeast Asia are the most threatened and all Philippine reefs are considered "hotspots" (Silvoza, 1998). Pujada Bay, like other coastal areas have been subjected to human intervention. Accounts of some local fisherfolks revealed that local extinctions of some resources are occurring. Data from some previously conducted studies already indicated a declining status of resources and degraded habitats. Despite their continuous removal, most of the resources in the area are largely not documented.

This research was conducted with the purpose of documenting and gathering data, some of which are benchmark information, on the reef resources of Pujada Bay. This information, in addition to other previously gathered information, provides a more refined picture of what resources are present and what their status is. Such information can help authorities come up with intelligent decision on what action to take in their management. If properly managed, they may be sustained and their productivity enhanced.

The research was conducted with the purpose of determining the current status of the coral reef resources in Pujada Bay. Particularly, it aimed to:

1. Determine the coral cover and the substrate composition of coral reef in the

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area;

2. Determine the spatial distribution and abundance of soft-bottom macrobenthos in the reefs of Pujada Bay; and

3. Identify the composition, spatial distribution and abundance of reef fishes in the area.

Materials and Methods

Study Area and Sampling Sites

Pujada Bay is located in the southeast part of Mindanao, between 6 048’04” and 6 0 54’25” N latitude and between 12609’08” and 126 0 19’33” E longitude. It is a U-shaped Bay with its mouth opening south-southeast facing the Pacific Ocean (Fig. 1). It has an area of about 168 km^2 and is under the jurisdiction of Mati, Davao Oriental.

Within the Bay’s reefs, representative sites were chosen as sampling stations These were the reefs of Lawigan, Manguihay, Guang-guang, Mamali and Macambol.

Assessment of Corals and Reef Fishes

Underwater assessment was conducted on June 30 and July 1 in 2002. Divers from Zamboanga State College of Science and Technology who had ample experience in coral and reef fish assessments were hired to do the work. Line Intercept Transect (LIT) method and Fish Visual Census (FVC) technique were adopted (English et al. 1994).

Reef site with water depth of 3 •m (the shallow site) and 10 m (the deep site) were established in each of the identified sampling stations. At both depths, a 50-m transect line was placed parallel to the reef crest. Following the laying of transect, the diver/observer swam along the line noting fish species, counting their abundance and estimating their lengths along a 5-meter radius. After the FVC, LIT followed employing the same transect line. Another diver/ observer swam along the transect recording the length or distance of each coral lifeform category that falls along the line. Data were scribbled under water on a slate board, which were later transferred to the computer.

Assessment of Soft-Bottom Macrobenthos

Sampling for soft-bottom macrobenthos followed the transect-line quadrat method where along the intertidal zone of each sampling station, three, 100-m transect lines were placed perpendicular to the shoreline. A 1 x 1 rn2 quadrat was placed on both sides at the start (O meter) l middle (50 m), and end (100 m) of the transect line. Sediment within the quadrat up to 10 cm thick was gathered and sieved in situ on a screen with a mesh size of 1 mm (Fig. 2). Screened live organisms were placed in labeled containers with 5% buffered formalin solution. Shells and remains of dead organisms were also collected and placed in labeled containers. Samples were sorted, identified and counted in the laboratory. Specimens were identified using taxonomic keys and picture comparison in the following published materials: Engermann and Hegner (1981), Schoppe (2000), Vincx and Coomans (1998), Sabelli (1980), Nichols and Bartsch (1 945), Sotto and von Cosel (1982) and Abbott and Dance (2000).

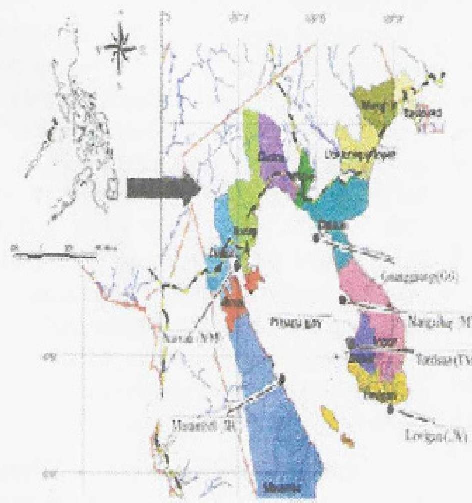

Fig.1 Map of the study area

Fig.2. Sediment collection and sieving

Data Analysis

Coral benthos data were processed by getting the sum of the distances that each coral life form category or each differing substrate composition covers along the transect line. Their percent ratio of coverage was calculated using the formula: % cover = total length of category/length of transect x 100.

Based on the calculation, coral status was categorized as excellent if area was with coral cover of 76%-100%, good if with 51%-75%, fair if with 26%-50%, and poor if with 25% or less coral cover, respectively (English et al., 1994; Uychiaoco et al., 2001).

Abundance and diversity of fish and soft-bottom macrobenthos were calculated using the formula:

RA (%) = no. of individuals of species/total no. of observations x 100

Density (inds/m^2) = no. of observations/area sampled

Shannon Diversity Index (H') = $- \Sigma p_i \ln p_i$ where, p_i = proportion of individuals found in the species

Biomass = aL^b, where, a = multiplicative factor
L = estimated (total) length (cm)
b = exponent (b>1)

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Results and Discussion

Coral Benthos

Coral cover in Pujada Bay ranged from 18.8% to 55.7% in the shallow site and 12.0% to 51.8% in the deep site, corresponding to poor to good condition. Higher coral cover was found in the shallow site of Macambol and the deep site of Guangguang (55.7% and 51. 8%, respectively). Both sites had coral cover corresponding to good coral condition. Areas with poor coral cover were those in Lawigan and Mamali, the former both in shallow and deep sites, the latter in the shallow site. Other sites had fair coral category with a coral cover of 25.4% to 45.3% (Table 1).

The shallow site in Lawigan had a very high percentage (53.9%) of dead corals that were already encrusted with algae. Likewise, Mamali and Manguihay had high percentage of abiotics also in the shallow site (74.4% and 52.9%, respectively). Mamali comprised largely of silty areas, while Manguihay had large sand tracts.

In general, corals in the area were in poor to fair condition. Depauperate areas had patches of young corals and most of the rubbles were seen already covered with algae, suggesting that the generally poor to fair condition of corals was not of recent origin. It is an evidenced of unscrupulous fishing activities long before the survey. A few freshly uprooted corals though were also observed, indicative of anchor damage. Management-wise, the situation can pose a challenge as corals are very slow to grow, and hence, to recolonize degraded areas. A good to excellent coral cover is desirable as corals support high biodiversity and the latter, productivity (Robichaud et al. 2000; Sancho et al., 2000; White, 2001). Management efforts in these sites must thus, be directed at declaring good areas as no fishing zone and rehabilitative activities in degraded reef sites. Further, banning the use of fishing gears and gleaning destructive to the corals must be strictly enforced.

Table 1. Reef substrate cover (%) in Pujada Bay

Substrate Characteristic	Sampling Station									
	Lawigan		Manguihay		Guang-guang		Mamali		Macambol	
	SS	DS	SS	DS	SS	DS	SS	DS	SS	DS
live coral:	19.58	11.98	38.34	45.32	25.36	51.78	18.78	41.06	55.68	42.00
hard coral	18.90	8.14	38.34	45.32	22.26	51.78	18.20	—	55.68	42.00
soft coral	0.68	3.84	—	—	3.10	—	0.58	3.94	—	—
dead coral w/ algae	53.94	13.72	7.54	32.88	35.10	35.86	5.76	5.08	9.40	17.26
sponges	4.56	1.94	—	—	—	3.06	—	0.60	—	1.80
algal assemblage	5.60	3.26	—	—	—	—	1.06	3.78	3.78	4.00
other living orgs.	—	49.46	12.00	—	—	—	—	9.84	21.02	—
Abiotics:	16.32	19.64	52.92	21.80	39.54	9.30	74.40	39.64	10.12	34.94
water	16.32	1.72	—	—	—	—	—	—	—	—
rubble	—	17.92	—	6.20	—	—	34.54	2.10	2.14	—
silt	—	—	—	—	—	—	72.42	28.72	0.20	—
sand	—	—	52.92	15.60	5.00	9.30	1.98	8.82	7.78	34.94

Legend: SS = shallow site; DS = deep site; — = no observation

In Mamali, large tract of the intertidal flat was covered with thick layer of mud and corals grew only along the reef edge.

Further, the water was very turbid. Muddy substrate and turbid water are conditions detrimental to corals. Corals need a relatively hard base to settle (Hodgson and Liebeler, 2002; King, 2007) and clear water for sunlight to penetrate through. Light is needed by the photosynthetic zooxanthel/ae that live in coral tissues that support and drive coral growth (Uychiaoco et al., 2001; King, 2007). To address the high silt deposition, enhancing vegetative cover in the surrounding landmass must be aggressively taken. Vegetation holds the soil from eroding into the low-lying coast. Further, massive planting of mangrove should be done as mangrove root system traps terrigenous materials, holding these from being exported to reef areas (King, 2007). In fact, planting of mangrove should be done all along the coasts Of Balite and Pujada Bays.

Macrobenthos

Four macrobenthos groups in four phyla were found in Pujada Bay. These were: the mollusks (Mollusca), polychaetes (Annelida), echinoderms (Echinodermata), and crustaceans (Arthropoda). All major macrobenthos groups were found in four sampling stations, except in Mamali having had only mollusks.

The mollusks comprised the greatest number of macrobenthos collected (Fig. 3). The mollusks were primarily shelled and included the gastropod, bivalve, scaphopod (tusk/tooth shell) and the polyplacophod_ Seventy-three genera of mollusk under 51 families were found. Within the mollusk group, the bivalves were most abundant (Fig. 4). Echinoderms included the sea stars, brittle stars, heart urchins, sand dollars and sea cucumbers. The annelids found were primarily polychaetes while the arthropods found included crabs, shrimps and beach n ea.

Lawigan, Manguihay and Guang-guang had comparably higher macrobenthos abundance. Wnile Mamali station was least in abundance, it had the densest macrobenthos population of 10.9 ind/m2. Shannon’s Diversity Index showed that though all sampling stations had high species diversity, Mamali had relatively lowest diversity value (Table 2). Except in Mamali, the Bay’s profile showed that its reefs harbor a good at Tay of macrobenthos particularly shellfishes. In Mamali, the anoxic condition of the muddy/ silty substratum-imposed limitation to their existence (Vlncx and Coomans, 1998).

Hence, the observed lower abundance and diversity. Their high density is indicative of an extreme condition. When populations are exposed to extremes of situation, one or a few species that can tolerate or most suited to the condition can monopolize and thus, dominate the area (Ray & Grassle, 1991).

Macrobenthos is important in the maintenance of ecosystem function. Many species of mollusks, echinoderms and crustaceans have been exploited by local residents for food and as source of income. Thus, it is important that these be sustained in a healthy state. Factors contributory to siltation (soil from denudation of vegetative cover, "development" in the surrounding land, etc.) in Mamali must be addressed.

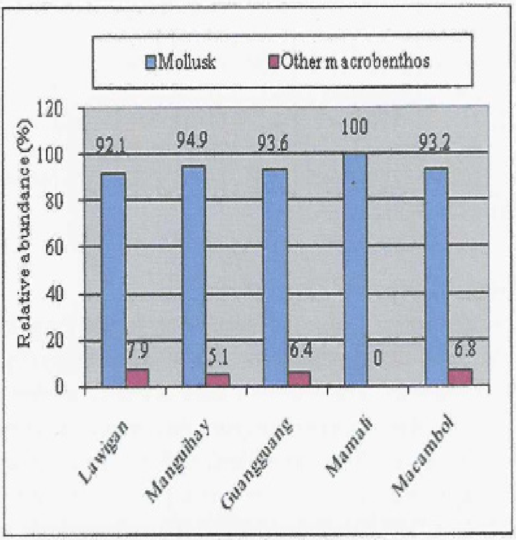

Fig. 3. Abundance (%) of mollusk relative to other macrobenthos group

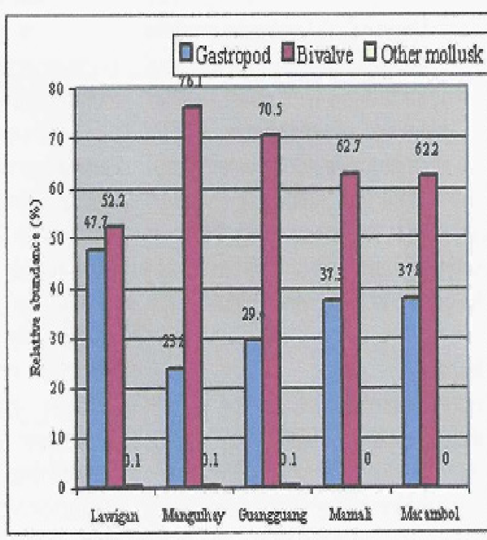

Fig.4. Relative abundance (%) of major mollusk group in the sampling sites

Table 2. Abundance and diversity of macrobenthos in Pujada Bay.

Parameter	Sampling Station				
	LW	MY	GG	MM	MC
Relative Abundance (%)	24.6	26.6	25.0	10.2	13.7
Density (ind/m²)					
1. Mollusks:					
a. Gastropods	3.9	2.2	2.5	4.1	3.2
b. Bivalves	4.2	6.9	5.9	6.9	5.2
c. Other mollusks	0.0	0.0	0.0	0.0	0.0
Total mollusks	8.1	9.1	8.4	11.0	8.4
2. Other Macrobenthos (annelid, crustaceans, echinoderms)	0.7	0.5	0.6	0.0	0.6
Total	8.8	9.6	9.9	11.0	9.0
Shannon's Diversity Index (H')	4.51	4.24	4.12	3.44	4.43
Evenness value (e)	0.84	0.77	0.74	0.78	0.86

Legend: LW= Lawigan; MY= Manguihay; GG= Guang-guang; MM= Mamali; MC= Macambol

Reef Fish

A total of 99 fish species in 23 families were observed. Family Pomacentridae had the highest occurrence of 23 species. While some species had wide distribution (Observed in all or almost all of the sampling stations), others were restricted. Among the stations, Macambol had the highest Occurrence of 45 species. Guang-guang had the least with 31 species only.

Similar to the pattern seen on macrobenthos, reef fish density in Mamali was higher (964 ind/500 m^2) comprising 31 % Of the total reef fish observed among the stations (Table 3). Mamali was also higher in fish biomass (9,497.2 g/500 m^2), though second to Macambol. It was, however, the least in total diversity (H'= 2.2) and diversity of indicator species and richness in herbivore population (Table 4) _ The relatively higher biomass of the fish fauna in the area was attributed by the preponderance of target families, both in richness and in abundance, particularly of the planktivory and carnivore population (Tables 5 and 6).

Fish diversity was highest (H'=3.1) in Macambol reef where the greatest coral cover was found. Fish diversity is enhanced by the complexity of the architecture of the substrate; and corals contribute to this by creating crevices (microhabitat) where fish can find shelterto, and protection from their predators (Choat & Bellwood, 1991; Jeffries, 1997; White 2001). That the area was rich in herbivores indicates rich vegetative cover. Like corals, habitat complexity is increased by the nooks and crannies created by, and among the plants' leaf and epiphytes (Nañola et al., 2002). Aside from increasing the biodiversity, seagrass beds also increase the area's productivity due to

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their capacity to allow breeding of various marine organisms and nurture their young to adulthood (English et al., 1994; Uychiaoco et al., 2001). In fact, the high species diversity in Macambol is a contributory factor in the area's higher fish biomass. The station had the highest biomass (12,067.34 g/500 m7), though low in fish density (511 ind/500 m2) (Tables 3 and 4).

The herbivore population also comprised the great majority of the biomass of the target fish species in Lawigan, Manguihay and Guang-guang stations. In Mamali, 71% of the biomass of target species was composed of the planktivorous caesionids (Tables 5 and 6).

Table 3. Abundance of reef fishes in Pujada Bay

Parameter	Sampling Station				
	LW	MY	GG	MM	MC
Species occurrence (no. of species/500 m²)	41	40	31	36	45
Number of occurring families/500 m²)	16	15	12	14	11
Density (no. of ind/500 m²)	554.0	710.0	417.0	964.0	511.0
Relative Abundance (%)	17.6	22.5	13.2	30.5	16.2
Total Biomass (g/500 m²)	5,177.0	3,000.9	2,156.4	9,497.2	12,067.3
Biomass of target families (g/500 m²)	2,048.9	931.4	373.4	7,750.5	8,930.5

Legend: LW= Lawigan; MY= Manguihay; GG= Guang-guang; MM= Mamali; MC= Macambol

Table 4. Diversity and richness of major fish groups in Pujada Bay.

Parameter	Sampling Station				
	LW	MY	GG	MM	MC
Shannon's Diversity Index (H')	2.6	2.8	2.7	2.2	3.1
No. of species of major families:					
Labridae (wrasses)	7	5	4	7	9
Pomacentridae (damselfishes)	9	14	10	10	14
No. of species of reef indicators:					
Chaetodontidae (butterfly)	6	4	5	4	5
Pomacanthidae (angelfishes)	2	0	0	0	1
No. of species of target families	4	4	3	6	4
No. of species of major reef herbivores:					
Acanthuridae (surgeonfishes)	4	1	2	1	4
Scaridae (parrotfishes)	1	2	0	0	3
Siganidae (rabbitfishes)	0	1	1	1	1

Legend: LW= Lawigan; MY= Manguihay; GG= Guang-guang; MM= Mamali; MC= Macambol

The pomacentrids comprised a great proportion of the fish fauna in the reef sites. They were the most dominant fish group in Manguihay (comprising 81.7%), Guangguang (comprising 79.6%), and Macambol (comprising 65.8%). In Lawigan, they were second (37.7%) but almost equal in abundance to Plotosidae (which comprise 38.4%). A similar situation can be found in Mamali where pomacentrids comprise 40.1% while the highest fish group, the cardinalfish (Apogonidae), comprised 42.1%.

Target reef fish, which included serranids (groupers), acanthurids (surgeonfishes), caesionids (fusiliers), lutjanids (snappers), lethrinids (emperors), siganids (rabbitfishes) and mullids (goatfishes), were low in abundance and biomass in the Bay. Among the stations, they were more abundant in Mamali and Macambol. Within stations, these important food fishes constituted only a small fraction of the reef fish population in Manguihay and Guang-guang (with RA = 1.8% and 3.1%, respectively). In Lawigan, they had a relative abundance of 10.3%, while that in Mamali, they constituted 14.5%. They were more abundant in Macambol comprising 23.5% of the total fish population (Table 6).

Pomacentrids are low-value species and their high occurrence in the reef sites (and low incidence of target species) suggested that the area was under high fishing pressure (DENR et al. 2001; Hodgson & Liebeler, 2002; King, 2007).

Table 5. Relative abundance (%) of major reef fish guilds among and within stations

Fish Group	Relative Abundance (%)/Sampling Station				
	LW	MY	GG	MM	MC
Target Fish Species:					
Among Stations	16.6	3.8	3.8	40.8	35.0
Within Stations	10.3	1.8	3.1	14.5	23.5
Major Reef Herbivores:					
Among Stations	27.1	4.8	4.8	4.2	59.0
Within Stations	9.2	1.3	2.2	0.8	21.7
Indicator Species:					
Among Stations	38.2	10.3	19.1	8.8	23.5
Within Stations	4.7	1.0	3.1	0.6	3.1

Legend: LW= Lawigan; MY= Manguihay; GG= Guang-guang; MM= Mamali; MC= Macambol

Table 6. Biomass (g/500 m^2) of target families and their relative importance (%) within the sampling sites.

Family	Station									
	LW		MY		GG		MM		MC	
	BM	RI	BM	RI	BM	RI	BM	RI	BM	RI
Caesionidae	0.0	0.0	0.0	0.0	0.0	0.0	5,528.9	71.3	0.0	0.0
Lutjanidae	6.5	0.32	296.7	31.8	0.0	0.0	210.2	2.7	0.0	0.0
Mullidae	162.5	7.9	0.0	0.0	0.0	0.0	26.0	0.3	299.3	3.4
Serranidae	0.0	0.0	76.0	8.2	136.9	36.7	527.6	6.8	0.0	0.0
Acanthuridae*	1,834	89.5	356.7	38.3	236.1	63.3	333.4	4.3	6,380.3	71.4
Scaridae*	45.98	2.2	196.5	21.1	0.0	0.0	0.0	0.0	2,073.4	23.2
Siganidae*	0.0	0.0	5.5	0.6	0.0	0.0	1,124.4	14.5	177.4	2.0
Total Herbivore	1,880	91.8	558.7	60.0	236.1	63.3	1,457.8	18.8	8,631.2	96.6

Legend: LW= Lawigan; MY= Manguihay; GG= Guang-guang; MM= Mamali; MC= Macambo
BM=biomass; RI=relative importance; Herbivore*

Chaetodontids, which include species of the family Chaetodontidae (butterflyfishes) and Pomacanthidae (angelfishes), were generally low in abundance as well as in richness. Among the sampling stations, reef with the highest butterflyfish density Was in Lawigan. There were only six species and 20 individuals in 500 m2 of reef. In comparison, APO and Balicasag Islands in the Visayas, which had a long history of protective management, had a mean density of 121.8 and 36.4 individuals of butterflyfish, and 9.0 and 4.7 butterflyfish species per 750 rn2 of reef area, respectively (Savina and Vvhite, 1987). Their low abundance bespeaks of the well-being of corals and supports the findings of the poor-fair condition of corals in the area. Chaetodontids are considered reef indicators, being largely dependent on corals for food (Uychiaoco et al., 2001).

Conclusion

The coral cover of Pujada Bay showed a degraded state. However, new coral recruits were an indication that the Bay was recovering. The preponderance of low-valued reef fish species and the low incidence of high-valued species were symptomatic of overfishing.

The low incidence of indicator species further bespeaks the not-so-good condition of the coral reefs in the Bay. On the other hand, the reef sites support a diverse group of macrobenthos some of which have commercial importance. As such, protective, enhancement and rehabilitative activities are needed to stop if not reverse the situation. Rehabilitation activities need to be intensified while areas of good coral condition need to be strictly protected to save what are left from further destruction.

Sampling stations showed distinct preponderance of fish and benthos population, an important aspect that must be considered in planning for management. Species have different sets of optimum resource requirement and their existence in an area is tailored to their physiological needs. Along with this physiological constraint, a plethora of reef processes interacts in synchrony and in opposition to bring about the displayed structure. If populations of the species displayed variation in patterns within a relatively small area, as the case in this study, the differing response of the populations is a reflection of variation in environmental influences affecting the habitats of the population (Robertson, 1991). The introduction then of certain management measures in certain reef site in Pujada Bay might not be suitable in other reef sites within the Bay because of specific peculiarities in factors affecting the reef sites. Thus, these spatial differences should be considered in the formulating and eventually implementing specific management interventions.

Recommendations

1. Taxonomic inventory of corals and microbenthic species be made so as to document changes in their composition if similar studies are conducted in the future.

2. Frequent short-duration FVCs during the day be made to account for the high mobility of fish as well as conduct of night-time fish surveys to include nocturnal species to provide a more accurate picture of the fish resources in the reef area of Pujada Bay

3. Monitoring Of reproductive activities/ development of sought-after fish species be examined and evaluated to determine the degree of their exploitation.

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Literature Cited

Abbot, R.T. & Dance, S.P. 2000. Compendium of Seashells. California: Odyssey Publ. 411 p.

Alcala, A.C. & Russ, GR. The role of socio-economic factors in coral reef protection and management. In press.

Choat, J.H. & Bellwood, DR. 1991. Reef Fishes: Their history and evolution. In P.F. Sale (ed.), The Ecology of Fishes on Coral Reefs. USA-Academic Press, Inc. 39-66 p

DENR. (Undated). Community-Based Coastal Environmental Program for Pujada Bay (Model Site). CEP Prirner. p.

Department of Environment and Natural Resources, Department of Agriculture Bureau of Fisheries & Aquatic Resources, and Department of Interior & Local Government. [DENR, DA-

BFAR & DILGI. 2001. Philippine Coastal Management Guidebook: Managing Municipal Fisheries. Cebu City, Phi. 122 p.

Engermann, J.G. & Hegner, R.W. 1981 Invenebrate Zoology. New York: Macmillan Publishing Co. p.

English, S, Wilkinson, C. & Baker, V. (ed.). 1997. Survey Manual for Tropical Marine Resources. Townsville, Australia: Australian Institute of Marine Science. 390 p.

Environment and Natural Resources Atlas of the Philippines. 1998. philS.: Environmental Center of the Philippine Foundation. p.

Gomez, ED., Aifio, P.M., Licuanan, W.R.Y. & Yap, H.T. 1994. Status report on coral reefs Of the Phi's. In: Proc. 3rd ASEAN-Australia Symposium on Living I Costal Resources. p

Gomez, E.O. & Chavez, V.B. 1987. Research on Philippine Mollusks, In: Mafigaser, M.A. & Lantican. C.M. (ed). Status of Molluscs Resources and Prospects for Development. Phils_: Phi. Council for

Agriculture, Forestry and Natural Resources Research & Development, BeaureuFisheriesAquat1cResources. p.

Hilomen, V.V. 1998. Output of workshop on the standardization Of field methods for the assessment of coastal resources of the Sutu-Celebes Project. p.

Hodgson, G. & Liebeier, J. 2002, The Globäl Coral Reef Crisis: Trends and solutions. Phl. Reef Check Foundation. 77 p

King, M. 2007. Fisheries Biology, Assessment and Management. UK: Blackwell Pubishing. 382 p

Jeffries, M.J, 1997. Biodiversity and Conservation. London: Routledge. p.

Nanola, CL. Jr., P.M. AliöO, AL. Dantis, M.C. Rafiola, V. Hilomen & J. Cabansag. 2002. Understanding Philippine Reef Fishes: A key to fisheries management and marine biodiversity conservation. In: Aliöo, P.M., Miclat, E.F.B. Nahola. CL. Jr.,

Roa-Quiaoit, HA. & Campos, R.T (ed.), Atlas of Philippine Coral Reefs. Quezon City, Phl.: Philippine Coral Reef Information (Philreefs), Goodwill Trading co., Inc. 22-26 p.

Nichols, J.T. & Bartsch, P 1945. Fishes and Shells of the Pacific World. NY: Macmillan Co. p.

Ray, G_C. & Grassle, J.F. 1991. Marine biological diversity. BioSdence 41 (7):453-457.

Robertson, D.R 1991. The role of adult biology in the timing of spawning of tropical reef fishes. In: Sale, P.F. (ed.). The Ecology of Fishes on Coral Reefs. USA: Academic Press, Inc. 356-386 p.

Robichaud, D. Hunte, W. & Chapman, M.R. 2000. Bulletin of Marine Science 67(2): 331-844.

Sabelli, B. 1980. Simon and Schuster's Guide to Shells. Feinberg, H.S. (ed.). NY: Simon and Schuster's, Inc. 512 p.

Sancho. C., Solow, AR. & Löbél, p.s. 2000. Environmental influences on the diel timing of spawning in coral reef fishes. Marine Ecology Progress Series 206:133-212.

Savin. G, & White,A.T '967. Neighboring islands may not be the same. Tropical

Coastal Area Management. 2(2):7-10.

Schoppe, S. 2000. A Guide to Common Shallow Water Sea Stars, Brittle Stars, Sea Urchins, Sea Cucumbers and Feather Stars (Echinoderms) of the Philippines. Singapore: Times Media Private Ltd. p.

Silvoza P L. 1998. Sea Gardens in Danger. Canopy International. 24(5): 2.

Sotto, F. B. & von Cosel. 1982. Some commercial bivalves of Cebu, Philippines. The Philippine Scientist. 19:43-101.

Vincx. M.D. & Coomans, A. 1998. The Benthos of the Sea. Marine Biology, University of Gent. p.

White, A.T. 2001. Philippine coral Reets. • A natural history guides. Manila, Phi Bookmark, Inc, and Suiu Fund for Marine Conservation Foundation, Inc. p.

Uychiaoco, A.J., Green, S.J. dela Cruz, M.T. Geite, P_A_ Arceo, H.O. AlihO, P.M & White, AT. 2001. Coral Reef Monitori for Management. Phi' UP-MSI, UNDP GEF-Srnall Grants Program, Guiuan Development Foundation, Inc, Voluntary Service Overseas, UP Center for Integrative and Development Studies, CRMP, and FRMP. 110 p.