Coastal habitats of Asid Gulf, Masbate, Philippines: assessment and role of marine protected areas for management development

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Abstract. Three areas in Asid Gulf, Southern Luzon Island, Philippines were assessed of their coral reefs, seagrass and seaweeds, and reef fishes namely Guinlobngan Island, Guinawayan Island and Nagarao Island. Legally-declared marine protected areas (MPAs) have been established in each of the latter islands, while the former is apparently managed privately. Live coral reef cover in Guinlobngan Island was 39% ranging from poor to good. In Guinawayan Island, live coral was fair with 32%. Nagarao Islands showed 33% live cover at poor to fair. Biomass of coral reef fishes was higher in Guinlobngan (3.4-12.5 kg-250 m^{-2}) than in the two islands. The information generated from the study provides comprehensive baseline for the gulfs coral reef resources. The major challenges to managing the coastal habitats of the gulf emphasize the protection and rehabilitation of coral reefs and associated habitats. The role of MPAs is crucial to revive the coastal ecosystem and protect fish stocks, scallops and other invertebrate fisheries.
Key Words: critical ecological habitats, scallops, coral cover, reef fish biomass, coastal management.

Introduction. Philippine coastal resources are highly diverse so are the challenges for management facing them. Diversity begets conflict. Thus the need for information is stressed so that management proceeds. Opting to be precautionary, a synoptic resource assessment is prescribed that will provide basis to initiate for a management approach. However, it could be that it is not science that is lacking but it is how decision makers appreciate scientific information to guide management. A pragmatic view is that simply "policy is politics" (Hilborn 2004; Longhurst 2006). In Asid Gulf, the need both for technical assessment is urgent plus significant action to utilize the best information available.

Nine marine protected areas (MPAs) are listed (Pajaro et al 1999) in the province of Masbate; 3 of them are in the gulf and 2 are in Ticao Pass. Beginning 2000 in the gulf, there had been more interest on MPA establishment when some 12 of them were proposed and established in its 5 coastal towns (Soliman et al 2002). The MPAs in the gulf provide opportunities for evolving initiatives for fisheries management. The Recodo Marine Fishery Reserve (RMFR) in Cawayan, largest MPA in Masbate lying within Asid Gulf, presents an opportunity to protect and regulate harvest of commercial scallops in the gulf by way of effectively managing the MPA. Furthermore, a major legal impetus for coastal resources management in the province is its Environmental Code of 2001 (Provincial Ordinance #166), which mandates declaration of "at least 25% to a maximum of 40% of the municipal waters as marine sanctuary and fishery reserves to be co-managed by the local government, FARMC, non-government and peoples organizations". From 2002 to 2011, 3 MPAs were added increasing total coverage to less than 4% of the gulfs 2,800 km^2 area that is low relative to the codes mandate and inadequate ecologically to provide significant benefits from spill-over and larval dispersion.

There is a dearth of published studies on the assessment of resources and habitats of the gulf and for the waters of the province as a whole. With all MPAs, except for the RMFR, they did not benefit from comprehensive assessment as requisite to establishment, and they are not monitored regularly. The reasons for these are varied including low accessibility of the site to enable research staff to conduct assessments and the lack of technical capacity of agencies close to the MPAs. Capacitating schools in the province for coastal assessments and fishery research is a major effort toward the right direction. As a country of islands, the protection toward sustainability of coastal resources and habitats, particularly remote coastal areas in the Philippines, should benefit most from capacitation of local institutions that have the largest stake at these resources.

This paper presents an assessment of the coastal habitats of the gulf with emphasis on seagrass and seaweed beds, live coral cover, reef fish diversity, density and biomass. This information provides the first comprehensive baseline on the gulfs coastal habitats. An MPA is declared in one of the three islands, planned in the other, while one is under an apparently “private” protection. Implications of the estimates of biomass of coral reef fish’s vis-à-vis total fishery production of the gulf have been discussed.

Material and Method

Brief description of the study site. Masbate Islands lie about in the center of the Philippine archipelago between latitudes 11°43' and 21°36' N, 123°09' and 124°15' E. Asid Gulf is bordered by five coastal towns from Jintotolo Island of Balud (in the southwest) through Milagros, Cawayan, Placer and Esperanza (in the southeast) extending to a coastal length of 142 km (Figure 1). The study was conducted in May to December 2012 that covered dry and wet months.

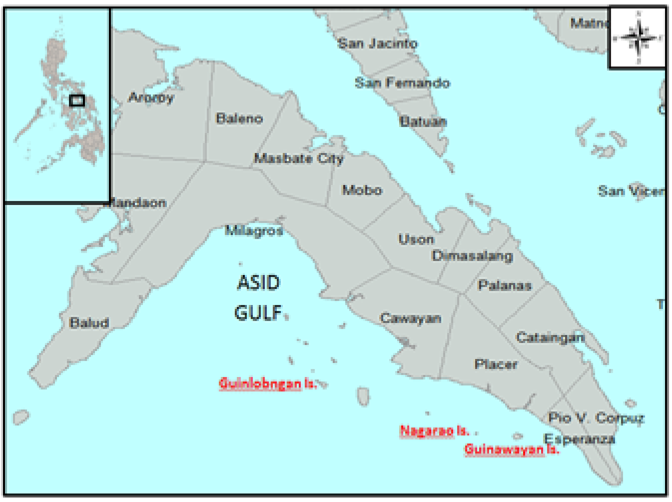

Figure 1. Asid Gulf (Philippine map, inset).

Assessment of coral reefs, reef fishes. Three sites were assessed for benthic lifeform coverage and reef fish biomass and density namely (i) Guinlobngan Island in Cawayan (ii) Nagarao Island and (iii) Guinawayan Island both in Placer, all within Asid Gulf, Masbate (Figure 1). The stations were shallow with average depth of 15 feet. Seven transects were assessed in the three sites at 2-3 transects for every site (Table 1).

The spatial extent of coral reefs in Guinlobngan was observed to be wider than that in Guinawayan and Nagarao Islands. Coral reefs were also observed to be along a narrow strip in the latter two islands. The initial information on the distribution of coral reefs in the gulf was obtained from the *Sangomap* of the Ministry of Environment of Japan (Figure 2).

Table 1

Coordinates of sampling stations for coral reefs and reef fish surveys in the 3 islands

1.Guinlobngan Island	Station 1 (Transects 1 & 2)	11^{0} 56' 22" N	123^{0} 35' 14" E
	Station 2 (Transect 3)	11^{0} 56' 18" N	123^{0} 35' 13" E
2.Nagarao Island	Station 1 (Transects 1 & 2)	11^{0} 48' 39" N	123^{0} 50' 02" E
3.Guinawayan Island	Station 2 (Transects 3 & 4)	11^{0} 47' 35" N	123^{0} 59' 17" E

Line-intercept transect (LIT) described by English et al (1997) was used to determine the percentage cover of various benthic lifeforms. LIT involved laying of 50-m transect line in the reef following contour or parallel to the shoreline. Benthos under the transect line were identified and measured. The readings for the fish visual censuses were done in transects for benthic lifeform assessment. Fishes within 5 m from either side and above transect were counted. Data collected from the manta tow, line intercept and visual census were stored and analyzed using a spreadsheet program.

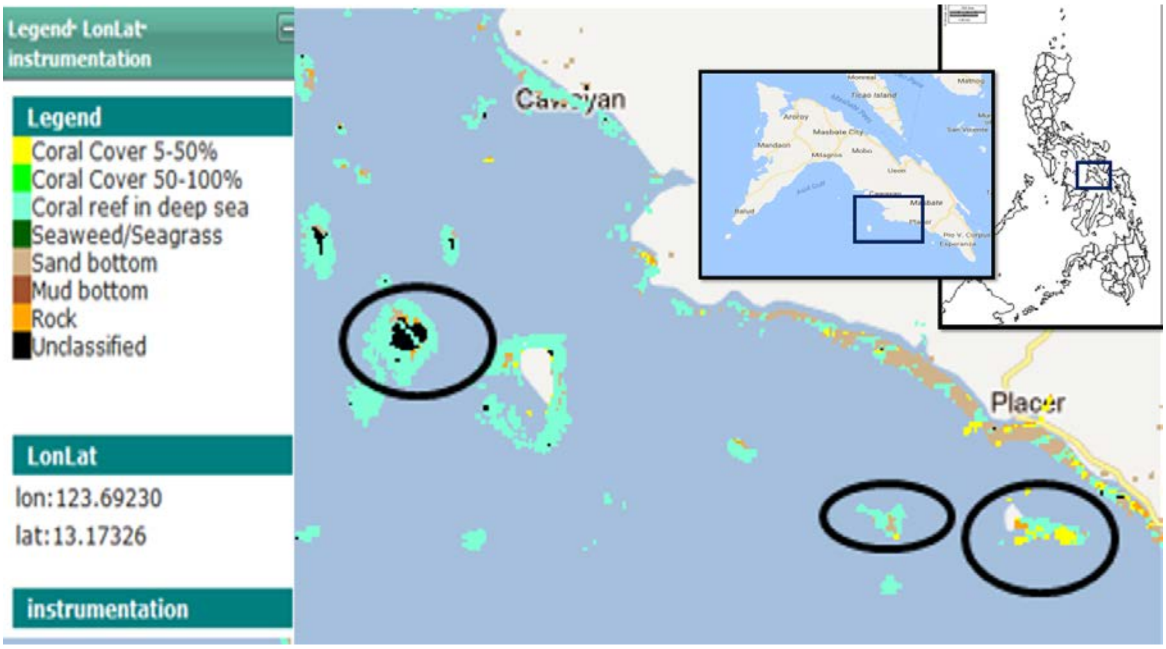

Figure 2. Basis for initial determination of the survey stations for coral reefs in Asid Gulf.

Fish visual census modified from English et al (1997) was used in determining the species richness and biomass of coral reef fishes. The census was done vis-à-vis the benthic lifeform identification. Divers swam along the tape identifying fishes at genera level (species level when possible) observed within 2.5 m on both sides and on top of the transect line. Individual standard length (SL) estimates of each species were obtained visually, and with this, reef fish biomass (expressed as Total Weight (TW) was estimated using power length-weight relationship ($TW = a*SL^{b}$) data from published literatures.

Results. Seven transects were assessed for condition of benthic lifeforms and reef fishes with 3 transects in Cawayan and 4 in Placer (Table 2). Of the 7 transects, 1 recorded good live coral cover, 4 fair cover and 2 poor cover. Live coral for the two sites ranged from 16% to 67% (poor – good condition). Most of the corals were dominated by non-*Acropora* corals such as massive, encrusting and digitate lifeforms.

The first site (Transects 1 and 2) in Guinlobngan Island is characterized by sand-rubbles mixtures interspersed with macroalgae (*Sargassum* sp.) while the second site (Transect 3) is dominated by live hard corals and rubbles.

Table 2

Benthic lifeforms (%) in Guinlobngan, Nagarao and Guinawayan Islands

Transect	*Hard corals*		*Total*	*Soft Corals*	*Total live corals*	*Coral cover condition*	*Dead corals*	*Algae*	*Others*	*Abiotic*
	Acropora	*Non-Acropora*								
Guinlobngan, S	0.00	14.88	14.88	0.88	15.76	Poor	26.96	4.56	9.72	43.00
Guinlobngan	0.00	33.08	33.08	0.00	33.08	Fair	29.56	8.20	4.16	25.00
Guinlobngan	18.12	48.84	66.96	0.00	66.96	Good	5.28	0.00	3.60	24.16
Nagarao	6.92	33.80	40.72	0.00	40.72	Fair	8.00	15.88	1.20	34.20
Nagarao, S	4.08	15.64	19.72	4.52	24.24	Poor	1.76	70.80	0.00	3.20
Guinawayan	1.84	32.16	34.00	0.00	34.00	Fair	2.36	44.08	4.20	15.36
Guinawayan, S	1.96	27.84	29.80	1.36	31.16	Fair	10.00	48.60	0.00	10.24

S – shallow.

Live cover ranged from 16% to 67%. Dead corals were high for the first site which is about 30% and 5-8% for the second site. Other fauna is also relatively abundant (3-10%) that consisted of echinoderms and molluscs. Abiotic factors (sand, rubbles and rocks) were also abundant comprising at 25-43%.

Associated algae were 0-8%. Mean live coral cover in Guinlobngan is 39% at fair condition.

In Nagarao Island, seaweed dominated the reefs represented mostly by brown algae. The second transect was almost a *Sargassum* bed occupying about 71% of total cover. The first transect had about 16% macroalgal cover. The area with higher algae coverage had low live coral cover and vice-versa. Almost 80% of the hard corals were represented by non-*Acropora* corals. Abiotic factors ranged between 3-34%. Due to the vast *Sargassum* bed in the second transect the abiotic component may not have been well detected registering only 3%. Live coral cover in this station is fair with an average of 32%.

The third site is Guinawayan Island characterized by highly dense *Sargassum* beds recording more that 40% in both transects. Live coral cover was 31-34% which was dominated by non-acroporids. Dead corals were considerably low (2-10%). This can be due to the presence of thick *Sargassum* community which made dead corals unrecognizable. Abiotic factors were 10-15% which are considerably low. Other fauna is low at 0-4%. Mean coral cover was 33% which is fair condition.

Some 29 fish species in eight families were identified from fish visual census in Guinlobngan Island. The family Pomacentridae has the most number of species with 12, Labridae with 6 and Nemipteridae with 4. The other 5 families have 1-2 species. Remarkable is the presence of commercially important species such as labrids and nemipterids. Highly-valued grouper species were also found. Presence of reef predators such as the caranx and snappers indicate adequate supply of their food in the reef area. Occurrence of different labrid species indicates abundance of algae nearby which is shown in the lifeform survey.

Thirty-nine fish species belonging to 13 families and 32 species from 10 families were recorded in Nagarao Island and Guinawayan Island, respectively. Pomacentrids, apogonids and plotosids were the 3 most abundant families in both islands. For biomass, three groups namely pomacentrids, apogonids and labrids were the highest. But these density (542 and 503 ind-250 m^{-2}) and biomass (11,782 and 9,667 g-250 m^{-2}) values are relatively low. The areas could be affected by heavy fishing and habitat destruction. The high percentage of abiotic factors and algal cover in both sites indicate the poor habitat condition. Although there is an MPA in Guinawayan Island, the site is heavily perturbed by anthropogenic factors and with high siltation. For both sites, it was observed during the survey that reef fishes were aggregating on small coral patches probably indicating the reef fishes are utilizing available space for shelter or protection. Apogonids and pomacentrids are usually dependent on reef patches as retreat area during daytime. Individual sizes of the apogonids were large.

Discussion. From the assessment of benthic lifeforms, the predominance of abiotic components, dead corals and macroalgae indicate heavy pressure on the reef both from fishing and domestic influences. The coral reefs in eight islands in the gulf within Cawayan were surveyed in 2004 (Soliman & Mendoza 2005). From the eight islands (i.e., Chico, Naro, Naro-Dyut, Cobre, Piña, Gilutungan, Namatyan, Guinlobngan), the latter 2 islands were only assessed. This was because the 25-m transect for benthic lifeform assessment could not be set for a reasonable assessment because the coral reefs and other lifeforms were severely degraded and destroyed in the other 6 islands. For the 2 islands where assessment was made mean live cover was 54% in Namatyan Island and 53% in Guinlobngan Island. In Naro Island, the second largest island in the gulf (Piña Island is the largest), it showed poor live cover with mean of 18.5% from a recent study (Mendoza & Soliman 2011).

The large proportion of macroalgae indicates low abundance of herbivorous fishes and invertebrates due to overfishing and high nutrient loadings from terrestrial ecosystem. The use of destructive fishing methods such as blast fishing, trawls and other illegal fishing methods contributed much to the decline of the coastal habitats in the gulf that affected reef structure and function (Russ & Alcala 1989; Stockwell et al 2009). Furthermore, high fishing pressure has brought negative consequences on reef fish structure and biomass (as discussed in Russ & Alcala 1989; Alcala & Russ 1990). Poor values of branching corals particularly the acroporids would indicate rampant destructive fishing that results to the high percentage of rubbles. The loss of habitat and herbivores may lead to increased macroalgal cover (Paddack et al 2006) that may further affect coral development by affecting settlement and as a competitor in space (Mumby & Steneck 2008). Since corals serve not only as a feeding ground for other fishes but as shelter, their structure and quality could influence reef fish structure (Stockwell et al 2009; Friedlander & Parrish 1998). Results obtained in the present study are in corollary with the result of Bell & Galzin (1984) that coral reef structure may have direct influence of other reef fish residents but not on the apogonids. Reef fish structure and biomass in the study sites were low and can be correlated with the structure of the coral reef but apogonids were not affected by the changes or status of coral cover. One good indication is the presence of coral recruits in almost all sites surveyed that may indicate decreasing fishing pressure and use of destructive methods in reef areas.

The stations in Nagarao and Guinawayan Islands showed heavy disturbance from anthropogenic and natural factors. Most of the corals are in shallow portion which is the main reason why they are easily destroyed especially branching corals. This may also explain why both stations are dominated by non-acroporids especially massive and encrusting corals. Illegal and destructive fishing has been rampant in these areas about two decades ago (pers. comm. with fishers and scallop gatherers). However, few sites showed new growth of branching coral species which is a good ecological indication. In Guinlobngan Island, it is noteworthy that even though Station 1 has lower live coral cover than Station 2, it has more reef fishes. This can be due to the interaction between coral reefs and macroalgae. Seaweed beds interacting with coral reefs result to higher productivity and food availability that improves fish abundance. Many reef fishes (e.g., siganids) consume seaweeds and the organisms clinging unto their blades. It may be recalled that Station 2 does not have algal cover that is vital habitat and source of food for reef fishes such as labrids and other herbivores. This may also explain the presence of predator fishes such as carangids and lutjanids in Station 1 that contributed to better fish density and biomass. The presence of nemipterids could be explained by the high percentage of sand and rubble which are important substrata for this reef associated fishes.

Most of the reef fishes are plankters and algal feeders but they are of low commercial value. But there were few high valued fishes such as groupers and snappers. The presence of few predators in Nagarao and Guinawayan Islands may have allowed the apogonids to increase in size and number. Most of them were seen clustering in crevices and massive coral colonies. Nemipterids, one of the abundant fish families in the gulf (as also observed in local market), were abundant in both sites. This was attributed to the huge rubble and sandy areas that are the preferred sites by these species. The low percentage of coral polyp feeders (e.g., butterfly fishes) reflects the low live coral percentage. Overall, the general condition of the sites reveals the low abundance of reef fishes. Anthropogenic factors especially the heavy and destructive fishing in the gulf is the main contributor of the low diversity and biomass of reef fishes.

Guinlobngan Island is one of the few, if not the only remaining coral reef area in the gulf with good live coral cover. Unfortunately most reef areas in the gulf showed poor coral cover. It was noted that Guinlobngan Island is being controlled privately by a family who has taken good stewardship of the reefs and associated habitats and the whole Island in general. In Guinlobngan Island (Transect 3), live coral cover was 62% during a survey in 2003 (Soliman & Mendoza 2005) but in this study, live cover was 67%. If it were not for the very strong typhoons in 2007 to 2009 that hit Masbate, coral reefs could have been better. This is a remarkable achievement for coral reef protection despite the rampant operation of trawls and blast fishing in the area. It also challenges the traditional view in MPA management that effective protection is afforded with legal declaration. However, this out does not diminish the value of an MPA ordinance, but rather, it increases the options for which MPA management can be practiced. Given the seemingly insurmountable challenges of managing MPAs in the country, should we consider MPA privatization as a valid option?

In general, the mere presence MPAs can serve as a platform for development and research activities in the gulf. Local government should be encouraged to rally behind such an encompassing conservation cause that permeates into the gamut of coastal rural society (Russ et al 2004; White et al 2006; Eisma-Osorio et al 2009). Research and academic institutions should be attracted to an "ecosystem of ecosystems" (Carpenter & Springer 2005), with a dynamic spatial extent depending on the range size of animals it provides feeding, nursery and refuge areas to. Successful partnership can be built among these institutions including agencies that do advocacies and environmental protection (Christie et al 2009). Implementers of successful MPAs have capitalized on this social synergy to meet scientific and socio-economic and ecosystem objectives (Alcala 2001; White et al 2005; Alcala & Russ 2006). Developing local research institutions by enhancing their capability and increasing their participation to research and development activities should catalyze the science-management link for biodiversity conservation (Pollnac & Pomeroy 2005). For the gulf, a key potential ecological benefit from an MPA is so-called "seeding effect" (Kendall & Picquelle 2003) whereby scallop gametes and larvae are dispersed over an area much larger than the reserve. Scallops are relatively immobile so the spatial extent of larval dispersal will determine its influence to early life history and productivity in the gulf.

Scallop production beds in the gulf are within the RMFR and portion of the beds is in the adjacent coastal towns. Therefore, the efforts to manage the protected area and the schemes to regulate and enhance the scallops stocks should be complementing one another towards an ecosystem-based fisheries management. The reserve was established by virtue of Cawayan Municipal Ordinance No. 99-02 passed in 1999. The ordinance has codified all laws on fisheries and aquatic resources of the municipality, as consolidated in the proposed ordinance adopting CRM as the "dynamic approach to the sustainable use and management of the economically and ecologically valuable resources" in its coasts. The ordinance expands the area coverage of the MPA and cover six sites namely Panan-awan, Malbug, Piña Island, Naro Island, Guinlobngan and Namatyan. The reserve is also identified under the NIPAS System with the Department of Natural Resources Regional Office No. V. The eight islands consisting of Naro and Naro-Dyut, Guinlubngan, Gilutungan, Pobre, Piña, Bagamanoc, Chico and Namatyan, spaced about a kilometer or less apart, are within the administrative jurisdiction of Cawayan. The consolidated ordinance includes among others provisions for fishermen registry, protection of ecological habitats, limited entry into overfished areas, reporting and monitoring system, and creation of CRM Section in the municipality. The Recodo Barangay Council in coordination with the Cawayan local government manages the reserve.

Conclusions. Critical coastal habitats in Asid Gulf in the Southern Luzon Island, the Philippines, such as coral reefs, seagrass and seaweeds beds, are facing destruction mainly from anthropogenic activities. The low coral cover and abundance of seaweeds is a confirmation of the effect of the activities. Weak implement of existing laws and regulation coupled with low political willpower exacerbate the worsening reef and other coastal habitats in the Gulf. Presence of MPAs can serve as a platform for development and research activities in the gulf. Strong policies will power of the local government and enforced to encourage and rally behind conservation and rehabilitation of critical marine habitats. Also, research and academic institutions should work in partnership with the LGU and other non-government organizations that do advocacies and environmental protection. Implementers of successful MPAs have capitalized on this social synergy to meet scientific and socio-economic and ecosystem objectives. Developing local research institutions by enhancing their capability and increasing their participation to research and development activities should catalyze the science-management link for biodiversity conservation. For the gulf, a key potential ecological benefit from an MPA is so-called "seeding effect" or spill-over effect whereby scallop gametes and larvae are dispersed over an area much larger than the reserve

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