Protected versus unprotected area with reference to fishes, corals, macro invertebrates, and CPUE in Honda Bay, Palawan

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ABSTRACT

The impact of Sabang Reef Fish Sanctuary in Honda Bay, Palawan was evaluated using fish, coral cover, macro-invertebrates and CPUE as measures for success. Visual census and LIT methods were used for fish, macro-invertebrate and coral cover surveys, while administered interview was used to gather information on CPUE. The protection of fish sanctuary has shown its impact to the coral reef fisheries by the improvement in quantity of the resources. Fishes, macro-invertebrates, and hard coral cover inside the Sabang Reef Fish Sanctuary (Binduyan) showed increased in abundance, diversity, and number of commercial species compared to those outside of the sanctuary. This reflects the positive impact that a protected area gained over four years. Results indicated high exploitation rates of resources in the fished areas just outside the sanctuary. Furthermore, as a consequence of improved reef fisheries, more fishermen fishing in areas closest to the sanctuary have increased their catch.

Keywords: Protected, unprotected area, fishes, corals, macro invertebrates and CPUE

INTRODUCTION

Marine protected area or fish sanctuary is a popular strategy for the conservation and protection of coral reefs and the resources therein. It is well accepted as an initiative for coastal management. Alcala (1981) and other workers made studies on impacts of marine protected areas in some islands of Negros Oriental, Philippines. The gains that coral reefs have afforded to their stakeholders were accounted by White and Trinidad (1998). However, stakeholders could relish the benefits and gains of fish sanctuaries only if they are effectively and successfully managed. The scenario could be worse when the coastal dwellers are still in doubt of the benefits that they can gain from the sanctuary. Thus, it has become necessary not only to gather baseline information, but also monitor and evaluate the effects and impacts of fish sanctuaries. It is equally important that this information must reach the local resource users.

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There are many indicators to measure successful fish sanctuaries. Among others, community managed fish sanctuary must have an improvement in the resource, increase in the quality and quantity of flora and fauna (Pollnac & Crawford 2000), increased catch, legal framework and full enforcement of laws inherent to the management of sanctuaries. Similarly, Crawford et al. (2000) mentioned increased fish abundance and diversity, improved coral cover, and increased fish catch by local fishermen as some of the success measures for community based marine sanctuary. On the other hand, time series data on resources and catch rates were used by Alcala et al. (2004) as evidences for local fisheries enhancement by marine reserves.

In its effort to efficiently manage the fisheries of Honda Bay, the Puerto Princesa City Government established three fish sanctuaries between year 2000 and 2004, namely: Manalo, Sabang Reef and Puntod Ilis fish sanctuaries. However, although Gonzales (2004) initially reported an increase in fish catch in the vicinity of fish sanctuary in Sabang Reef, Honda Bay, information on virtual gains and benefits by these sanctuaries to the local reef ecosystem and fishermen must also be known. The management of Sabang reef is done by patrolling along the sanctuary. This is being carried out by the people's organization (PO) members with the assistance of the Sangguniang Barangay. In addition to this, guard house was also situated near the sanctuary for monitoring purposes.

On the other hand, resource assessment of proposed fish sanctuaries in Honda Bay was conducted by DA-BFAR, Fisheries Resource Management Division in 1999. The DA-BFAR Fisheries Resource Management Project also provided baseline data on coastal resources of Honda Bay in year 2000 (FRMP 2001).

The general aim of this study was to evaluate the impact of Sabang Reef Fish Sanctuary to reef resources and fish catch. The specific objectives were: 1) to determine fish catch close to Sabang Reef Fish Sanctuary to other fishing areas distant from the sanctuary but within Honda Bay; and 2) to assess the conditions of coral cover, reef fishes, and macro-invertebrates inside and outside the fish sanctuary.

MATERIALS AND METHODS

Coral Cover and Fishes

Survey of coral cover was done in three sites in Honda Bay: Sabang Reef Fish Sanctuary, Bush Island, and Meara Island on May 24-28, July 26-30, August 9-13, and September 16-21, 2004 (Figure 1). Meara and Bush Island Stations were included in this study in order to elicit more inferences for the comparison of protected and unprotected areas. Line transect method (LIT) of English et al. (1997) and SCUBA were used during all survey periods. This study used the same methods employed by FRMP (2001) and Becira (2003) in the same sites.

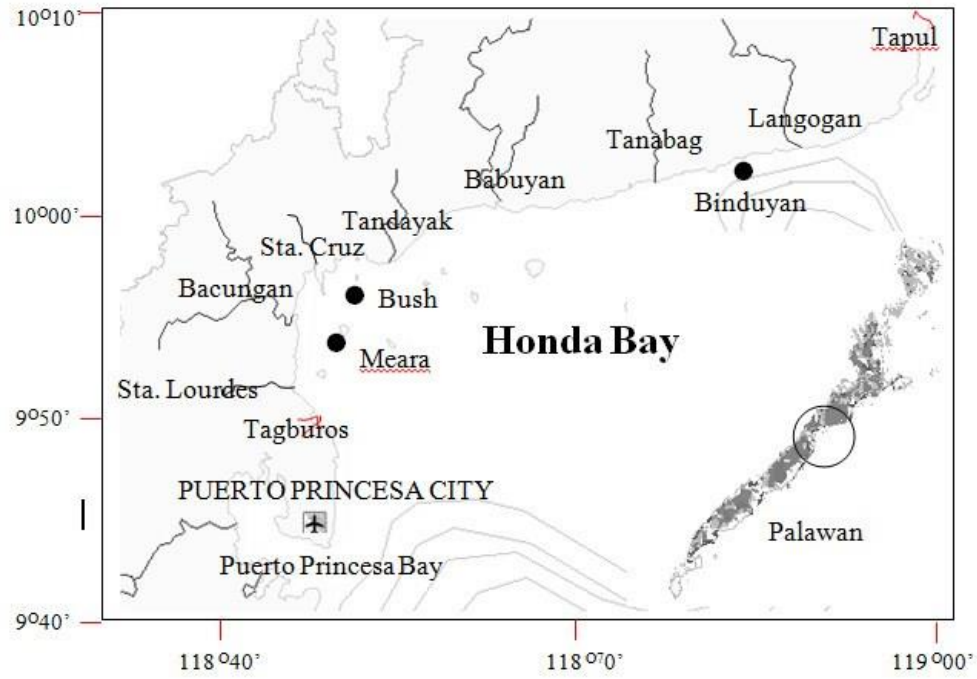

Figure 1. Map showing Palawan (lower right) and the location of sampling sites (+) in Honda Bay, Puerto Princesa City.

In Sabang Reef Fish Sanctuary, concrete block markers with 100-meter transect lines were established (Figure 2). Polyethylene ropes were used to connect concrete blocks, which could serve as permanent transect lines for future monitoring. Positions of fish transect inside (FTI-1 to 3) and outside (FTO-1 to 2) are shown in Figure 2. The data of one of the transect

lines (FTI-2) inside the sanctuary were not included due to its difference in depth with other sites.

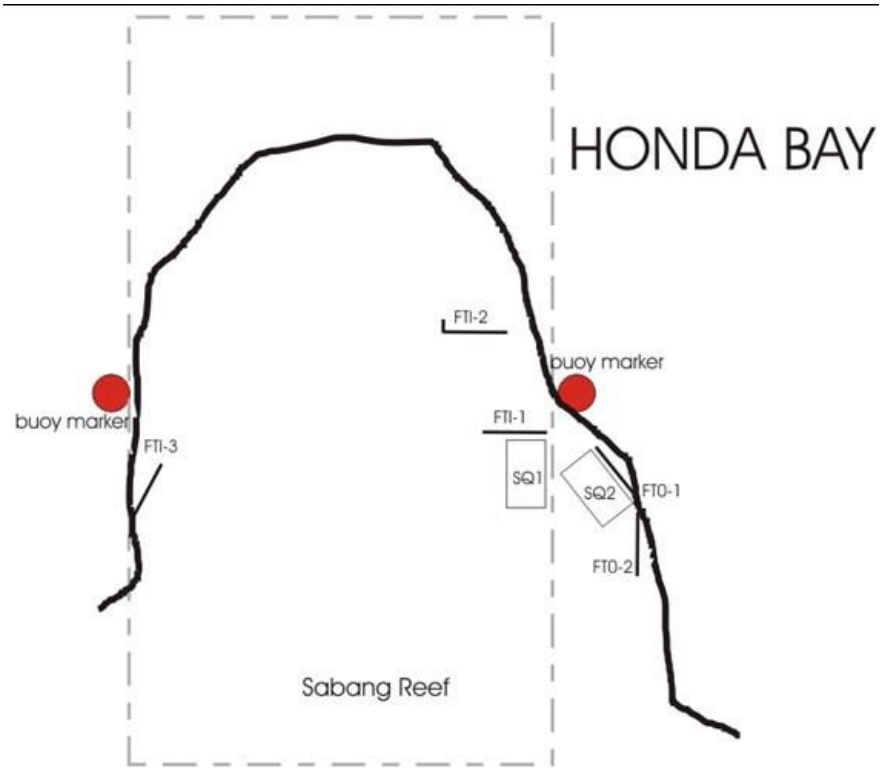

Figure 2. Sketch map of Sabang Reef Fish Sanctuary, showing the locations of permanent transect lines and quadrats used in this study. Fish Sanctuary area is enclosed by dotted lines.

Table 1. Geographical positions of the different sites in Sabang Reef Fish Sanctuary.

Sites	Longitude	Latitude
FTI-1	N10°00.474'	E119°04.217'
FTI-2	N10°00.406'	E119°04.262'
FTI-3	N10°00.570'	E119°04.360'
FTO-1	N10°00.494'	E119°04.164'
FTO-2	N10°00.502'	E119°04.184'

FTI = Fish sanctuary inside; FTO = Fish sanctuary outside

Macro-invertebrate Survey (Exclusive of Corals)

Data collection of the macro-invertebrates on the surveyed sites was conducted in conjunction with the transect surveys for coral reef and fish visual census. Visual census was conducted along imaginary 2m wide transect belt, using the transect lines for fish visual census and coral cover surveys. In Sabang Reef Fish Sanctuary, two permanent quadrats measuring 5m x 20m were used for the survey, one inside the fish sanctuary (SQ1) and another just outside of the sanctuary (SQ2) (Figure 2). Common species were identified to the lowest taxa possible. The organisms were classified according to phyla, while a taxonomic listing was generated.

CPUE and Impact to Fishermen

An administered interview was conducted, using interview forms designed to elicit the catch per unit effort of gears used by fishermen in Honda Bay. Interview forms included a map where the respondent can easily locate and mark his fishing grounds and information on catch per unit effort (CPUE), diversity of fish caught, size of fish caught, and other questions pertinent to the awareness and behavior of respondents towards the fish sanctuary.

Selection of barangays for interview was based on main fish landing areas and number of fishermen as recorded in the City Agriculture Office. Interviews were conducted to fishermen fishing in non-protected areas (Meara, Bush Islands, around Aracille Island, Pandan and Snake Island) and around protected area (Sabang Reef Fish Sanctuary) (Figure1). Interviews were conducted in Barangays Binduyan, Tagburos, Manalo, Lucbuan, Babuyan, San Rafael, and Concepcion. A total of 397 Honda Bay fishermen were interviewed comprising 77% of local fishermen fishing around the sanctuary.

Results were categorized according to major fishing gear used. Since the common major gear used by fishermen fishing near the Sabang Reef fish sanctuary and those fishing far from the sanctuary is handline, handline CPUE values were used to directly compare CPUEs between fishermen fishing near and far from Sabang Reef Fish Sanctuary. In this study, handline refers to simple handline as well as the multiple handline. Estimated distances of fishing area from the sanctuary were obtained from a navigational map and through informal interviews.

RESULTS AND DISCUSSION

Fishes

The result for the diversity, density, and biomass of reef fishes in four stations are shown in Table 2. Transects inside Sabang Reef Fish Sanctuary showed most number of fish families, number of species, number of commercial species, and highest density, except for biomass, which is lower than that of Meara Island station. This result is an indication that fish sanctuary in Binduyan has numerous fish species but small in size. This also suggests that the reef fish biomass in the sanctuary is still in the process of recuperation. Thus, continuous protection of the area will allow subsequent growth of fish populations therein.

The fish visual census conducted just outside the perimeter of the sanctuary revealed lowest values in species diversity, density, biomass, and number of commercial species. This result implies that the areas just around the fish sanctuary are most vulnerable to fishers, because fishers probably think that it is advantageous to catch spilled over fishes from the fish sanctuary.

On the other hand, the richness of the areas near the sanctuaries is manifested by the diversity of the fish families still found in the area. This implies that given a chance to regenerate, this area may also increase its fish production just like those inside the fish sanctuary. Similarly, if the area inside the fish sanctuary is not protected, most likely it will have the same condition with those in the outside area.

Table 2. Number of families and commercial fishes, diversity, density and biomass of coral reef associated fishes and their categories in four stations of Honda Bay, Palawan. Categories were after Hilomen et al. (2000).

Indicator/ Stations	Inside Sabang Reef Sanctuary (Ave.)	Category	Outside Sabang Reef Sanctuary (Ave.)	Category	Reef in Bush Island	Category	Reef in Meara Island	Category
No. of families	14.5		13.5		9		11	
*Species Diversity	106	Very High	36.5	Poor	52	Moderate	72	Moderate
**Density	1,052	Moderate	515	Poor	726	Moderate	580	Poor
***Biomass	4.7	Very Low	2.4	Very Low	4.5	Very Low	7.2	Low
No. of commercial species	9.5		3.5		6		3	

*Number of species per 1000m^2 144
**Number of individuals per 1000m^{2}145
***Estimated weight in mt per km^2

This study has provided information on the trend of diversity, density and biomass of reef fish surveys in Honda Bay (Table 3). The number of species within was nearly three times higher than outside the fish sanctuary. For Bush and Meara, the species richness and volume of catch were nearly three times lower than the previous studies. Survey sites in this table are with permanent transect lines, 149 thus could be useful for future studies.

Table 3. Trend in volume of catch and biomass of reef associated fishes in Meara, Bush and Sabang Reef Sanctuary.

Year/ Station	Inside of sanctuary			Outside of sanctuary			Bush			Meara			Source
	spp	indv.	kg	spp	indv.	kg	spp	indv.	kg	spp	indv.	kg	
2000							66	400	12	79.3	833.3	21.4	Nañola and Rodriguez (2001)
2004	106	1,052	4.7	36.5	515	2.4	52	726	4.5	72	580	7.2	This study

Coral Cover

The results of coral cover survey are presented in Tables 4 and 5. Outside Sanctuary has the highest benthic cover (55.36%), followed by Bush Island (53.40%). In terms of hard coral cover, Bush Island was the highest, followed by the Inside Sanctuary. Hard coral cover in the Inside Sanctuary (38.00%) was higher than the Outside Sanctuary (34.48%). There was higher soft coral cover outside the sanctuary than in the Inside Sanctuary.

The three sites were dominated by the presence of massive and branching corals. The genus *Acropora* was observed only in Bush Island and Binduyan fringing reefs. Presence and growth of coral recruits were observed in 4-year old permanent transect blocks.

Table 4. Benthic coverage (%) of the three areas in Honda Bay in May 24 – 28, 2004.

Category/Station	Inside Sanctuary	Outside Sanctuary	Bush	Meara
Biotic	51.47	55.36	53.40	31.90
HC	38.00	34.48	51.40	26.84
SC	10.41	19.73	0.00	0.70
SP	0.76	0.00	0.40	3.91
OT	2.30	1.15	1.60	0.45
Abiotic	30.59	44.65	46.60	68.10
DCA	27.79	22.62	18.95	29.97
R	3.73	4.10	12.85	0.00
RCK	9.71	3.35	0.00	18.59
S	7.30	12.38	2.40	0.00
Si	0.00	0.60	6.00	4.80
WA	0.00	1.60	6.40	14.74

Table 5. Trend in hard coral cover (%) in Meara, Bush Islands and Sanctuary.

Year/Station	Inside Sanctuary	Outside Sanctuary	Bush	Meara	Source
1999 (3-9m)	33.18				Tan et al. (1999)
FRMP-RSA 2000			39.32	22.24	Aliño et al. (2001)
July-Aug 2003 (1-3m)	40.50				Batin et al. (2003)
2003			45.83	43.20	Becira (2004)
2004 (3-9m)	38.00	34.48	51.40	26.84	This Study

Hard coral cover in 3-9m depth of Inside Sabang Reef Fish Sanctuary Station has increased from 33.18% in 1999 to 38.0% in 2004 (Table 5). On the other hand, consistent increased in coral cover was observed from 39.32% in 1999 to 51.4% in 2004 in an unprotected area (Bush Island), although far from conclusive, this suggests that coral cover can improve either the area is protected or not protected or more likely, destructive fishers have not yet visited the Bush Island Station between 2000 and 2004.

In Meara Island, hard coral cover has increased from 22.24% in 2000 to 43.20% in 2003. However, it showed a rapid decrease in 2004 with 26.84%. The four-year period data of coral cover in Meara Station exhibits an interesting trend, suggesting further indebt study in order to determine the factors influencing the abrupt changes in coral cover.

Comparing the results across country survey sites, current live coral cover in Honda Bay (31.90-55.36%) was higher compared to Romblon (17.2%) and Mindoro (19.94%) (SPCP-ASTI 1999) and similar to those of in Panglao Island (45.18%) and Bais Bay (50.26%), (Becira 2004).

This result also showed improvement (31.90-55.36%) compared to earlier assessment of Honda Bay live coral cover, which ranged from 19.3 to 50.63%, (SPCP-ASTI 1999; Becira 2004), and to the Philippine average live coral cover of 25 to 49.9% (White & Trinidad, 1998).

Macro-invertebrates

In Meara Island, a total of six species belonging to four families were noted in the survey area. Giant clams (Family Cardiidae) were the most dominant, having three species observed (Table 2). In terms of density count, *Tridacna squamosa* was most abundant with a density of 550 individuals per hectare. *Tridacna squamosa* was followed by the sea anemone (Class Anthozoa) having a density count of 500 individuals per hectare, *Tridacna derasa* with 250 individuals per hectare, and *Tridacna gigas* with 150 individuals per hectare (Table 6).

Inside the Sabang Reef Fish Sanctuary, a total of seven species were recorded (Table 6). Representative organisms of the Phylum Echinodermata were the dominant group. In terms of density count, *Euapta godeffroyi* (Family Synaptidae) was the most abundant having a density of 200 organisms per hectare, the rest have a density of 100 organisms per hectare.

There were six commercial species of macro-invertebrates found inside the Sabang Reef Fish sanctuary (Table 6): *Holothuria whitmaei*, *H. rigida*, *Lambis lambis*, *Tectus niloticus*, *Tridacna derasa*, and *T. squamosa*, while only one commercial species (*Holothuria rigida*) was recorded outside the sanctuary. On the other hand, there were three very important species observed in Meara station, namely: *Tridacna derasa*, *T. gigas*, and *T. squamosa*.

The Inside Sanctuary Station revealed the more diverse species, more number of commercial species, and highest total density of macro-invertebrate compared to those of the Outside Sanctuary and Meara Stations (Table 7). The number of commercial species and total density of macro-invertebrates immediately Outside Sanctuary Station were lower than that of Meara Station.

Table 6. Density (indv./ha) of macro invertebrates found in three stations in Honda Bay, Puerto Princesa City

Species	Sabang Reef Fish Sanctuary		Meara Island
	Inside (n=4)	**Outside** (n=3)	
ECHINODERMATA *Lamprometra* sp.		100	
Archaster typicus	100		
Echinaster luzonicus	100		
Echinaster callosus	50	50	
Linkia laevigata	350	150	50
Ophiarthrum pictum		100	
Ophiothrix nereidina	217		
Echinothrix diadema	50		50
Holothuria whitmaei	100		
Euapta godeffroyi		200	
Holothuria rigida		100	
MOLLUSCA *Rhinoclavis fasciata*	100		
Melanella candida		100	
Cypraea moneta	100		
Cypraea annulus	50		
Lambis lambis	250		
Tectus niloticus	150		
Tridacna derasa	100		250
Tridacna gigas			150
Tridacna squamosa	150		550
TOTAL	**1867**	**800**	**1050**

Table 7. Density and diversity of macro-invertebrates observed inside and outside of Sabang Reef Fish Sanctuary and Meara Stations.

Indicator\Station	Inside Sabang Reef Fish Sanctuary	Outside Sabang Reef Fish Sanctuary	Meara
Species diversity	14	8	5
No. of commercial species	6	1	3
Total density (no. of indv./ha)	1867	800	1050

Catch per Unit Effort

While going through with the completed CPUE forms, it was observed that the fishing ground in Honda Bay could be divided into three areas. These fishing grounds can further be classified into: A) most distant to sanctuary, B) distant to sanctuary, and C) close to sanctuary(Table 8). The CPUEs in these fishing areas, including those before and after the establishment of fish sanctuary are presented in the same table. The trends of catch per unit effort of handline in fishing grounds A (most distant from sanctuary), B, and C (close to Sanctuary) are compared in Figure 3 and Table 8.

The CPUE of all surveyed municipal fishing gears in fishing ground most distant to sanctuary showed a decreasing trend from 1998 to 2004. The CPUE of the two common gears in Honda Bay, which are spear gun and handline have decreased from 3.91 kg/person/hr and 4.66 kg/person/hr to 1.29 kg/person/hr and 1.57 kg/person/hr, respectively. The handline has been reducing its catch at the rate of 0.52 kg/person/hr per year (Table 8), while the spear gun at 0.44 kg/person/hr per year.

On the other hand, catch of gillnet has also declined from 10.7 kg/person/hr in 1998 to 2.15 kg/person/hr in 2004, having the highest rate of decrease at 1.43 kg/person/hr per year.

Table 8. Catch per unit efforts of fishermen fishing in three fishing Grounds (A, B, and C) in Honda Bay.

Fishing ground / CPUE	CPUE (kg/person/hr) from 1998 to 2004 Handline	Annual rate of decrease in CPUE Handline	% of respondents with increased CPUE in 2004	CPUE (kg/person/hr) Handline Before establishment of sanctuary 2002	CPUE (kg/person/hr) Handline After establishment of sanctuary 2004
A. Fishing areas extending from Bat Island to Bush Island (most distant to sanctuary, 30-40 km.)	4.66 to1.57	0.52	0	4.52	1.57
B. Fishing areas off the waters from barangays Manalo to Concepcion (Snake, Barlas, Arraceffi, Fundeado Islands) (distant to sanctuary, 11-30 km)	4.64 to1.64	0.5	4.3	4.19	1.64
C. Fishing grounds around Sabang Reef Fish Sanctuary (close to sanctuary, 0-11 km.)	2.60 to1.64	0.16	27	2.58	1.64

The rate of decrease in handline catch near a protected area (Sabang Reef Fish Sanctuary) was slower than the rate of decrease in handline catch in unprotected area (Figure 3). The CPUEs of the three fishing grounds before and after the introduction of management regimes are shown in Table 8. Annual rate of CPUE decrease was least in fishing ground C (160g), near sanctuary, compared to fishing grounds A and B (approximately 500g) (Table 8). This may be due to the impact of the sanctuary, which mitigated the abrupt decrease in fish catch in areas near Sabang Reef Fish Sanctuary, though detailed studies on the spillover effect and recruitment of target fishes should be conducted.

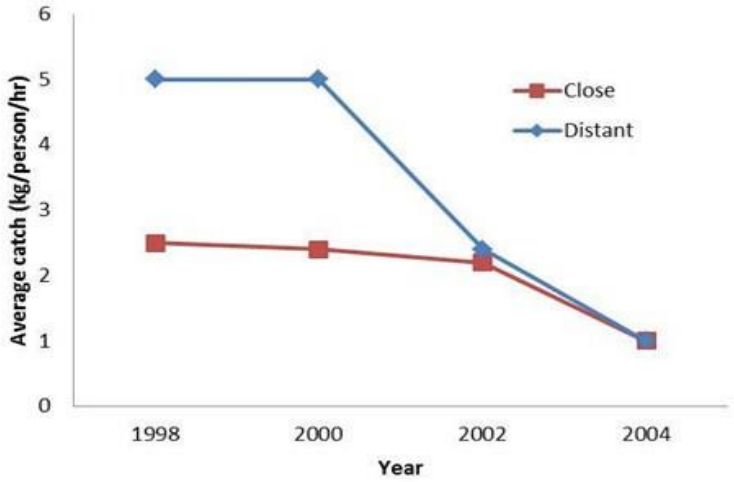

Figure 3. Catch trend in handline fishing from 1998 to 2004 in areas distant and close to fish sanctuary in Honda Bay, Palawan, Philippines.

The percentage of respondents with increased catch was highest (27%) in fishing ground closest to the sanctuary, of which gradually decreases in fishing grounds B (4.3%) and A (0%), which were far from the sanctuary (Figure 1, Table 8). This implies that the greater distance from the sanctuary the lesser is the chance for increased catch and vice versa. This observation is supported by the study in Apo Marine Reserve, where the density of large predatory fishes is highest in fished areas closest to the reserve (Alcala et al. 2004).

Empirical computation may generalize that having 27% of local fishermen who had increased their fish catches in a 2.5-year old sanctuary, suggests that approximately 10% of the local fishing population has increased catch per year. Assuming that the process and conditions will continue, all local fishermen of Sabang Reef Sanctuary shall increase their catch within 10 years after the establishment of the sanctuary. However, interviews revealed that the sanctuary ordinance was not fully enforced. Thus, if the sanctuary ordinance is fully enforced, it would take less than 10 years before 100% of local fishermen fishing near the sanctuary will increase their catch.

General Discussion

Comparing the results among the Outside Sanctuary Station and Meara and Bush Stations, there is a general observation for higher resource exploitation outside the perimeter of sanctuary area than those in the same

unprotected area away from the sanctuary. This was observed in fish visual census and macro-invertebrates survey outside perimeter of sanctuary, wherein results revealed a decrease in species diversity, density, biomass, and number of commercial species (Tables 2 and 7). On the other hand, results of CPUE survey indicated high catch rate at the perimeter of the fish sanctuary.

The above result showed that the areas just around the fish sanctuary are most vulnerable to fishers, because they probably think that it was advantageous to competitively catch the spilled over resources coming from the fish sanctuary. Since Sabang Reef Fish Sanctuary was still young (2.5 years old), the sanctuary was in its recuperating stage in which, it cannot yet readily supply the existing resource requirements of the fishery outside its boundaries.

The CPUE that was reported to have increased to 5kg per trip in areas near Sabang Reef in 2003 (Gonzales 2004) represented the average catch of different kinds of gears in the area. This should not be confused with the result of this study, having a CPUE of 1.64kg for the catch/person/hr of hand lines in the area in 2004.

The protection of fish sanctuary has showed its impact to the coral reef fisheries by the improvement in quality and quantity of the resources. Fishes, macro-invertebrates, and hard corals inside the Sabang Reef Fish Sanctuary showed increase in abundance, diversity, and number of commercial species compared to those outside of the sanctuary. This reflected the positive impact that a protected area has gained overtime.

Further studies to infer on movement and direction of target fishes across the boundaries of MPAs should be promoted (Polunin 2002). Sightings of sharks, including whale sharks, turtles, and dolphins in pursuit of the schools of small pelagic fishes inside and along the perimeters of the sanctuary are also manifestations of improved coastal habitats and resources. It is also worthy to note that as a consequence of improved reef fisheries, more fishermen fishing in areas closest to the sanctuary had increased their catch.

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