Trends of coral, fish, and fisheries near and far from human developments in Coral Bay, Southwest Sulu Sea, Palawan, Philippines

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Abstract. Coral Bay is the main source of marine-based food to the people of Bataraza, Palawan. Rio Tuba being one of the most populated barangays of Palawan has the challenge to balance the utilization and protection of bay's resources. Hence, the author analyzed results of socio-economic studies conducted in the area and the 3-year coral and fish assessments results to form as basis for its future EAFM/coastal management plan. In order to discern possible impacts of developments, the bay was divided into two zones according to distance from development sites: landward and seaward zones. Fishers of Coral Bay averaged 46 years-old with 4.25 average number of children. Trading/vending of dried and fresh fishes was dominated by women, while aquaculture and capture fisheries by men. From 2007 to 2009, all fish indicators in stations at Landward Zone either remained the same or have improved conditions, except for decreased in fish biomass in two stations, while in seaward zone fishes have generally decreased in abundance and biomass. The live coral cover trend increased in landward zone at 1.0%/year, while 4.4%/year decreased in seaward zone. The fish density (abundance) in landward zone has increased to 25% from previous average density in three years, while has decreased to 39% in the seaward zone. The average fish biomass per year in the landward zone (3.53 kg/250 m^2) was more than three times than that in the seaward zone (1.15 kg/250 m^2) in 2009. This may be because the seaward zone was open to any kind of fishing, including destructive means. While the landward zone has an in-placed security systems provided by private sectors that prevented destructive fishing and therefore might have protected coral and fish resources. In addition, the landward zone has viable population of crocodiles known to enrich estuarine waters that enhances primary productivity and growth of resources. This situations showed that in Coral Bay, proper protection of coastal fishing grounds and resources is a must, whether located near or far settlement/development areas. This study manifests that natural resources adjacent to heavy human population are not necessarily at risk as long as the protection mechanisms are properly in-placed. Hence, the local government must jointly plan with private sectors on how to institutionalize and perpetuate the protection of the bay's resources and more studies like siltation and chemical analysis shall be conducted to augment the results of this study. Information gaps for appropriate management of the bay were recommended in this paper.
Key Words: coral reefs, fishes, coastal resource management.

Introduction. Coral Bay is a relatively small bay with an approximate area of 7,000 ha and a coastline of 5 km, located east of the Municipality of Bataraza. The bay is biophysically situated in Barangays Rio Tuba and Okayan, bounded in the north by two large rivers, Okayan and Tuba Rivers (Figure 1). From its name Coral Bay, it is assumed that this bay might be historically bountiful in coral reefs.

Two major rivers drain to the Coral Bay, Rio Tuba and Okayan River Systems. These rivers are the main source of nutrients of the bay, but also serve as spillways of siltation from the upstream. From the mouth of Okayan River, the substrate consists of muddy platform gradually sloping from 2 m down to 10 m, while Tuba River has a deeper water at the center of its mouth (5 m), gradually sloping to 20 m towards the center of the bay. Mangrove communities thrive near the mouths of Tuba and Okayan Rivers.

Patches of sand bars and coral reefs can be found both in shallow and deep portions of the bay, including coralline-sandy beaches of the Small and Big Sandbars. The

live coral covers in the bay ranged between 46.10-55.70% hard and soft corals (Haribon-Palawan 2007) categorized between fair and good condition.

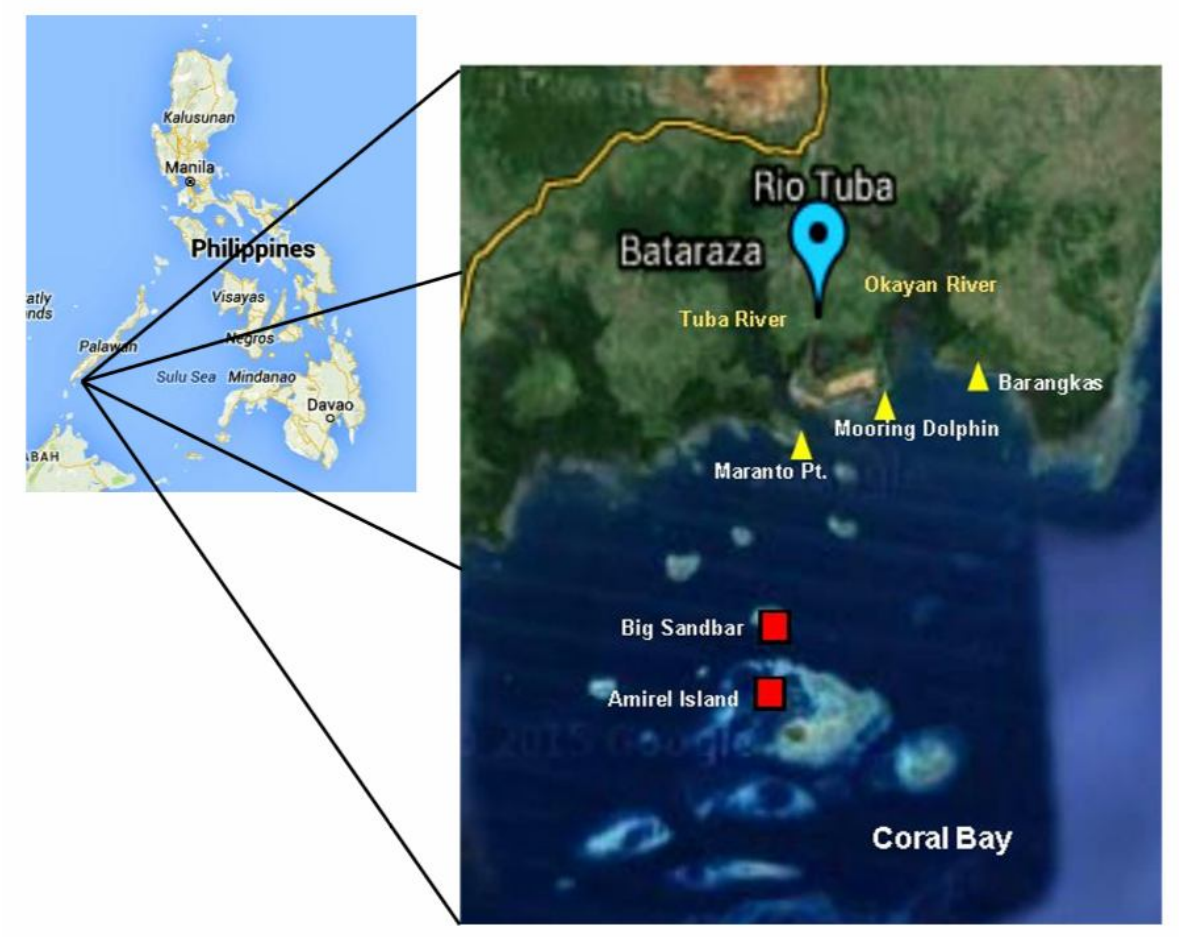

Figure 1. Map of the Philippines (www.nationsonline.org) and Coral Bay (www.maplandia.com), showing locations of stations in landward zone (yellow triangle) and seaward zone (red square).

A relatively small island named Ameril is located at the middle of the bay. It has an estimated land area of 10 hectares, predominantly covered by coconuts, while a two-hectare forest can be observed in the southwestern portion of the island. An extensive reef flat characterizes fringing reefs of the island, where patches of reefs having different forms can be found between 3 to 20 m depth. Diverse tropical fishes dominated by damsel fishes (palata, local name) abound around the reef of the island. The clear green and blue waters which surround this island were in contrast with the relatively turbid waters of the reefs near the mainland.

Coastal resources are important to us, because it provide food, income, and environmental services. The waters surrounding Palawan are rich in such ecosystems as mangrove forest, sea grass beds, and coral reefs, which also serve as habitats to a variety of marine life, including fishes, which serve as the staple food of Filipinos. Hence, it becomes necessary to conserve and protect them for longer optimum benefits that can result to inclusive growth among stakeholders. Furthermore, coastal resources have to be managed through ecological approach (Staples et al 2014), considering the governance, biophysical, and socioeconomic aspects of the management area. Bay ecological profiles and management were done in Honda Bay, Palawan by Gonzales (2003, 2004).

Base on census, population in Bataraza reached 63,644 in 2010. Coral Bay is the direct source of marine food to the people of Rio Tuba. In 1980s, even small pelagic fishers of Panacan, Narra, a well-known fishing ground in the province, used to venture fishing in Rio Tuba (Coral Bay) during lean seasons in their fishing ground. Rio Tuba has

fast increased its built up area, now being probably one of the most populated barangays in the province. As such, Coral Bay resources should be properly managed in order to sustain the support and services that it renders to the human population of Rio Tuba. Unfortunately, until now there are few published information regarding the coastal and fisheries status and activities of the bay, which is necessary as basis for the formulation of the bay's conservation plans and strategies. An external campus of the Western Philippines University (WPU) is located in Rio Tuba and as a development partner conducts several studies on fisheries in the bay.

This study aims to gather existing information on fisheries, coral cover, and reef fish assemblage in the bay; compare and analyze results across studies, analyze conditions of corals and fishes near and far from coastal developments in the mainland, and provide recommendations on the management and utilization of fisheries resources in the bay.

Material and Method. This study presents the conditions and trends of fish and coral cover drawn from the 3 year assessments conducted in the bay (Haribon-Palawan 2007, 2008, 2009) of which the first author was a member of the team. And the fisheries – related studies conducted at the coastal barangays of Bataraza between 2007 and 2015 (Heramis 2012; Dizon 2012; Musa 2012; Molino 2013). The fish and coral assessments were done in Coral Bay (Figure 1) every mid-March of the year. The resource assessments were conducted by five diver-researchers from the Haribon-Palawan and the Western Philippines University assisted by Coral Bay Nickel Corporation staff. Coral cover and fish assessments were done in five stations, recorded by GPS with marked permanent transects (Table 1).

Table 1

Geographical locations and depths of the fish and coral reef stations surveyed in Coral Bay

Zone	*Name*	*Depth (m)*	*Latitude*	*Longitude*
Landward zone	Barangkas reef	3–4	8.30400	117.28290
	Mooring dolphin reef	2–6	8.49458	117.44619
	Ameril Island	3–5	8.45203	117.43685
	Maranthow point	2–3	8.49490	117.42927
Seaward zone	Big sandbar	4–6	8.47737	117.44054
	Ameril Island	3–5	8.45203	117.43685

The survey stations were classified into two zones: the landward zone consisted of Barangkas, Mooring Dolphin Reef, Maranto Point Stations; and the seaward zone consisted of Big sandbar and Ameril Island Stations (Figure 1).

Methods used in coral and fish surveys were the same all throughout 2007 to 2009. Survey of coral cover and fish assemblage were observed from the same transect lines – fish team using SCUBA did the observations first, followed by the coral reef persons. A one 100 m permanent transect were laid in every station at similar depths. Benthic life forms were assessed using line intercept transect (LIT) method by English et al (1997). Live coral cover percentage was expressed as the sum of percent cover of hard and soft corals.

References used for fish identification were: Gonzales (2005), Myers (1999), Kuiter & Debelius (1997), Kulbicki et al (1993) Randall (1992), and Masuda et al (1984). While references for fish biomass were Gonzales et al (2000) and Hilomen (1998). Information on fisheries profile was taken from studies of Rio Tuba External Campus of the Western Philippines University.

Results and Discussion. Coastal fisheries profile in the bay. The fisherfolk of Coral Bay averaged 46 years old in age, ranging from 40 to 55 (Table 2), which was relatively young to handle the physical requirements of their jobs. The trading and vending works, involving dried and fresh fishes were dominated by women, while the aquaculture

(silviculture; crab fattening) and capture fisheries (bag net fishing) were dominated by men (Table 2).

Table 2

Profile of fisherfolk engaged in different types of livelihood in Bataraza, Palawan

Type of fisherfolk	*Average age*	*Gender (%)*	*Average no. of children*	*Education*	*Source*
Fresh fish	46	90 female	3	48% reached high school	Heramis (2012)
Dried fish	44	88 female	5	30% reached high school	Molino (2013)
Mud crab culture	55	60 male	5	60% reached high school	Dizon (2012)
Bag net fishers	40	male	4	31% reached high school	Musa (2012)

The average number of children of the fishers was 4.25. Mud crab and fresh fish traders have higher educational attainment compared to dried fish and bag net fishers. In general, the fisherfolk have low educational attainment, hence programs to address this problem have to be considered, e.g., scholarships offered to high school and college children.

Fishers were engaged in markets of different marine products as fresh fish (Heramis 2012), dried fish (Molino 2013), and mud crabs (Dizon 2012). Some fishers were also observed engaging in live reef fisheries (LRF) of red grouper (*Plectropomus leopardus*) at the stilt houses along Rio Tuba River. Through the years of survey, the use of home-made dynamite for fishing was observed to be common in the bay. While Sitio Biya-biya, Barangay Taratak, Bataraza has engaged in specific fisheries like bag net (Musa 2012). Although it still needs a detailed study, the three years consecutive monitoring has led to the observation that the popular fishing methods in the bay were limited to bag net and blast fishing. The use of blast fishing must be mitigated since it is illegal because of the destruction it brings to all kinds of wildlife in the sea. Furthermore, fishers of Coral Bay must be encouraged to engage in more diverse gears and methods for fishing in order to diversify fishing activities, and capacitate more fishers. Hence also diversify fish catch.

Ideally, the use of diverse gears will catch diverse species, which is a healthy practice for bay fisheries. A particular fishing gear tends to harvest a specific group or species of fish. These are manifested in the studies done in Palawan conducted by Gonzales (1997), Gonzales & Matillano (2008), and Palla et al (2015). For example, bag net targets mainly small pelagic fishes, troll lines targets large migratory species, while blast fishing targets schooling fishes. Hence target fishes will be overexploited overtime due to constant harvest when single or few gears are being used in the bay. Extreme specific fishing effort directed towards a single species will likely lead to fast overfishing of such species. On the other hand, diversification will not only prevent the collapse of populations of a single or few species or a group of fish which are in great demand, but also balance the species of fish being harvested from the sea. More importantly, diverse gears should be non-destructive to the environment. As such, studies on different fishing gears and methods used and their respective catches must be conducted in the bay in order to augment existing knowledge and information.

Bag nets in the 7,000-ha Coral Bay landed an estimated total volume of 40,502 kg/month of fish catch (Table 3), which was very similar to the total volume (40,800 kg/month) landed by bag nets in a 192,000-ha Taytay Bay, Palawan (Palla et al 2015). This implies that bag net was an important fisheries in Coral Bay and that the bay could be one of the main bag net fishing grounds of the province, landing more volume of fish catch per unit area. However, more detailed studies on bag net fisheries should also be done to support these findings.

Table 3
Total and mean volume of catch per month of bag net in Coral Bay (n=16) (Modified from Musa 2012)

Fish catch	*Total volume of catch (kg)*	*Mean volume of catch (kg)/boat*
Dilis (Anchovey)	12,098	756
Tamban (Sardines)	8,647	540
Galunggong (Round scads)	5,798	362
Tulingan (Tuna spp.)	4,009	250.5
Matambaka (Scads)	2,486	155
Sapsap (Slipmouths)	2,588	161.7
Sarimburao (Mackerel)	1,683	105
Pusit (Squids)	1,610	100.6
Tanguige (Spanish mackerel)	1,583	98.9
Total	40,502	281

Mean catch/boat/month of bag nets in Coral Bay was estimated to be 281 kilograms (Table 3), which was lower than the basing catch/boat/month in Calagua Island, Lamon Bay in 1991 (Calvelo et al 1991). However, the work of Calvelo et al was carried out in 1991 when fish resources were then relatively abundant compared to the present.

The bay has been subjected to open-access fishery, except for portions near the operation areas of private companies, which have stringent security measures. The open access of the resources may be remedied through fishing boat and gear licensing and registration or limited access regimes, for example establishment of protected or management areas where activities can be regulated or restricted and issuance of fishing permits to fishers. We must look at the larger fisheries ecosystem in our management and broaden the scope of coastal management to include upland problems and population issues as emphasized in coastal management practices (Gonzales 2003).

Honda Bay of Puerto Princesa City has had an open access issues in early 2000 (Gonzales 2003), But at present, the city and barangay governments together with private sector, and peoples organization in the community have jointly took control of most activities in the bay, limiting free or open access activities in the bay. Situations may be different between Honda Bay and Coral Bay in terms of becoming a tourist site. Although the latter has security issues, Coral Bay still has to protect its resources for it to continuously provide food, services, and income to its people and explore or develop existing micro and macro enterprises. Coral Bay being located at the southern tip of mainland Palawan can capitalize on its proximity to Indonesia and Malaysia, where it has an advantage of readily interacting with businesses like trading potentials and might take advantage of the spillover tourists and tourism opportunities coming from neighboring Indonesia and Malaysia.

Coral cover in landward zone. In 2009, the live coral cover in Mooring dolphin reef slightly increased and has the highest coral cover among the stations with 52.4% (51.2% hard and 1.2% soft), compared to 2008 survey having 50.9% (hard and soft) coral cover, where both were classified as in good condition (Table 4). On the other hand, Barangkas Reef Station has the lowest coral cover, having 45.6% composed of 40.8 % and 4.8 % hard and soft coral cover, respectively. The total live coral cover in Maranto Point station was 51.8% (hard and soft), dominated by branching acropora with 9.5%, 20.2% dead corals, 18.2% coralline algae and 4.3% coral rubbles. Coral cover slightly increased compared to 2007 and 2008 surveys (Tables 4 and 5). The average coral cover in the landward zone was 49.9%. The mean live coral cover of the landward reefs from 2007 to 2009 has a gradually increased (Table 4). The coral cover trend increased in landward zone at 1.0%/year.

Table 4

Live coral cover percentage at different stations of two zones in Coral Bay 2007-2009

Zone/Station	*% Live corals (hard + soft)*		
Year	*2007*	*2008*	*2009*
Landward zone			
Barangkas reef	46.1	45.2	45.6
Maranto point	47.3	49.0	51.8
Mooring dolphin reef	47.3	50.9	52.4
Mean	46.9	48.5	49.9
Seaward zone			
Big sandbar	52.7	49.14	47.73
Ameril Island	55.7	55.6	50.52
Mean	54.2	52.4	41.1
Total Mean	49.81	49.97	49.61

Adjectival rating on coral reef condition was used to assess the health of coral community: <25% - poor; >25% but <50% - fair; >50% but <75 – good and >75 – excellent Gomez et al (1981).

Coral cover in seaward zone. The Big sandbar reef has 47.73% live coral cover, dominated by branching corals having 9.87%, 22.5% dead corals, and 16.75% coral rubbles, gradually decreasing compared to 52.65% and 49.14% cover in 2007 and 2008, respectively. In Ameril Island station, the percent coral cover decreased, with 50.52% compared to 2008 survey (55.6%, hard and soft) coral cover. There was no significant difference among the percent live coral cover of the five stations in terms of classification (Table 4). All stations of coral reef have no significant changes in percent cover compared to results of 2007 and 2008 surveys (Table 5). The average coral cover of the seaward zone was 49.1%, slightly lower than the coral cover of the landward zone. The coral cover trend decreased in seaward zone at the rate of 4.4%/year.

The coral cover trend has increased in the landward zone, 46.9-49.9 % (1.0/year) in three years, while decreasing coral cover in the seaward zone from 54.2 to 41.1% (4.4/year), while the total mean live coral cover of the landward reefs from 2007 to 2009 remained a little less than 50% (Table 4).

In spite of the good coral condition in Ameril and Maranto stations, the research-divers observed frequent blast fishing incidents in Big sandbar station while conducting underwater study. This situation was also confirmed by employees of CBNC. This could have caused the decrease in coral cover in the area. Hence the survey stations should be continuously monitored to detect changes in the condition of the resources through time fishes in the landward zone. In 2009, a total of 18 fish species belonging to 6 families were identified in Barangkas reef (Table 5).

Table 5

Fish diversity (family and species) per station, Coral Bay 2009 (modified from Haribon-Palawan 2009)

Zone/Station	*Family*			*Species*		
Year	*2007*	*2008*	*2009*	*2007*	*2008*	*2009*
Landward zone						
Barangkas reef	8	6	6	21	17	18
Mooring dolphin reef	9	10	10	21	22	22
Maranto reef	14	7	10	16	22	14
Mean	10.3	7.7	8.7	19.3	20.3	18.0
Seaward zone						
Big sandbar	6	5	5	20	25	22
Ameril Island	9	3	8	20	11	25
Mean	7.5	4.0	6.5	20	18	23.5
Total mean	9	6	7.8	19	18.2	20.2

The fish assemblage was composed of 15 major species and 3 target species. No indicator species has been observed in the station, though observed during 2007 and 2008 surveys (Table 6).

Table 6

Fish diversity (species) per category per station, Coral Bay, 2009

Zone/Station	*Indicator*			*Major*			*Target*		
Year	*2007*	*2008*	*2009*	*2007*	*2008*	*2009*	*2007*	*2008*	*2009*
Landward zone									
Barangkas reef	2	1	-	16	14	15	3	2	3
Mooring dolphin reef	3	1	2	12	14	13	6	7	7
Maranto reef	1	3	-	7	15	10	8	4	4
Seaward zone									
Big sandbar	1	2	2	19	19	20	1	4	-
Ameril Island	1	-	-	17	8	19	2	3	6
Total mean	1	1.4	0.8	1.4	13.2	15.4	4	3.6	4.0

Barangakas reef has the total biomass of 193.6 g/250 m^2, which slightly increased compared to the 2008 survey.

In Mooring dolphin reef, 22 species of 10 families were noted, composed of 13 major species, 7 target species, and 2 indicator species. On the other hand, 14 species belonging to 10 families were found in Maranto Point with 10 major species, 4 target species and no indicator species. Fish species in Maranto Point has decreased compared to 2007 and 2008 assessments. Total species diversity in the bay has slightly decreased, while the number of Families remained almost the same (Figure 2). The number of indicator, major, and target species has decreased from 2007 to 2009.

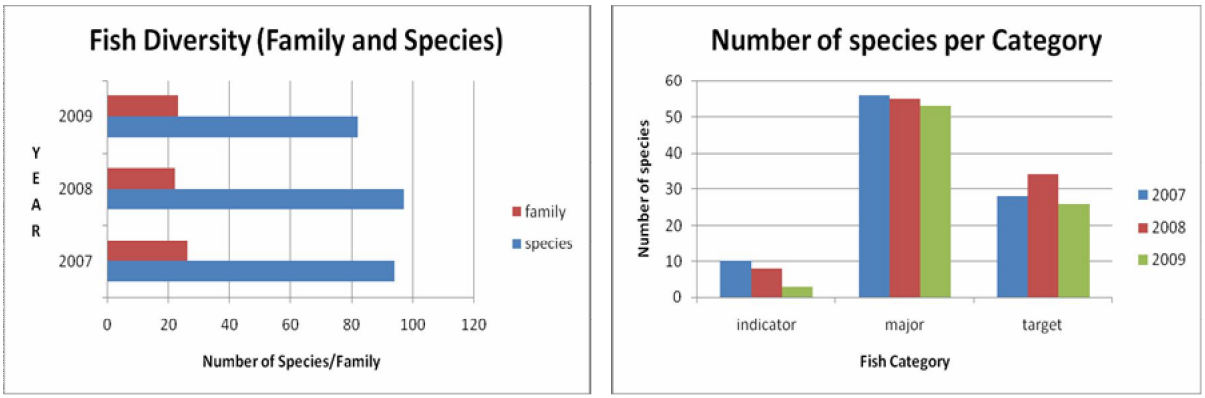

Figure 2. Fish diversity (left) and number of indicator, major, and target species (right) in Coral Bay (Haribon-Palawan 2009).

In terms of fish abundance (Table 7), a total of 66 major species, 3 target species, and no indicator species with the total of 69 individual fish (Table 8) were counted in Barangkas Reef, while a total of 502 individual were counted composing 403 target species, 97 major species and 2 indicator species in Mooring Dolphin Reef. In Maranto Point, 7 individuals of target species were noted, 37 major species and no indicator species with a total number of 44 individuals, lesser compared to the previous survey (Tables 7 and 8), Table shows the total estimated fish density (individuals/250 m^2) of indicator, major, and target species respectively surveyed in five stations having a total of 1047 individual species, 6 for indicator species, 610 species for major, and 431 target species (Table 7).

Mooring dolphin reef station has the highest fish biomass of 5918.74 grams/250 m^2, its biomass decreased compared to 2008 survey (Table 9). It was followed by

Maranto Point with a total biomass of 2540.83 g/250 m^2, increased compared to 2008 survey.

Table 7

Fish densities (individuals/250 m^2) of two zones per station in Coral Bay, 2007-2009

Zone/Station	*Fish density (individuals/250 m^2)*		
Year	2007	2008	2009
Landward zone			
Barangkas reef	58	20	69
Mooring dolphin	237	337	502
Marantow reef	126	125	44
Mean	140.3	160.7	205.0
Seaward zone			
Big sandbar	109	61	298
Ameril Island	256	195	134
Mean	182.5	128.0	216.0
Total	786	738	1047
Total mean	157	147.6	209.4

Table 8

Estimated density (individual/250 m^2) of indicator, major and target fish species in two zones of Coral Bay, 2007-2009

Zone/Station	*Indicator (Butterfly species)*			*Major (common commercial species)*			*Target (Commercially-valuable species)*		
Year	2007	2008	2009	2007	2008	2009	2007	2008	2009
Landward zone									
Barangkas reef	4.0	1.0	-	48.0	17.0	66.0	6.0	2.0	3.0
Mooring dolphin reef	7	4	2	61	69	97	169	264	403
Maranto point	4	4	-	36	117	37	86	4	7
Mean	5	3	0.7	48.3	67.7	66.7	87	90	137.7
Seaward zone									
Big sandbar	4	3	4	104	54	294	1	4	-
Ameril Island	3	-	-	248	185	116	5	10	18
Mean	3.5	1.5	2.0	176.0	119.5	205.0	3.0	7.0	9.0
Total	22	12	6	497	442	610	267	284	431
Mean Total	4	2.4	1.2	99	88.4	122	53	56.8	86.2

Fishes in the seaward zone. In Big sandbar, a total of 22 species belonging to 5 families were identified, composed of 20 major species, 2 indicator species and no target species (Tables 5 and 6), while there were 298 individuals counted in Big sandbar comprised of 294 major species, no target species, and 4 indicator species. The Big sandbar station has the total biomass of 435.62 g/250 m^2, which slightly increased compared to the 2008 survey. Twenty five fish species belonging to 8 families were noted in Ameril Island, composed of 19 major species and six target species and no indicator species (Tables 5 and 6).

In Ameril Island, in terms of fish abundance, a total of 116 major species, 18 target species were counted with 134 individuals. Compared to 2007 and 2008 survey fish abundance on the island has decreased (Table 7). The fish biomass (1,493.34 g/250 m^2) in Ameril Island has decreased compared to 2008 survey (Table 9).

All indicators in the landward zone either remained the same or have improved its quality and quantity except for the decrease in fish biomass in Mooring dolphin. The significant decreased of fish biomass in Mooring dolphin station in 2009, maybe

attributed to the frequent passing of migratory school (pelagic) fishes, so that during the survey 2008, fewer but bigger fishes were recorded, while in 2009 survey, more but smaller fishes were observed in the station. Thus, initiatives may be done to attract and retain migratory species in the area, such as setting of floating and submerged fish attracting structures and devices.

Table 9

Fish biomass in stations of landward and shoreward zones in Coral Bay 2007-2009

Zone/Station	*Fish biomass (kg/250 m^2)*			*Average biomass/year*
Year	2007	2008	2009	
Landward station				
Barangkas reef	0.364	0.125	0.194	0.228
Mooring dolphin reef	3.023	14.435	5.919	7.792
Maranto reef	3.889	1.205	2.541	2.545
Mean	2.4	5.3	2.9	3.533
Seaward station				
Ameril Island	0.667	3.354	1.493	1.838
Big sandbar	0.300	0.266	0.436	0.334
Mean	0.48	2.0	0.96	1.15

A total of 82 species of fish representing 23 families were recorded in the bay in 2009. A large majority of the species observed were members of the major species with 53 individuals, 26 target species and three indicator species.

The fish density (abundance) in landward zone has increased to 25% from previous average density within three years, while has decreased to 39% in the seaward zone (Table 8). The average fish biomass per year in the landward station (3.53 kg/250 m^2) was more than three times than that in the seaward zone (1.15 kg/250 m^2) in 2009.

The above situation suggests that most of the conditions of coastal resources in the landward zone were maintained or improved compared to seaward zone, maybe due to the strict prohibition of the mining company on destructive fishing gears and methods near the shore.

The result of assessment in the landward zone showed improvements or maintained conditions in all biological and physical indicators, except for the decrease in biomass in Maranto station. This situation was in contrast with that of Mooring dolphin. In Maranto point, the abundance decreased, while biomass increased. This means that compared to last year, less yet larger fishes were noted in this station. The individual fish in the area might have grown bigger in size, but has decreased in number due to mortality, most probably by fishing. It was also worth noting that Maranto point was located in front of a fishing village, making the conditions of its fish and corals unstable and vulnerable to human activities. Protection of this area should be considered, since a relatively rare Apogon species was also recorded by the first author in this station (Gonzales 2014).

In the seaward zone, four biophysical indicators showed negative trends (Table 10). This was due to open access fishing in the seaward portions of the bay, further aggravated by rampant last fishing. In one of our dive surveys, the team had experienced three blasts within 45-minute work underwater. The team has further witness actual blast bottles thrown in the water around 300 m distance from the first author's boat, somewhere south of the Ameril Island reefs in 2007.

Ideally, with an open access mode of fishing, the seaward area should have high integrity of corals and fish resources since it is far from the mainland, hence far from human disturbance and impacts. However, the results of this study showed otherwise, that the conditions and trend of corals and fishes near the human settlement were in better condition than areas far from mainland. This may be because of the prohibition of fishing and other human activities near the vicinity of private companies in mainland Rio Tuba, Bataraza. The limited access to fisheries in the shore might have hindered the exploitation of resources therein.

Furthermore, the better resources in the nearshore areas, including the estuary ecosystem may be due to the presence of a viable population of crocodiles, which might have reduced fishing pressure by humans and played a role in altering the nutrient regimes thereby enhancing the aquatic primary productivity of the ecosystem (Bucol et al 2014). Hence the better fishes and corals in the landward zone may be attributed to the presence of stringent law enforcement and partly to the presence of viable population of crocodile in the area.

Table 10

Status and trends of fish abundance (indviduals/250 m^2) and biomass (kg/250 m^2), and % live coral cover in different stations of two zones of Coral Bay from 2007 to 2008

Zone	*Station*	*Resources*	*Resources status*			*Trends*
			2007	2008	2009	
Landward	Barangkas reef	Fish (abundance)	58	20	69	Increased
		Fish (biomass)	0.36	0.12	0.19	Slightly increased
		Live corals (%)	46.1%	45.2%	45.6%	Slightly increased
	Mooring dolphin reef	Fish (abundance)	237	337	502	Increased
		Fish biomass	3.0	14.44	5.91	Decreased
		Live corals (%)	48.3%	50.9%	52.4%	Increased
	Maranto point	Fish (abundance)	126	125	44	Decreased
		Fish (biomass)	3.9	1.2	2.5	Increased
		Live corals (% cover)	48.3%	49%	51.8%	Increased
Seaward	Big sandbar	Fish (abundance)	109	61	298	Increased
		Fish (biomass)	0.30	0.26	0.435	Slightly increased
		Live corals (%)	52.65%	49.14%	47.73%	Decreased
	Ameril Island	Fish (abundance)	256	195	134	Decreased
		Fish (biomass)	0.67	3.35	1.5	Decreased
		Live corals (%)	55.7%	55.6%	50.52%	Decreased

Conclusions

1. Fishers of Coral Bay averaged 46 years-old with 4.25 average number of children.
2. Fish vending was dominated by women, while aquaculture and capture fisheries dominated by men.
3. Fishers of Coral Bay have low educational attainment.
4. The good coral and fish conditions are increasing in the landward zone, while decreasing in the seaward zone.
5. Near or far from human settlements or activities as long as they are protected, resources will abound.
6. Within the context of this study, coastal development with limited access to fisheries is better than without development, but open access to fisheries.

Recommendations

1. Development of a focused public information and awareness raising program for Coral Bay stakeholders (EAM) with the trust of streamlining EAFM in government agenda.
2. Conduct consultative workshop for formulation of management plan, adopting Ecological Approach Fisheries Management, including the sustainability of coastal resource protection as implemented by the private sector.
3. Enact legislation on permits and regulations of fishing boats and gears and establish marine protected areas.
4. Restore and rehabilitate damaged coral reefs, and replenish natural stocks in degraded reef areas.
5. Conduct detailed studies on relationships and trends of resource conditions against open and limited access fisheries, including Catch per Unit Effort. Siltation,

chemical analysis of water and primary productivity studies should also be conducted to support and augment the findings of this study.

6. More studies on the role of crocodiles in estuarine fisheries and livelihood of Bataraza community members.

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