Vol. 1 No. 1 December 2010
CHED Accredited Research Journal, Category A
Print ISSN 2094-5019 • Electronic ISSN 2244-0461
doi: http://dx.doi.org/10.7828/ajob.v1i1.106

Asian Journal of Biodiversity
Art. #106, pp. 139-164

Fish Diversity, Ecological Status, and Conservation Measures of the Coastal Waters in Tubay, Agusan del Norte, Philippines

MARK ANTHONY P. ALIMA
JOSE HERMIS P. PATRICIO
sporting_ph@yahoo.com
Department of Environmental Science
Central Mindanao University

Date Submitted: Oct. 7, 2009
Final Revision Complied: Dec. 1, 2009

Abstract - This study was conducted primarily to determine fish diversity of the coastal waters of mining areas in Tubay, Agusan del Norte. There were 23 fish species identified belonging to 19 genera and 12 families. Indo-pacific sergeant fish (*Abudefduf vaigiensis)* was relatively the most abundant in all the three stations comprising more than 25% of the total. Station 1 had the most numerous (556) and diverse (1.969) fish species. There was a significant difference in the number of fish individuals but had no significant difference on species diversity index with respect to sampling stations. Station 2 had the highest species richness index (0.633), while Station 3 had the most even distribution (0.817). Stations 1 and 2 were 77.8% similar. The average water depth, temperature, transparency, pH and salinity were 4.52 meters, 26.53 ºC, 3.97 meters, 8 and 34.33 ppt, respectively. These all fall within the DENR standards for Class SC water.

Keywords - Fish diversity, properties, conservation, coastal waters

INTRODUCTION

The Philippines being an archipelago is abundant with highly productive habitats and coastal waters. In fact, Conlu (1986) revealed that there are 2,202 species, 718 genera and 207 families of fishes in the country. Because of their vastness, fish resources in the country provide substantial benefits primarily to Filipino fisherfolks in the form of income, food and essential body nutrients. It is likewise a source of valuable foreign exchange for the country's developing economy.

While most of us recognize their economic and ecological importance, still fisheries and coastal resources are seriously threatened due to human activities such as illegal fishing and habitat destruction. These practices are exacerbated by the increased demand for fish brought about by an ever increasing number of Filipinos. The unsustainable utilization of the same has led to declining fish catch, size and species composition around the country.

In Tubay, Agusan del Norte in the southern part of the Philippines, people claimed that the rapid decline of fish catch has become a major problem as majority of those who live in the coastal villages are dependent on fishing. These changes have been observed in recent years since polluting industrial mining and many other destructive human activities take place. It is also noteworthy to mention that the entire area of Tubay had been declared as bird sanctuary while five marine sanctuaries had also been declared in the area.

Such observation had driven the authors of this study to examine and analyze fish diversity of three (3) coastal villages as study sites. These villages are located close to two mining companies that operate in the area. Specifically, the study aimed to: 1) identify fish species in the study area and their ecological status; 2) determine fish diversity and abundance; 3) determine physico-chemical characteristics of the seawater of the study area; 4) find out existing threats and conservation practices on fish species in the study area; and 5) propose policy measures for the conservation of fish species in the study area.

MATERIALS AND METHODS

Locale of the study. The study was conducted in the coastal waters of Tubay, Agusan del Norte in the southern part of the Philippines with grid coordinates of 9º9'37' to 9º18' north latitude and 125º31' to 125º37' east longitude (MPDO, 2008). With a total land area of 13,800 has, the Municipality is comprised of eight coastal villages and five inland villages. Three coastal villages had been chosen as study sites owing to their proximity to two mining sites in the municipality. These villages include Tinigbasan (Station 1), Binuangan (Station 2), and La Fraternidad (Station 3).

Village Tinigbasan is a coastal village which is about ten kms from the nearest mining site. Located northwest of town proper, it has a total land area of 2,159 has, roughly 30% of which is allotted to residential or settlement district and the rest are distributed as farmlands or alienable or disposable areas (MPDO, 2008). On the other hand, Village Binuangan is likewise a coastal village which is about five kms from the town center and is about two kms from one of the two mining sites. It has a total land area of 764.43 has of which 11.28% is declared as alienable and disposable land. The village lies in the northern coast of the Butuan Bay along the seashore of Tubay. Finally, Village La Fraternidad is located nearest to the town proper and is also about two kms from the other mining site. The entire village is declared as alienable and disposable land.

Underwater fish sampling. Underwater fish visual census method was used to estimate diversity of fishes in the study area. One transect each in belt form was established per sampling station. Following the method used by Labrosse, Kulbicki and Ferraris (2002), each belt transect covered an area of 250 m^2 (50m x 5m) which was laid on a constant depth contour to facilitate identification, counting and recording of fishes found within transect boundaries. Snorkeling was used in diving as it was more ideal since the three study sites had water depth average of only 4.52 meters. Starting at one end of the line, fishes were counted for the first 5-meter mark and forward to next 5-meter mark until the 50-meter transect was completed.

Sampling was undertaken on July 1-3, 2008 for Station 1; July 9-11, 2008 for station 2; and July, 14-16, 2008 for Station 3. It was done two times a day (once during high tide and once during low tide) for three consecutive days per study station. A calendar was used to determine the time of tidal changes of the day.

Fish identification and counting, and assessment of ecological status. Fish species observed in the study area were identified using the taxonomic keys of Conlu (1986) and from the Salt Corner and Fish Base Organizations (http://www.saltcorner.com and http://www.fishbase.org). Identification of fish species was confirmed by Prof. Victoria Quimpang, an aqua-marine expert from Central Mindanao University. Fish familiarization during onsite exercise was done beforehand to enhance correct identification of different varieties of fishes. Simple sketches to illustrate fish body and characteristics were done to facilitate fish identification. Underwater and digital camera was also used to verify the identified fish species.

Fish counting was done with the use of underwater slates with attached pencil to record underwater observations. Difficulty in counting fish had been encountered in the conduct of the study due to the limitations of the human eye which can only count four objects at any one time. For this reason, group-counting method which consisted of counting a group of 10 to 20 fishes was used (Labrosse, Kulbicki and Ferraris 2002). To avoid counting same fish more than once, the most abundant fish species was counted first.

The ecological status of all observed fish species was determined based on the International Union for Conservation of Nature (IUCN) Red List (www.iucnredlist.org).

Determination of Physico-chemical Properties of Seawater in the Study Area. Seawater in the three sampling stations was characterized in terms of water depth, temperature, salinity, pH and transparency. This was done once during high tide and another during low tide for three consecutive days per study station. The mean of the measurements was derived.

Perception survey and key informant interview. A perception survey was done using a structured questionnaire. Thirty respondents per village for a total of 90 were chosen through random sampling. Each respondent was selected based on the following criteria: must be a resident of the village and must be at least 18 years old. The survey questionnaire was divided into two parts: 1) respondent's demographic profile, and 2) their perceptions on the threats of fish diversity, and their knowledge and local practices on the conservation and protection of fish resources in the study area. Key informants such as village captains and fisher folks were also interviewed to extract more information necessary in the study.

Statistical Analysis. Data gathered in the study were analyzed based on the following: 1) relative abundance, 2) Shannon-Weiner diversity index, 3) Simpson's dominance index, 4) Shannon's evenness index, and 5) Sorensen's index of similarity.

To test any significant difference in terms of the number of fish individuals and Shannon-Weiner diversity index values among sampling stations and between water tide levels, Analysis of Variance (ANOVA) and the Tukey's Studentized Range (HSD) Test were employed. Meanwhile, data on perception survey conducted were analyzed using simple descriptive statistics such as frequency counts, means, and percentages.

RESULTS AND DISCUSSION

Fish Species Composition, Distribution and Ecological Status

A total of 23 fish species, belonging to 19 genera and 12 families were recorded in the study area (Table 1 and Figs. 1-23). These comprise 1.04% of the total fish species in the Philippines as accounted by Conlu (1986). (The photographs of the fish species are found on pages 157-164 Figs. 1 to 23). The most represented fish species was from the family Pomacentridae which had 11 species while the family Acanthuridae had 2 species. The rest had only one representative species each namely: Balistidae, Chaetodontidae, Labridae, Lutjanidae, Microdesmidae, Mullidae, Nemipteridae, Synodontidae, Tetraodontidae, and Zanclidae. Species under the families Chaetodontidae, Zanclidae, Lutjanidae, Pomacentridae, Synodontidae and Labridae were widely distributed in all the three sampling stations.

All the 23 fish species identified in the study were not in the IUCN red list. This implies that all of these species are not endangered or threatened. Despite this, all fish species must still be conserved and protected because some of them might be useful in some other purposes, e.g. indicator of the health and biodiversity of a coral reef, useful in assessing marketable food species, (Labrosse, Kulbicki and

Ferraris 2002).

In terms of number of species, it is sampling Station 2 which had the highest particularly during low tides (Table 2). However, in terms of individuals, Station 1 significantly had the highest number with a mean of 556 while Station 3 had the least with 310. It is interesting to note that Station 1 was located farthest from the mining areas than Stations 2 & 3. It is however difficult to attribute the relative abundance of fish in any sampling station to the presence of mining activities in the study area as it is beyond the scope of this study.

Meanwhile, the number of fish individuals during low tides (481) was significantly higher than during high tides (398). This is possible since underwater space is widened during high tide which results to the less number of fishes that could be observed. Fishes during this time were also very mobile and the chance of seeing them along the transect is lessened. Indo-pacific sergeant (*Abudefduf vaigiensis*) was relatively the most abundant in all sampling stations.

As indicated in Table 3, fish diversity mean values in the study area are relatively high ranging from 1.922 to 1.992 wherein the difference among stations is not significant. However, it is during low tide that fish diversity is significantly higher as indicated in the ANOVA results. In terms of evenness index, mean values are likewise high ranging from 0.748 to 0.817 which is an indication of a high number of fish species thriving in the study area. Mean dominance values are relatively low as expected as this index is the reverse of diversity and evenness indices. This means that no single fish species is thriving dominantly in the study area.

Sorensen's index of similarity is shown in Table 4. Stations 1 and 2 had the most number of species commonly present to each other with 77.8% similarity. This could be attributed to the presence of healthy corals and lesser sedimentation as observed during the conduct of the study. On the other hand, Stations 2 and 3 were only about 55% similar. It is again noteworthy to mention that these two sampling stations are located more adjacent to the mining areas in the study area.

Table 1. Fish species recorded in the study sites of Tubay, Agusan del Norte (sampling period: July 1-3, 9-11, 14-16, 2008)

FAMILY NAME	**COMMON NAME**	**SCIENTIFIC NAME**	**STATION 1 (JUNE 1-3)**	**STATION 2 (JUNE 9-11)**	**STATION 3 (JUNE 14-16)**
Acanthuridae	Tomini tang	*Ctenochaetus tominiensis* Randall	x	/	/
Acanthuridae	White cheek surgeonfish	*Acanthurus nigricans* Linn.	/	/	x
Balistidae	Orange-lined triggerfish	*Balistapus undulatus* Park	/	/	x
Chaetodontidae	Vagabond butterflyfish	*Chaetodon vagabundis* Linn.	/	/	/
Labridae	Moon wrasse	*Thalassoma lunare* Linn.	/	/	/
Lutjanidae	Checkered snapper	*Lutjanus decussatus* Cuvier	/	/	/
Microdesmidae	Scissortail dartfish	*Ptereleotris evides* Jordan & Hubbs	x	/	x
Mullidae	Dash-dot goatfish	*Parupeneus barberinus* Lacepede	x	x	/
Nemipteridae	Two-lined monocle bream	*Scolopsis bilineata* Bloch	x	/	/
Pomacentridae	Indo-pacific sergeant	*Abudefduf vaigiensis* Linn	/	/	/

Table 1 continued

Pomacentridae	Staghorn damselfish	*Amblyglyphidodon curacao* Bloch	/	/	/
Pomacentridae	Clark's anemonefish	*Amphiprion clarkii* Bennett	/	/	x
Pomacentridae	False clown anemonefish	*Amphiprion ocellaris* Lacepede	/	/	/
Pomacentridae	Pink skunk anemonefish	*Amphiprion perideraion* Bleeker	x	/	x
Pomacentridae	Pearl-scaled angelfish	*Centropyge vroliki* Bleeker	/	/	/
Pomacentridae	Humbug dascyllus	*Dascyllus aruanus* Linn.	/	/	x
Pomacentridae	Bowtie damselfish	*Neoglyphidodon melas* Cuvier	/	/	/
Pomacentridae	Speckled damselfish	*Pomacentrus bankanensis* Bleeker	/	x	/
Pomacentridae	Neon damselfish	*Pomacentrus coelestis* Jordan & Starks	/	/	/
Pomacentridae	Lemon damselfish	*Pomacentrus moluccensis* Bleeker	/	/	/
Synodontidae	Variegated lizardfish	*Synodus variegatus* Lacepede	/	/	/
Tetraodontidae	Yellow dogface pufferfish	*Arothron nigropunctatus* Bloch & Schneider	/	x	x
Zanclidae	Moorish idol	*Zanclus cornutus* Linn.	/	/	/
TOTAL	23		18	20	16

Legend: /- present x-absent

Table 2. Abundance of fish species and individuals in the study area.

STATION	NUMBER OF SPECIES			NUMBER OF INDIVIDUALS		MEAN
	HIGH TIDE	LOW TIDE	TOTAL	HIGH TIDE	LOW TIDE	
1	14	16	18	524	587	556^{a}
2	15	19	20	372	534	453^{b}
3	13	15	16	298	322	310^{c}
MEAN				398^{b}	481^{a}	
TOTAL	19	22	23			1319

Note: Means with the same letter superscript are not significantly different.

Table 3. Diversity, evenness and dominance indices of fish species in the study area.

STATION	SHANNON-WEINER DIVERSITY INDEX			EVENNESS INDEX			DOMINANCE INDEX		
	High Tide	Low Tide	Mean	High Tide	Low Tide	Mean	High Tide	Low Tide	Mean
1	1.960	1.977	1.969^{a}	0.758	0.737	0.748	0.203	0.177	0.190
2	1.907	2.077	1.992^{a}	0.761	0.755	0.758	0.181	0.160	0.171
3	1.844	2.0	1.922^{a}	0.824	0.809	0.817	0.179	0.160	0.170
MEAN	1.904^{b}	2.018^{a}		0.781	0.767		0.188	0.166	

Note: Means with the same letter superscript are not significantly different.

Table 4. Similarity index of fish species observed in the sampling stations.

STATION	SIMILARITY INDEX, %		
	1	2	3
1	-	77.8	74.1
2	77.8	-	55.2
3	74.1	55.2	-

Physico-chemical Properties of Seawater in the Study Area

Certain physical and chemical properties of seawater in the three sampling stations were determined in the course of the study (Table 5). The study area has an average water depth of 4.52 meters, water temperature of 26.53 °C, water transparency of 3.59 meters, water pH of 8, and salinity of 34.33 ppt. These parameters were determined as these might affect the distribution pattern and abundance of fish species in the study area. The measured parameters all fall within the acceptable standards set by the DENR (2008) for Class SC waters.

Perceived Threats to Fishery Resources in the Study Area

A perception survey was conducted representing 30 respondents from each village covered in the study for a total of 90 respondents. Majority of them were fisherfolks themselves who had been staying in the area for almost 20 years. Four major environmental threats were identified which include mining, overfishing, improper domestic waste disposal and fish poisoning. Respondents from Village La Fraternidad all perceived that mining activities in the area are causing decline in fish population in their locality (Table 6 p. 151). The same observation was shared by almost all respondents from the other two sampled villages. Such perception is expected as Villages Binuangan and La Fraternidad are hosts to two mining companies in the area, namely: SR Metals, Inc. and Minimax Mineral Exploration Corporation. If not properly managed, mining activities could lead to soil erosion and sedimentation. Such is then detrimental to sea grasses and coral reefs of impact villages. This is very crucial because the greatest marine

Table 5. Physico-chemical properties of the seawater in the study area.

PROPERTIES	STATIONS									GRAND MEAN
	1			2			3			
	HT	**LT**	**MEAN**	**HT**	**LT**	**MEAN**	**HT**	**LT**	**MEAN**	
Depth, m	3.01	1.50	2.26	6.72	4.84	5.78	6.55	4.51	5.53	4.52
Temperature, ºC	26.44	26.11	26.28	26.33	27.0	26.67	26.67	26.65	26.66	26.53
Transparency, m	3.01	1.50	2.26	4.55	3.72	4.14	4.35	4.41	4.38	3.59
pH	8	8	8	8	8	8	8	8	8	8
Salinity, ppt	34.33	34.33	34.33	34.33	34.67	34.5	34.33	34.0	34.17	34.33

Legend: HT-high tide; LT-low tide; ppt- parts per thousand biodiversity can be found in the mixed coastal fauna of coral reefs, mangroves and seagrass beds, including approximately 2000 species of fish (NFEFI, 2008).

Overfishing has likewise been the cause of fish catch decline according to most of the respondents. Like in many cases, this can be attributed to the open access nature of the fishery in the coastal area. Anybody can fish at any time and harvest without limit. The use of catch-efficient gears such as fine mesh nets is prevalent in the area. This has proliferated because of the very poor enforcement of fishery laws. Bohnsack (1994) reported that if too many fish are removed too quickly, the reproductive capacity of the stock or population may be impaired and the fishery declines. Acknowledging that fishes in the Philippines are generally being harvested at very high levels, Trinidad, Pomeroy, Corpuz and Aguero (1993) have long recommended that the country must decrease fisheries activities by about 50-65%.

Many respondents also believed that improper solid waste disposal and poor sewage facilities have led to reduction in fish abundance and diversity in the area. The municipality has no systematic garbage collection. It does not even have an in-place Ecological Solid Waste Management Plan. Consequently, garbage has found its way to rivers and coastal waters. Sewage treatment systems are likewise deficient which would expectedly lead to contamination of well waters, rivers and coastal waters. Smith (2006) reported that only 10% of sewage in the Philippines undergoes treatment or disposal through environmentally sound manner. Improperly disposed solid waste and sewage would eventually end up in the sea. About 50% source of marine pollution in the country is due to runoff and land-based discharges. All these contaminants may cause red tide events that kill or make shellfish and some fish species toxic.

The problem of overfishing is further aggravated by the use of poisons (poisonous plants like *tubli and lagtang)* to increase fish catch in the area. This practice is unsustainable as it may kill juvenile fishes and coral polyps. Based on studies conducted, the most common chemical utilized in fish poisoning is cyanide. Smith (2006) reported that collectively, the so-called "search and destroy" fisherman sprays nearly 400,000 kilos of sodium cyanide on Philippine coral reefs annually. Reefs where cyanide is spread will first form black slime,

Table 6. Threats to fishery resources in the study area as perceived by the respondents (July 4, 8 & 13, 2008).

PERCEIVED THREAT*	**STATION 1 Tinigbasan**		**STATION 2 Binuangan**		**STATION 3 La Fraternidad**		**GRAND TOTAL**	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Mining	25	25.5	27	31.0	30	38.5	82	31.2
Overfishing	28	28.6	29	33.3	16	20.5	73	27.8
Domestic waste	25	25.5	18	20.7	19	24.3	62	23.5
Fish poisoning	20	20.4	13	15.0	13	16.7	46	17.5
TOTAL	98	100	87	100	78	100	263	100

* With multiple responses

and eventually become dead coral rock, driving away marine life. However, other chemical substances such as poisonous plants, bleach, chlorine, and even liquid dish soup are also used.

Existing Coastal Resource Management Practices Adopted in the Study Area

Based on the results of the key informant interview and perception survey conducted, the local government units together with fisherfolks in the area adopted the following management practices so as to protect and conserve fishery resources in the area: 1) establishment of a fish sanctuary; 2) conduct of information, education and communication campaigns (IEC); 3) putting up of artificial coral reefs; and 4) establishment of mangrove plantations.

Russ & Alcala (1999) said that the creation of a fish sanctuary can contribute effectively to the enhancement of fisheries and protection of reefs from destructive fishing. All of the respondents from the three sampled villages fully agreed that indeed the establishment of fish sanctuary in the area has helped in the conservation and protection of their fishery resources. Meanwhile, the conduct of IEC campaigns particularly seminars have also been instituted in the area as reported by more than 25% of the respondents. Increased awareness through seminars and other similar activities could lead to educating and empowering the local people to control their situation, and the sustainability of the protected area will be prolonged (Russ and Alcala, 1999).

Another strategy adopted was the putting up of artificial coral reefs although this practice has not been widely applied in the study area as people claimed that it is relatively expensive. However, the local government should strive to adopt this practice as providing suitable substrates for coral recruits speeds up the recovery of destroyed or degraded reefs and increase coral cover (Heeger, Sotto, Gatus. Laron and Huttche 2000; Edwards & Clark 1998).

Finally, although only a very few of the respondents adopt this management strategy, it is really important to establish and protect mangrove plantations in the area as they serve as habitat and nursery ground for fish species, prevent siltation and can balance the nutrient level of the sea water (Russ and Alcala, 1999).

CONCLUSIONS

Based on the results of the study, the following conclusions are drawn:

1. The study area during the sampling period is composed of 23 species of fish belonging to 19 genera and 12 families, the most abundant of which is Indo-pacific sergeant fish (*Abudefduf vaigiensis*). All of the species identified were not found in the IUCN red list.
2. There was a significant difference in the number of fish individuals but had no significant difference on species diversity index with respect to sampling stations. However, the number of fish individuals and species diversity are significantly higher during low tides.
3. Coastal waters of the study area still fall within the DENR standards for Class SC water.
4. The identified local threats to fishery resources in the study area include mining, overfishing, improper disposal of domestic waste and fish poisoning.
5. The identified fish conservation practices in the study area include the creation of fish sanctuary, the conduct of seminars, construction of artificial coral reefs and establishment of mangrove plantation.

RECOMMENDATIONS

Based on the foregoing, the researchers would like to recommend the following:

1. Participatory assessment and monitoring of fishery resources in the area including sea grasses and mangroves should be done regularly. This should be a multi-partite undertaking which may be composed of researchers, and representatives of DENR, local government units, the business sector such as that of mining companies, people's organizations such as fisherfolks, church and other stakeholders in the area. Participatory assessment and monitoring is not only a research tool, but it also serves as an agent to educate both resource users and decision makers;

2. Knowing the various threats to fishery resources in the area, the Municipality of Tubay together with other stakeholders should strive to come up with an integrated and comprehensive co-management agreement plan for the protection and conservation of fishery resources in the area. This is in compliance to Executive Order No. 533 as a strategy to ensure sustainable development of their coastal and marine resources;

3. While waiting for the co-management agreement scheme to get in-place, an intensified public awareness and education campaign must be done so as not to further aggravate the extent of destructive fishing-related activities in the area. Information on the importance and status of coastal and marine resources in the area and how they could be managed should be published not only in English but also in the vernacular;

4. Considering the presence of mining activities and the lack of a systematic solid waste management plan in the area, the LGU in coordination with other concerned government agencies and NGOs should strictly implement with strong political will pertinent environmental laws particularly those that address violations of provisions of RA 7942 (Phil. Mining Act of 1995), RA 9003 (Ecological Solid Waste Management Act of 2000), and RA 9275 (Philippine Clean Water Act). It is also important for the concerned LGUs to continue the strengthening local organizations to enforce coastal laws, such as the coast guard (*Bantay Dagat)*;

5. Alternative local livelihood programs should be provided to ease pressure on fishery resources in the area. This could be in the form of employment through ecotourism, businesses/industries nearby or perhaps engaging in agriculture. However, the provision of any livelihood program for the local populace particularly fisherfolks should not, in the process, result to the creation of a new environmental problem which has happened in many cases; and,

6. The LGU should also spearhead in addressing impacts of climate change such as sea-level rise and destruction of coral reefs on coastal and marine resources in the area. While it was beyond the

scope of this study, finding viable solutions to this environmental problem would consequently result also to enhancing fish diversity and abundance in the area.

LITERATURE CITED

Bohnsack, J.A.
1994. Marine reserves: they enhance fisheries, reduce conflicts and protect resources. Naga, Philippines: 4-7pp.

Conlu, V.
1986. Guide to Philippine flora and fauna: fishes. Volume IX. Natural Resources Management Center, University of the Philippines.

DENR [Department of Environment and Natural Resources].
2005. The State of Philippine biodiversity. Retrieved from the World Wide Web, August 15, 2008. http:/www.bwf.org.

Edwards, A.J. and S. Clark
1998. Coral transplantation: a useful management tool or misguided meddling? Marine Pollution Bulletin. 474-487pp.

Heeger, T., F. Sotto, J. Gatus, C. Laron, and C. Huttche
2000. Coral Farming, A Tool for Reef Rehabilitation and Community Ecotourism. Coral Farm Project for the Sea and the People of the Sea:1-3pp.

IUCN [International Union for Conservation of Nature] Red List.
2001. Retrieved from the World Wide Web September 1, 2008. http://www.iucnredlist.org.

Labrosse P., M Kulbicki and J. Ferraris
2002. Underwater visual fish census surveys. Reef Resource Assessment Tools (REAT), Secretarial of the Pacific Community Noumea, New Caledonia.

MPDO [Municipal planning and development office].
2008. Municipal profile. Tubay, Agusan del Norte, Philippines. Hon. Municipality Mayor Fidel E. Garcia Jr.

NFEFI [Negros Forest and Ecological Foundation, Incorporated].
2008. Biodiversity in the Philippines. Retrieved from the World Wide Web. http:/www.nfefi.org.

Russ, G.R. and A.C. Alcala
1999. Management histories of Sumilon and Apo Marine Reserves, Philippines, and their Influence of National Marine Resource Policy. Coral Reefs:307-319pp.

Trinidad, A.C., R.S. Pomeroy, P.V. Corpuz and M. Aguero.
1993. Bioeconomics of the Philippine Small Pelagic Fishery: 38pp.

Smith, R.
2006. Go easy on the sea, the fisheries improved for sustainable Harvest Project, Cebu City Philippines. Retrieved from the World Wide Web, December 19, 2007. www.oneocean.org.ph.

Species observed in the study sites.

Fig. 1. *Ctenochaetus tominiensis* Randall*

Fig. 2. *Acanthurus nigricans* Linn.*

Fig. 3. *Balistapus undulatus* Park*

Fig. 4. *Chaetodon vagabundis* Linn.

Fig. 5. *Thalassoma lunare* Linn.

Fig. 6. *Lutjanus decussatus* Cuvier

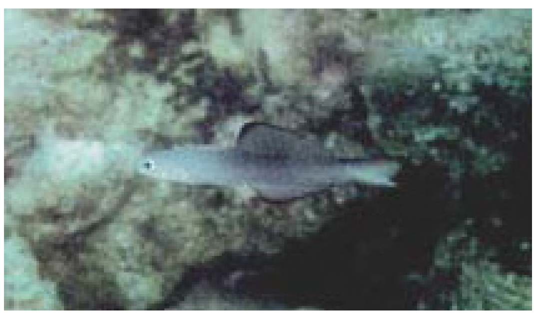

Fig. 7. *Ptereleotris evides* Jordan & Hubbs

Fig. 8. *Parupeneus barberinus* Lacepede

Fig. 9. *Scolopsis bilineata* Bloch*

Fig.10. *Abudefduf vaigiensis* Linn

Fig. 11. *Amblyglyphidodon curacao* Bloch

Fig. 12. *Amphiprion clarkii* Bennett*

Fig. 13. *Amphiprion ocellaris* Lacepede

Fig. 14. *Amphiprion perideraion* Bleeker*

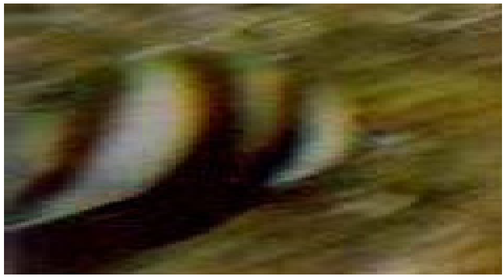

Fig. 15. *Centropyge vroliki* Bleeker

Fig. 16. *Dascyllus aruanus* Linn.*

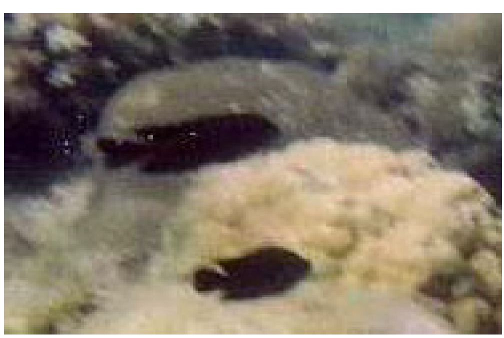

Fig. 17. *Neoglyphidodon melas* Cuvier

Fig. 18. *Pomacentrus bankanensis* Bleeker*

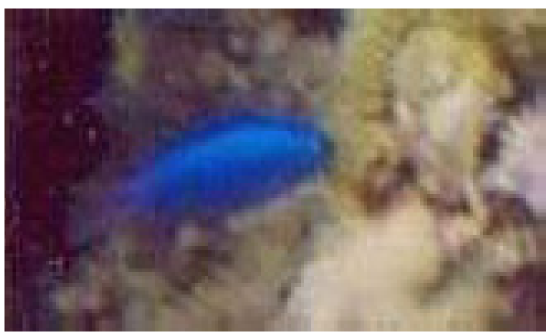

Fig. 19. *Pomacentrus coelestis* Jordan & Starks

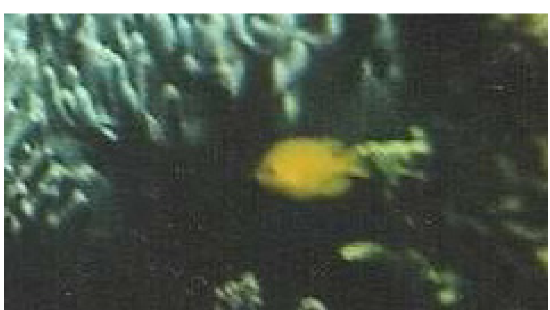

Fig. 20. *Pomacentrus moluccensis* Bleeker

Fig. 21. *Synodus variegatus* Lacepede

Fig. 22. *Arothron nigropunctatus* Bloch & Schneider*

Fig. 23. *Zanclus cornutus* Linn.*

Note: Photos with asterisk (*) sign were sourced from the internet (http://en.wikipedia.org/wiki/FishBase) while those without asterisk were actual shots in the study sites.