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Impacts of Management Intervention on the Aquatic Habitats of Panguil Bay, Philippines

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ABSTRACT

Impacts of previous interventions on the coastal habitats in Panguil Bay, Philippines were determined by assessing the bay's mangroves, seaweed and seagrass communities, coral reefs, marine sanctuaries, and artificial reefs using standard and modified methods. The bay has 21 true mangrove and 15 mangrove-associated species that serve as habitat for commercially important fish and crustaceans, particularly the mud crab, *Scylla* spp. Mangrove resources, however, are continuously threatened by fishpond development and other uses resulting in a significant decline in cover to only 4.36% of the estimated cover in 1950. The seaweed community is comprised of 26 species of green algae, 18 brown algae, 24 red algae, and 4 blue green algae. The present number is lower compared to the 105 species recorded in 1991. Most seagrasses and seaweeds are found only near the bay's mouth, while only few species represented by *Enhalus acoroides*, *Enteromorpha* and *Neomeris* are found in the inner part of the bay. The average cover of seaweeds and seagrass decreases from the mouth towards the inner side of the bay. There is a significant reduction in the cover since 1991 except for the seaweeds in Maigo, Lanao del Norte and the seagrasses in Clarin, Misamis Occidental. In several stations, seagrass cover is already less than 20% of that reported in 1991. Coral reef development is restricted to areas around the mouth of Panguil Bay where the overall condition of the habitats has declined in less than two decades. Results of the present assessment indicate a negative development index for all coral reef sites compared with positive development index obtained in 1991 and 1996. Their present status may be considered "poor" with average hard coral cover of less than 25%. Some coral reef and non-coral reef areas that have been protected as marine sanctuaries have relatively high fish species richness, abundance and biomass compared to the unprotected and poorly managed coral reefs. The artificial reefs in the bay also have relatively higher fish species richness than in the natural coral reefs although the present number of 157 reef fish species is slightly lower than the 160 species obtained in 1996. Observations of declining habitat quality in Panguil Bay suggest that these habitats have to be holistically managed to ensure their protection and sustainability.

Keywords: artificial reefs, coral reef, mangroves, sanctuaries, seagrass, seaweed.

INTRODUCTION

Fisheries policy on sustainable development and resource management in the Philippines found expression in two major important government intervention programs: the Fishery Sector Program (FSP) (1989, 1995-96) and, its sequel, the Fisheries Resource Management Project (FRMP, 1999-2004). The program that was implemented in many parts of the Philippines, including Panguil Bay in Mindanao, aimed to address two critical and interconnected issues, namely: the depletion of fisheries resources and the vicious cycle of poverty and environmental degradation. In addressing these issues, the program shifted from sectoral to integrated approach and from increasing capture fisheries production to habitat management with focus on fisheries resources protection, conservation, and sustainable development.

In 1991 and in 1995, the coastal habitats of the bay were assessed and critical issues and concerns were identified (MSUN, 1992; 1996). Results of the assessment indicated a steady decline in the health and productivity of the bay. The concerns were addressed through various forms of interventions aimed to improve the status of the habitats, particularly mangroves, coral reefs, seaweeds and seagrasses, and the waters upon which the fishery resource is hinged.

Considering the dynamic nature of the resources and the communities around the bay, the expectation of improved coastal habitat conditions following the interventions had to be evaluated. The mangroves, coral reefs, seagrass and seaweed communities were assessed again ten years after the last assessment to determine if the interventions had significantly improved their status. Specifically, the study was done to achieve the following: 1) determine the current status of the mangrove, seagrass and seaweed resources, sanctuaries, coral reefs, and artificial reefs; 2) identify threats, impacts, and stresses on the resources of Panguil Bay; and 3) gather relevant data necessary to update the integrated CRM plans of target municipalities and the integrated Bay-wide CRM plan.

METHODS

The Project Site

Panguil Bay is located in the northwestern part of Mindanao (Fig. 1). It covers approximately 18,000 hectares of water area and has a total coastline measuring 116 km from Clarin, Misamis Occidental to Brgy. Liangan, Maigo, Lanao del Norte (FAO 133). Situated along this coastline are the two cities of Tangub and Ozamiz and the municipalities of Clarin and Bonifacio in the province of Misamis Occidental; the municipalities of Aurora and Tambulig in the province of Zamboanga del Sur; and the municipalities of Maigo, Kolambugan, Tubod, Baroy, Lala and Kapatagan in Lanao del Norte. Altogether, 78 barangays belonging to these cities and municipalities are strategically located around the bay. Administratively, the bay is divided among the above-mentioned provinces and among Regions 9 and 10 where these provinces are politically located.

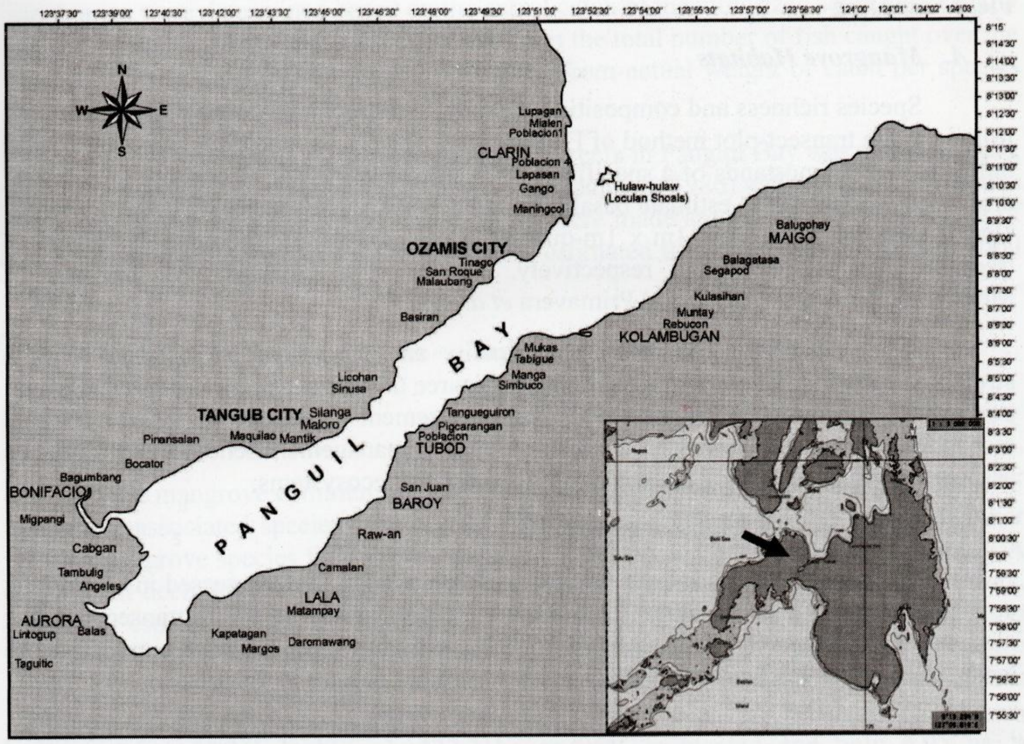

Figure 1. Map of Panguil Bay Northwestern Mindanao, showing the municipalities and cities covered in the assessment of coastal habitats. Inset is the map of Mindanao with arrow pointing to Panguil Bay.

The bay is flanked on its northern side by Mt. Malindang, a national park and watershed reserve with an area of 53,262 hectares, and by the Gurain mountain ranges in its southeastern flank (MSU-IFRD, 1981). From these highlands, 29 rivers and 46 minor tributaries carry freshwater and transport nutrients and sediments into the bay.

The bay is dotted with shoals and submerged islets at its mouth. The bottom close to the mouth, between Maigo, Lanao del Norte at one side, and Clarin, Misamis Occidental at the other side, is sandy and gradually becomes muddy towards its southernmost portion. The average depth of the bay is 15.4 meters. Its deepest portion is 55 meters located between Maigo and Clarin (Mendoza, 1982; MSUN, 1996); its shallowest is at its upper reaches.

The two sides of the bay is closest at the midportion of the bay approximately 1.7 km in the channel between Silanga, Tangub, Misamis Occidental and Tubod, Lanao del Norte. Commercial ferry boats, however, use the 5-km channel connecting Kolambugan, Lanao del Norte and Ozamis City in conducting land vehicles, passengers, and cargo to and from the opposite coasts.

Field Sampling

A. Mangrove Habitats

Species richness and composition, density, and basal area cover were determined following the transect-plot method of English *et al.* (1997). In mangrove plantations with uniform-sized monostands of a specific species, one or two plots, depending on the total area, were established to estimate basal area and density of the species. In mixed growths, 10m x 10m, 5m x 5m, and 1m x 1m-quadrats were established to determine density of trees, saplings and seedlings, respectively. Species were identified with the help of Melana and Gonzales (1996) and Primavera *et al.* (2004).

Key informants from each municipality and city were interviewed using a structured questionnaire to know patterns of resource utilization, people's knowledge and perception, and opinions on the mangrove management strategies. Randomly selected respondents were interviewed on the history, present management scheme, and problems associated with maintaining the health of the mangrove ecosystems.

B. Seaweeds and Seagrass Resources

The seaweed and seagrass resources of Panguil Bay were assessed in 13 stations covering areas around the mouth to the inner portion of the bay. The transect-quadrat method as described by English *et al.* (1997), with some modifications, was used to estimate cover, frequency, and density of every species present in the area.

In every station, at least two transects were laid perpendicular to the shore, stretching from the shore to the reef edge. Distance between transects is from 150-300 meters. Two quadrats, set at one meter apart, were laid at every interval of 10 meters along each transect.

C. Coral Reefs, Sanctuaries and Artificial Reefs

A manta tow survey (English *et al.,* 1997) was conducted to assess the condition of coral reefs along the coast of Maigo to Kolambugan, Lanao del Norte and the coral reef area of Hulaw-hulaw (Loculan shoal) Clarin, Misamis Occidental to Ozamiz City. The percent cover of live corals was translated into status categories (Gomez *et al*., 1981) to indicate condition of the reef (English *et al.,* 1997). The macro-benthic communities were assessed following the line-intercept transect survey techniques. Identification of corals and other invertebrates was based on Veron (1993) and Allen and Steene (1999). The synoptic indices developed by Aliño (1996) were used in the analysis of the ecological condition of the coral reef.

The status of the reef fish communities was assessed following the daytime Fish Visual Census method (English *et al*., 1997) and fish were identified using the guide by Myers (1991). Fish abundance was estimated from the actual count of fish encountered within the 100m x 10m corridor, and the status of reef fish community was described based on the categories developed by Aliño (1996) and Hilomen *et al.* (2000). Available biomass on the reef was estimated by converting length measurements to weight using length-weight parameters a and b.

The abundance and biomass of fish and crustaceans in the non-coral reef fish sanctuaries were determined based on the actual catch of the motorized scissor net locally called "sudsud". Abundance was estimated from the total number of fish caught over the total area being fished. Biomass was estimated from actual weight of catch per species over the area fished.

The fish community of selected artificial reefs in Panguil Bay was assessed using the Point-count Fish Census method (Bohnsack-Bannerot, 1986) with some modifications. Estimates of fish length and population counts were made around the designated area of the artificial reef complex. Fish biomass was estimated using the same method in coral reefs.

RESULTS

Mangrove Resources.

The mangrove communities in the bay are comprised of 21 true mangrove and 15 mangrove-associated species. The municipality of Kolambugan has the highest number of true mangrove species followed by Lala and Ozamiz City that both have 14 species. A significant decline in the mangrove areas in Panguil Bay is very evident in this survey. The total estimated area of 550.84ha is only 4.38% of the mangrove areas in 1950. As shown in Table 1, the rate of decline has become higher in the latter years. In 1995, there were still 2,732 hectares present (MSUN, 1996) but less than one-fourth of this area is left ten years later. Of the mangrove areas left, Kolambugan has relatively the largest, estimated at 139.26ha, although 132.31ha or 95% is planted and only 6.95 ha is considered natural growth. The municipality of Kapatagan has an estimated cover of 135.14 ha of natural mangrove forest. Total reforested area in the bay is estimated to be 215.19 ha only, not even half of the 494.52 ha of reforested area estimated in 1995 (MSUN, 1996). The mangroves in the bay serve as habitat for commercially important fish and crustaceans such as the mangrove or mud crab, *Scylla* spp. A large number of species of birds, fish, invertebrates, and epiflora also make use of the mangal, either in their adult or juvenile stages, or both as a breeding, nursery and refuge areas. From our surveys and interviews of the residents around Panguil Bay, majority have good

Figure 2. Mangroves in Lala, Lanao del Norte cut for fishpond development.

knowledge on the value of mangrove resources and their ecological significance. The mangroves are recognized as refuge for marine and transient animals, nursery ground for juveniles, and as barrier for wind and waves. They also associate mangroves with a number of consumptive functions that include extraction and collection of products such as construction materials, food items (e.g. bivalves, univalves, crustaceans and fishes), propagules for sale, branches used as fish aggregating devices or FADS, and firewood for domestic use. Despite their ecological importance and the implementation of interventions, mangrove habitats continued to decline (Table 1). The mangroves are continually being threatened by massive fishpond development (Fig. 2). Stewardship of the intact reforested mangroves remains uncertain. In some areas, private claims imply that the owners can make plans for development that may be contrary to established mangrove programs of the government. In general, the mangroves in Panguil Bay are already depleted as shown by their very small cover relative to the fishpond areas in particular and the whole bay area in general.

Table 1. Change in total area of mangroves in Panguil Bay though the years.

Year	Area (ha.)	Percent based on 1950	Reference
1950	12,590	100.00	NAMRIA, 1988
1981	4,750	37.73	Sanguila, 1981
1988	3,623	28.78	NAMRIA, 1988
1995	2,732	21.70	NAMRIA,1995
2005	550.84	4.38	MSUNFSTDI, 2006

Seaweed and Seagrass Resources. The seaweed and seagrass resources of Panguil Bay are relatively diverse. Results of the resource assessment in 13 stations within Panguil Bay recorded a total of 72 species of seaweeds dominated by the brown algae, *Sargassum* (Fig. 3), *Padina* and *Turbinaria*.. For the seagrass, eight species were identified dominated by *Cymodocea rotundata*, followed by *Thalassia hemprichii* and *Enhalus acoroides*. Associated fauna comprised a total of 48 species belonging to seven major groups largely represented by the *Strombus* and the small seashells identified locally as "Tapok-tapok". Seaweed cover ranged from 23.4% (Maigo) to less than 1 %, while the seagrass cover ranged from 42.2% (Clarin) to less than 7%. A

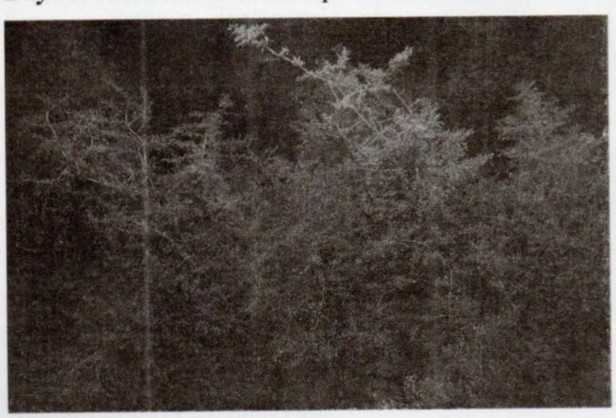

Figure 3. The brown seaweed *Sargassum sp.* profusely growing in Panguil Bay.

decreasing trend in seaweed and seagrass species and cover is observed from the bay mouth towards the inner part of the bay. Species composition, however, varies with the tendency of the tropical eelgrass *Enhalus acoroides* to dominate in the inner portion. Vegetation cover has significantly reduced since 1991 except for the seaweeds in Maigo, Lanao del Norte and the seagrasses in Clarin, Misamis Occidental (Table 2). In several stations, mean seagrass cover is already less than 20% of that reported in 1991.

Table 2. Average percent cover of seaweeds and seagrasses of Panguil bay for 1991 (MSUN, 1992), 1995-96 (MSUN, 1996) and 2005 (MSUNFSTDI, 2006).

	Seaweeds			Seagrass		
Station	**1991**	**1996**	**2005**	**1991**	**1996**	**2005**
Maigo	13.89	13.41	23.45	18.75	0.38	3.31
Segapod			6.37			1.87
Kulasihan			0.04			28.80
Mukas		10.83	0.00		11.18	7.62
Tubod			0.92	47.92		22.60
Baroy		0.85	0.00	81.11	10.73	16.93
Rau-an		0.16	0.78		2.22	0.00
Tangub			0.00			6.40
Silangga			6.79			0.00
Ozamiz			0.16	52.66		1.14
San Antonio			12.76			0.00
Hulaw-hulaw	31.95	16.7	5.54	49.82	11.69	6.25
Clarin		2.35	2.33		8.98	42.04

Coral Reefs, Artificial Reefs and Sanctuaries. Coral reef development is limited only in the mouth of Panguil Bay. The reefs offer a variety of habitat for relatively diverse flora and fauna (Fig. 4), however, the overall condition of the coral reefs in the bay has declined in less than two decades. Results of the present assessment indicate a negative development index for all coral reef sites, in contrast to the positive development index obtained in 1991 and 1996. Present status of the coral reefs in Panguil Bay may be considered "poor" (hard coral cover from 7.35-21.81%) or "fair" (HCC from 25.58-37.61%). Some coral reef and non-coral reef areas that have been protected as fish sanctuary have relatively high species richness, abundance and biomass of fish. Unprotected and less managed coral reefs have low species richness, abundance and biomass. On the average, reef fish abundance for the entire bay is relatively "poor" (202-676 fish.1000m^{-2}) but "moderate" in Labuay (677 fish.1000m^{-2} and Segapod (2267 fish.1000m^{2}). Average biomass for the entire bay is estimated at 13.98 tons per km^{2} which may be categorized as "moderate".

Calculated synoptic indices indicate declining condition and development of most coral reefs in Panguil Bay owing to decreasing hard coral cover and poor recruitment in most sites, including established marine protected areas (MPAs). Positive condition indices in 2005 were obtained only in Labuay, Maigo and Hulaw-hulaw marine sanctuary in Loculan Shoal, while the reef of Kulasihan and the Segapod marine sanctuary in Maigo had negative condition indices indicating very low proportions of live coral cover. Mortality indices of most reefs were high (0.34-0.69) which indicate large proportions of dead coral, possibly a result of blastfishing and other destructive reef uses. Negative succession indices suggest that recruitment of algae and other invertebrates on the reefs of Panguil Bay is low.

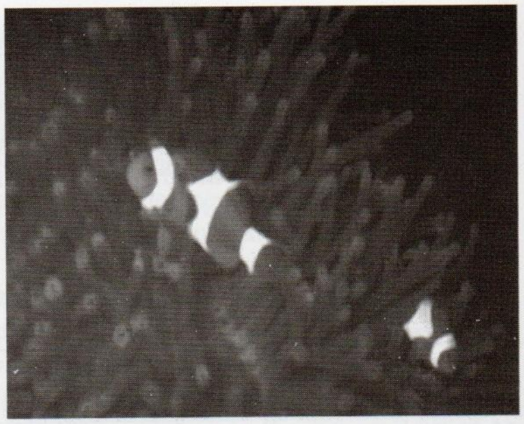

Figure 4. A colorful anemone fish in a coral reef sanctuary at Loculan Shoal.

Hard coral cover in Labuay has markedly improved (by 22.9%) since 1996, after coral cover declined from 44.6% in 1991 (Table 3). Everywhere else in the bay coral cover has progressively declined, such as in Hulaw-hulaw sanctuary from 36.9% in 1991 to only 21.8% in 2005, and in Kulasihan from 34.8% in 1991 to only 7.4% at present (MSUNFSTDI, 2006). Combined percent cover of dead corals and abiotics across all the sites in 2005 was extremely high (>60%), indicating degradation of coral reef habitats of the bay since 1991 and 1996 (MSUN, 1992; MSUN, 1996) as dead corals gave way to the production of rubble and sand.

Overall species richness of reef-associated fish in the bay in 2005 (157 species) is slightly lower than obtained in 1996 (160 species). Highest species variety occurs in Labuay (92 spp) which is higher than recorded in 1996 (81 spp). Lower species diversity is found in Segapod (77 spp), Hulaw-hulaw (54 spp), Kulasihan (35 spp), and Kolambugan (19 spp). Fish diversity in the Hulaw-hulaw sanctuary drastically declined (by 63.8%) from 149 species recorded in 1996 (MSUN, 1996) implying the lack of protection and law enforcement. Fish abundance in the bay is generally poor (mean = 504 fish.1000m^{-2}) based on the abundance categories established by Hilomen *et al.* (2000). Segapod (925 fish.1000m^{-2}) and Labuay (739 fish.1000m^{-2}) have moderate abundance, on the other hand, fish abundance is glaringly low in Kulasihan (174 fish.1000m^{-2}) and Kolambugan (275 fish.1000m^{-2}) fish sanctuaries. Average biomass estimate in Segapod (36.15t.km^{-2}) is considered high while that in Kolambugan (20.54t.km^{-2}) is considered moderate. Other reefs have very low biomass estimates and are, thus, considered poor. The relatively high values of abundance (0.71fish/m^2) and biomass (19.73t/km^2) obtained in Kapatagan are comparable with those in the protected coral reefs in the bay.

Artificial reefs have been deployed in Panguil Bay since the 1980s, providing shelter and habitat for various species of fish and invertebrates. Species richness of fish is relatively high in artificial reefs deployed in Labuay (43 spp.), Segapod (36 spp.), Kolambugan (21 spp.) and Clarin (38 spp.), exceeding the number of species, abundance, and biomass found in some natural reefs in the bay.

Fish communities in non-coral reef sanctuaries were not as diverse as those in natural or artificial reefs. Only 20 species of fish and crustaceans were found in Kapatagan (19 spp) and Sumalig (6 spp). Relatively high values of fish abundance (710 fish.1000m^{-2}) and biomass (19.73 t.km^{-2}), however, occur in Kapatagan which are comparable to those in protected coral reefs in the bay. This result manifests the effective law enforcement and coastal resource management program implemented by the LGU for the protection and sustainability of fish resources in Kapatagan.

Table 3. Time-series changes in percent cover of corals and other benthic lifeforms in coral reef sites and sanctuaries in Panguil Bay.

	Labuay			Kulasihan		Segapod	Hulaw-hulaw		
	1991	1996	2005	1991	2005	2005	1991	1996	2005
Live Coral	39.58	17.86	37.60	34.80	7.35	25.58	36.95	30.85	21.81
Dead Coral	0.75	4.05	-	0.67		-	0.56	3.55	-
Dead Coral w/Algae	52.78	35.06	19.42	38.59	10.21	12.90	25.37	30.66	9.13
Other Fauna	1.63	9.07	6.70	3.51	7.17	13.05	5.39	13.07	2.37
Algae	1.12	1.48	0.60	-	6.39	-	9.14	0.67	2.12
Abiotic	4.14	32.48	35.68	22.43	68.88	48.47	22.59	21.20	64.57
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

DISCUSSION

The aquatic habitats in Panguil Bay possess floral and faunal species that have immeasurable economic and ecological values to the communities. Yet despite the interventions implemented in the previous years to protect these habitats, the bay and its coastal ecosystems continue to be threatened and subjected to intense pressure from fishing and changing environmental conditions. The mangroves, for one, pose a great challenge for management. In 1989, DENR launched a mangrove reforestation project in the coastal areas of Lanao del Norte. Other organizations followed, doing replanting at various scales. In general, the project was a failure. Only a few trees left standing can be indicated as a result of such project. The whole project was not sustained – there was preoccupation with reporting the number of seedlings planted and the total area covered rather than determining the survival and growth of trees. Some mangrove forests remain in their pristine state only because ownership has yet to be resolved. The alleged owners operate big fishponds in the vicinity, hence, would most likely convert the remaining mangroves to fishponds once ownership is resolved. In many parts of the bay, the mangroves continue to be threatened by a variety of consumptive uses as whole trees, or parts of them, are cut down for products such as timber, posts and fuel. In addition, non-consumptive threats exist where unregulated human activities can indirectly damage the mangrove ecosystem. The adverse effects of both consumptive and non-consumptive activities are increasing with unregulated human population growth and broadening attempts to improve or modernize the living standards of coastal communities in the bay.

One of the biggest threats facing mangroves in certain areas is the clear-cutting and drainage of mangroves for development purposes such as urbanization, increase in housing demand, industrial areas, and harbor facilities. Low-lying areas now occupied by housing, industry, port facilities, and even resorts were once fringed by mangroves which were removed during land reclamation and development. The proposed construction of a bridge linking Tubod and Tangub City is a serious threat to the remaining mangroves in Panguil Bay.

The present survey of seaweeds revealed a lower species diversity than what was obtained in 1991 (MSUN, 1992) and in 1996 (MSUN, 1996). The differences could not be easily attributed to changes in environmental conditions of the bay, but rather differences in survey method. A more comprehensive survey was conducted in 1991, whereas the present survey was merely a rapid assessment. Nonetheless, a decreasing diversity towards the inner part of the bay is expected considering the reduction in light penetration due to increasing turbidity towards the inner bay area. Salinity also drops towards the inner part, thus, limiting the growth of seaweeds and seagrasses. A number of studies have already shown the negative effects of reduced light on aquatic plants as caused by heavy siltation (Fortes, 1988; Duarte, 1991; Uy, 2000). Siltation in the inner portion of the bay remains a major concern. This and the use of destructive gears such as scissor net (*sudsud*) and beach seine (*baling*) that severely damage the seagrass beds during operation could reduce seagrass cover in the bay.

Coral reefs are found only near the mouth of Panguil Bay. The percent live coral cover in this part is relatively high and progressively decreases towards the interior. While sedimentation was not monitored in the present study, it is believed that the sediment load from river runoff in Maigo, Segapod, Kulasihan, Rebucon and Kolambugan, Lanao del Norte, and from the interior of the bay caused massive mortalities of corals and rendered the reef unfavorable for coral and invertebrate development.

The relatively low development and condition index values obtained in different sites suggest that the macrobenthic organisms in the coral reef habitat are frequently exposed to physiological stress. Results show high combined percent cover of dead corals, rubble, and coral fragments in the area that suggest recent death of corals. Aside from sedimentation, damage to the corals may be caused by physical (anthropogenic or natural) and biological (physiological stress or disease) factors. Fishermen who go fishing trample many of these corals. This is quite a concern because the decrease in percent live coral cover and lifeform diversity means reduction in space, physical architecture and complexity of microhabitats. These, in turn, reduce the habitats available and suitable for fish species and other invertebrates. This may explain the relatively "low" values of development, condition, and succession indices obtained in most of the coral reefs in Panguil Bay except in Labuay that has a relatively better coral recruitment and development.

The reduction in the variety, abundance, and biomass of reef fishes point to a degradation of coral reefs in the bay. Hope is not lost, however, as some protected reefs in Segapod and Kolambugan have improving fish biomass particularly of commercially important food families (e.g. Caesionidae, Carangidae and Lutjanidae). The high values of abundance and biomass obtained in the non-reef sanctuary of Kapatagan is another positive outcome of effective management. Kapatagan authorities ban any form of activity, including mere passage, in the sanctuary. Obviously, ban on fishing and protection of the sites allowed these groups of fish to grow and attain maturity. Conversely, the Sumalig sanctuary is not an enforced one, as evidences of ongoing fishing activities inside the sanctuary have been noted. These observations would explain the relatively low abundance and biomass in this area. It is believed that if efficient management in selected coral reef areas is sustained these areas could become important sources of recruits of economically important species that could then spill over to other areas of the bay. Likewise, a well–managed artificial reef may become an important source of recruits for the nearby coral reefs. Spillover of juvenile and adult fish can contribute to improved fisherman catch and income through time.

CONCLUSION AND RECOMMENDATIONS

Despite an apparent rise in resource and environmental consciousness in Panguil Bay, the assault on coastal resources continues. For lack of other options for survival, many coastal dwellers are forced to extract any resource from the bay by any means, causing its rapid and continuing degradation. Because the bay is a shared resource, its co-management by its various users becomes a necessity, if not the only option for sustainability. Considering that the mangrove, seaweed, seagrass and coral reef resources are an integral part of the overall status of fishery in Panguil Bay, the present assessment has recognized the need to improve and develop a coastal resource management scheme appropriate to the recent environmental condition. The local government units from barangay to the provincial level, fishing communities, and other stakeholders need to define and play their respective roles in its management to stop further degradation. There are many constraints to the successful implementation of projects intended to improve the productivity of the bay. These consist of the interplay of environmental, ecological, economic, social, and political factors that have not been properly addressed or resolved over time. The present findings imply that there remains a great challenge to the national and local government, resource management organizations and the fisherfolk communities to accelerate efforts to save the degrading habitats of Panguil Bay.

The degraded coastal habitats in Panguil Bay can be improved through the adoption of the following recommendations:

- Reduce silt load and prevent the shallowing of the bay through erosion abatement measures, such as intensifying upland and coastal reforestation.
- Reduce pollution from industrial and domestic sources in order to protect seaweed production and improve fisheries of the bay. Regulation of upland and

lowland agriculture and mariculture activities would reduce their negative impacts on the bay's ecology.

- Strengthen law enforcement (e.g.,RA 8550) on coastal environment protection through concerted efforts of the FARMCs, Bantay Dagat, the FLET and the Municipal or City Agriculture's Office.
- *Review marine sanctuary management to include restoration activities to enhance* natural regeneration in coastal habitats, e.g. through coral transplantation to rehabilitate damaged reefs and effective protection and management of existing artificial reefs. Participation of coastal communities or people's organizations in the management of LGU-driven marine sanctuaries can ensure sustainability of these projects.
- Conservation and restoration of mangrove habitats should employ a multi-species mangrove reforestation strategy. Where appropriate, nets may be placed along the river banks to trap sediments and favor establishment of seedlings. Since fishpond development is a major threat, fishpond owners should be required to plant mangroves on the fringes of their fishponds and idle or non-performing fishponds should be converted into mangrove rehabilitation sites.

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