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Inventory of ecologically-important fish species in Bugang River, Philippines

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Abstract. Bugang River is recognized as one of the cleanest river in the Philippines and a popular tourist destination in Panay Island for its Malumpati Health Spring and Tourist Resort, however Bugang River's biota is not well known. This study aimed to provide baseline information on fishes present in Bugang River. A survey was conducted for four months (November 2013 to March 2014) using a variety of gears including gill net, filter net, scoop net, hook and line, and local contrivances made of bamboo such as modified fish weir and traps. Four sites, representing upstream, upper midstream, lower midstream and downstream served as the sampling areas. The study revealed the occurrence of thirty-eight (38) species in the river belonging to thirty (30) genera and twenty (20) families. Eleotridae is the most dominant family, with six species, followed by Gobiidae (four species). The fishes were also ecologically classified based on their origin and tolerance to saltwarer, indicating that majority of the fishes were sporadic visitors. Migratory fishes were also seen representing a minor proportion of the population.
Key Words: Bugang River, Malumpati Health Spring and Tourist Resort, biodiversity, freshwater fishes, migratory, sporadic visitors.

Introduction. Fish populations have engendered a wide array of ecological benefits among human societies. Fish are conspicuous for their function in food chain, nutrient cycling and regulation of biological processes, among others. Owing to their daily, seasonal and annual migration patterns across spatial borders, fish effeciently serve as active and passive carriers and dispensers of nutrients, energy and genetic reserves. Functional significance of fish also includes genetic library, which may evenly be useful in the domains of medicine and of aquaculture (Hammer & Holmlund 1999). Freshwater constitutes only 1% of the entire expanse of the earth (Helfrich et al 2009). Tiny fraction though, freshwater is a home for at least 100,000 species out of the 1.8 million identified ones (Dudgeon et al 2006). There are 28,900 species of fish that have been identified (Butler 2006), greater proportion of it is found in marine waters, accounting for some 58%. Conversely, the remaining 41% have been found to occur in freshwater bodies and 1% is identified as diadromous (Helfrich et al 2009).

In terms of biological diversity, freshwater habitats are classified as one of the richest (Ward & Tockner 2001). Freshwater fish species can be categorized into two groups on the basis of the postulated habitats of their ancestors. Comprised of around 8,000 species, the first group termed as the primary freshwater species, is deemed to have first emerged in fresh water bodies. Conversely, the second group with 1,500 species is assumed to have originated from marine species and is coined as secondary freshwater species (Allen 1982).

Rivers in the tropics, particularly in Asian countries support a rich but barely known biota (Allen 1991). While they serve significant functions in human populations, tropical Asian rivers remained poorly understood and studied (Kottelat & Whitten 1996). In the Philippines, recent studies have been done by some institutions to prime the biodiversity analysis of some riverine systems.

A diverse assortment of freshwater fish fauna was shown to occur in some riverine systems that have been surveyed in the Philippines. The Makiling Forest Reserve alone is

a home for sixteen species of freshwater fish species. This figure was recorded from the three watersheds of the reserve. Included in the list is an endemic species, five native species and ten introduced species. The reserve is dominated by species from families Gobiidae and Poeciliidae (Paller et al 2011).

A freshwater body from Negros Occidental, the Bago River was assessed in reference of its fish faunal composition. The river supports fifty-five species of fish belonging to thirty-three families (Pacalioga et al 2010). Forty-eight species were collected during the wet season, and thirty-three for the dry season. The family Gobiidae dominated the count, with seven species, followed by the family Ophichthidae (six species). The 5 tributary rivers of Subic Bay Forest Reserve in Zambales indicated 16-40 species of fish collected from each site (Pagulayan, n.d.). A number of endemic and native species were also found to occur in substantial numbers in this area.

There are also a number of unique species of freshwater fishes that are known to be confined only to isolated rivers and lakes in the country (Herre 1953; Paller et al 2011). Included here are gobies, halfbeaks and pipefishes whose status on these freshwater environments is not yet fully known (Herre 1953; Butler 2006). The most diverse group among the freshwater fishes in the Philippines are gobies, with 16 species found only in the country (Froese & Pauly 2010; Eschmeyer 2011). Interestingly, the world's only known freshwater sardine, *Sardinella tawilis* occurs only in Taal Lake (Herre 1927; Hargrove 1991). The country is also endowed with a species of rice fish from the Family Adrianichthyidae, *Oryzias luzonensis* (Herre & Ablan 1934; Froese & Pauly 2014).

Philippines belongs to the megadiversity hotspots and endemism centers of the world (Mallari et al 2001). Great potentials in terms of species biodiversity lie on Philippine inland waters. However, much of the studies have been devoted in marine biodiversity, and little is known about the diversity of freshwater life forms (Ong et al 2002). Freshwater fish are among the most endangered groups because of their high vulnerability to aquatic habitat modification (Laffaille et al 2005; Kang et al 2009; Sarkar et al 2008). Further, considerable proportion of inland waters in the globe has experienced serious threats. Among these hazards are habitat degradation, conversion to private use, impacts of climate change and pollution, overexploitation and introduction of invasive species (Bagarinao 2001; Cagauan 2007; Vidthayanon 2007). This could lead to the endangering and eventually, the loss of inherent fish faunal population in the area even before they are studied. Hence, this study was conducted to collect and record fish species present in Bugang River, which can provide supplemental data on assessing the biodiversity of freshwater enviroments in the Philippines.

Material and Method

Description of the study area. The map of Bugang River (Figure 1) shows the location of the four sampling sites. These are headstream, upper midstream, lower midstream and downstream areas. These sites were selected based on the distance from the river mouth and the data gathered through global positioning system.

The four sampling sites of Bugang River have different vegetative cover, geomorphology, and existing anthropogenic activities that may have potential influence on the habitat's biodiversity. The upstream area (11° 46.3873' N, 122° 4.5826' E) is covered by intensive riparian vegetation and steep land walls. Substrate is dominated by sand and rocks. The depth varies from 3-7 feet on areas prior to the headstream, but the headstream itself is 3-40 meters deep. The upper midstream area (11° 46.0306' N, 122° 4.6109' E) is surrounded by semi-intensive riparian cover and substrate is rocky-sandy. The depth in this area ranges from 2-7 feet. The Malumpati Cold Spring is a part of this site. The lower midstream site (11° 45.2164' N, 122° 4.4699' E) is characterized as mixed fresh and brackish water area lined with *Nypa fruticans.* The substrate is largely sandy-muddy and depth in this section ranges from 2-7 feet. The downstream area (11° 44.9157' N, 122° 4.3585' E) varies from 2-3 feet in depth. Mangroves are present in this area - *Sonneratia alba*, *Lumnitzera littorea, Rhizophora stylosa*, *N. fruticans*, *Avicennia marina*, among others. The river bed is generally sandy-muddy and is covered by thick layer of muddy substrate in the mouth. This is where the river converges with Pandan

Bay. Bugang River (11° 44.9157' N, 122° 4.3585' E) is situated in Pandan, Antique, Philippines. The river is 6 km long, and includes shallow rocky areas and sandy-muddy bottoms. The water depth varies from the headstream at around 30-40 meters to the downstream, with some parts exposed during low tides. Bugang River traverses five (5) barangays namely: Brgy. Cadari, Brgy. Santo Rosario, Brgy. Guia, Brgy Zaldivar and ends at Brgy.Mag-aba. It then converges with Pandan Bay.

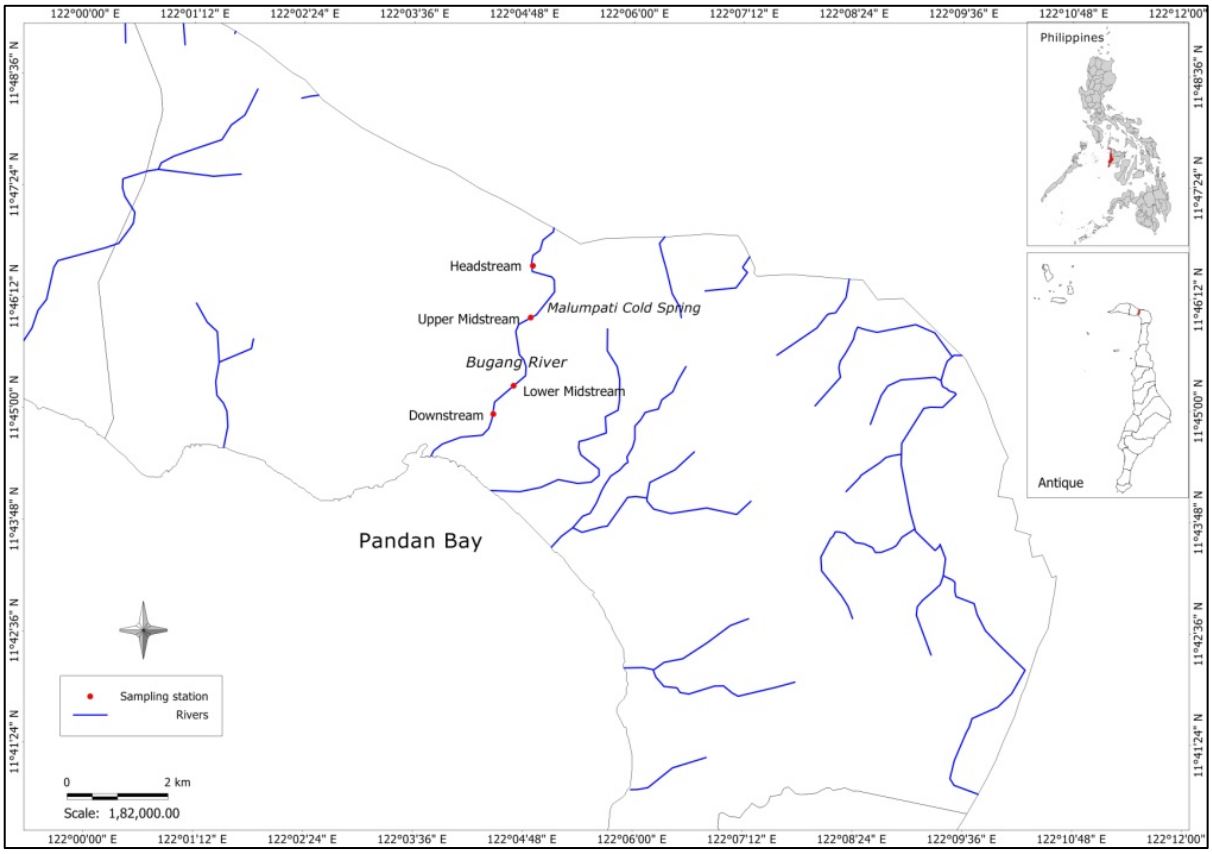

Figure 1. Map of Bugang River showing location of the four sampling sites (original).

Bugang River seizes one of the top tourist destinations in Panay, the Malumpati Health Spring and Tourist Resort. Locals believe that the spring possess healing attributes, hence its name. Apart from its distinct value in tourism, the river is also a source of potable water in Pandan. Bugang River was also recognized as the cleanest inland water body in the Philippines during the First National Summit on the State of Philippine Rivers in 2005, winning the "Dangal ng Ilog" Award. It is also a recipient of the "Hiyas ng Turismo" Award granted by the Gawad Pangulo sa Kapaligiran in 2006.

Anthropogenic activities, such as laundry and fishing exist in the area but are substantially established with limitations. In effect of an ordinance imposed by the Local Government Unit of Pandan, fishing activities are carried out only using passive gears such as shrimp pots and hook and lines.

Sampling methods. The four sampling sites were examined and the collection spots were selected randomly. Fish samples were collected using different gears such as gill net (32 m x 1.3 m), filter net, hook and line, scoop net and local contrivances such as fish traps and modified fish weir made of bamboo (locally known as "*lipa-lipa")*. Sampling was conducted from November 2013 – March 2014 and carried out during day time and night time. Collected samples were identified in the laboratory facilitated by various references such as Migdalski & Fichter (1976), Randall (1995), Matsuura et al (2000), Masuda et al (1984), Conlu (1986), and the FAO Species Identification Guide to Fishery in the Western Central Pacific Series (Carpenter & Niem 1999a, b). After identification, the specimens

were fixed with 10% formalin solution and were photographed for further analysis and identification (Motomura & Ishikawa 2013).

Results and Discussion. Thirty-eight species (38) from thirty genera belonging to twenty families were recorded (Table 1) from the four sampling sites of Bugang River. Eleotridae is the most abundant family (Figure 2), with the highest number of species (six) followed by Gobiidae (four), while Families Mugilidae and Tetraodontidae had three species each; Ambassidae, Carangidae, Gerreidae, Mullidae, and Terapontidae had two species respectively, and the remaining eleven (11) families had a single species each. Among the 8 orders found in the area, Perciformes is the most dominant, contributing to 56% of the fish fauna; Mugiliformes and Tetraodontiformes follow, each accounts for 14% of the fish population.

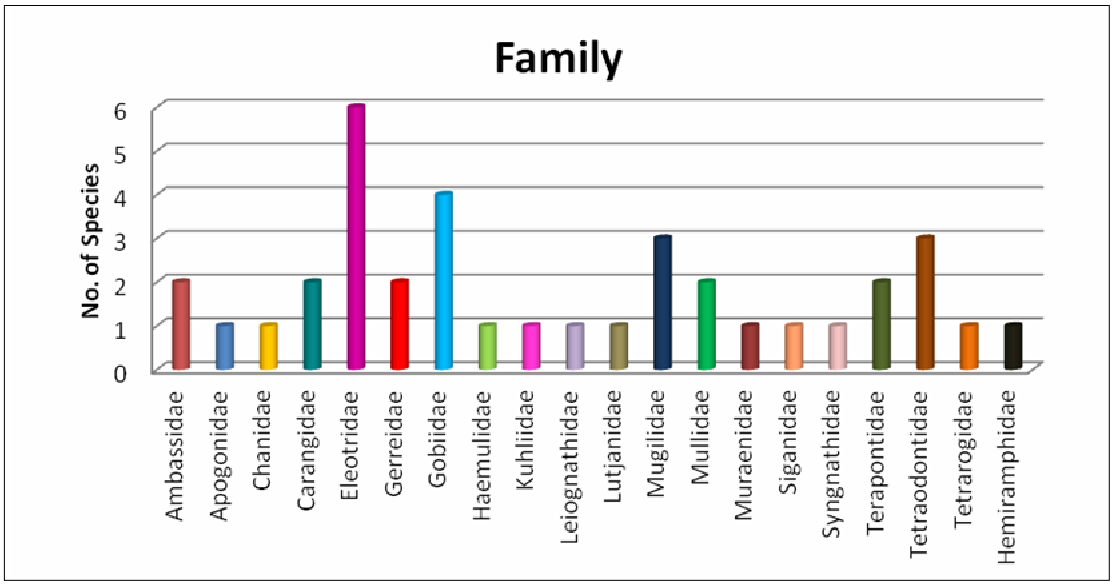

Figure 2. Number of fish families in Bugang River.

Among the 38 species, no primary and secondary freshwater fishes were recorded in the area; five species are migratory, and the remaining thirty-three species are sporadic visitors. They were observed in all sampling sites, with sporadic visitors dominating the population (Figure 3). This categorization is based on the ecological classification of Davies (1997) reflecting their origins and their tolerance to saltwater.

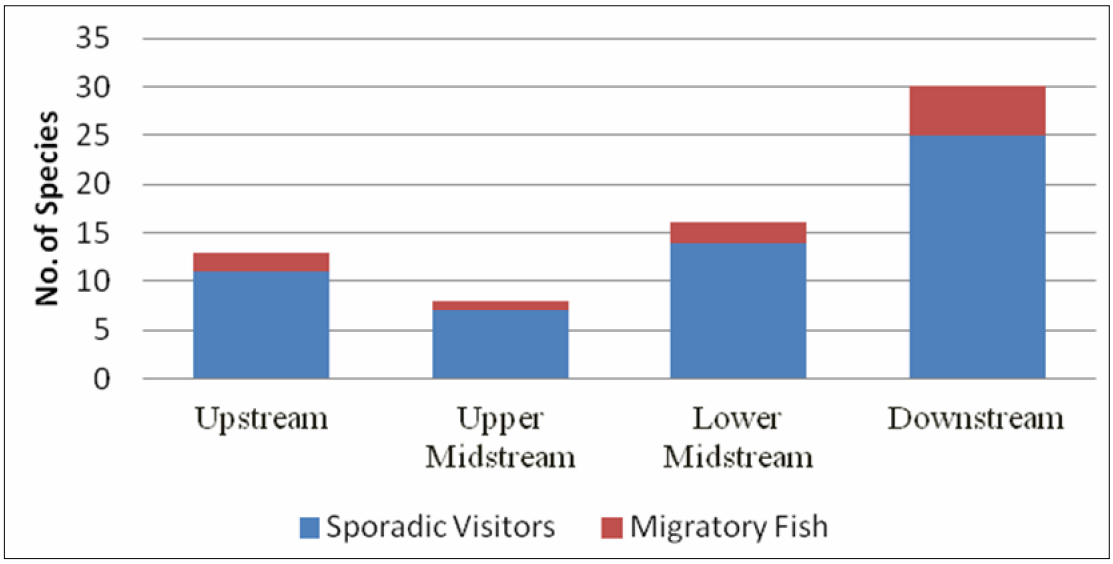

Figure 3. Fish species composition in four sampling sites.

Table 1

List of fish species recorded in Bugang River

Family	*Species*	*Common English name*	*Local name*	*HS*	*UM*	*LM*	*DS*
Chanidae	*Chanos chanos*	Milkfish	Bangrus	-	-	-	+
Carangidae	*Caranx sexfasciatus*	Big eye trevally	Ngayaw	-	-	+	+
	Caranx ignobilis	Giant trevally	Ngayaw	-	-	-	+
Mullidae	*Upeneus sulphureus*	Sulphur goatfish	Ti-aw	-	-	-	+
	Upeneus vittatus	Striped goatfish	Ti-aw	-	-	+	-
Mugilidae	*Chelon subviridis*	Green back mullet	Gisaw	+	+	+	+
	Liza macrolepis	Largescale mullet	Gisaw	-	-	-	+
	Liza vaigiensis	Squaretail mullet	Gisaw	+	-	+	+
Gerreidae	*Pentaprion longimanus*	Longfin silverbiddy	Murok	-	-	-	+
	Gerres filamentosus	Whipfin silverbiddy	Murok	-	-	-	+
Tetrarogidae	*Tetraroge niger*	Wasp fish	Lupo	-	-	-	+
Eleotridae	*Butis butis*	Duckbill sleeper	Kimi	-	-	-	+
	Genus *Eleotris*	Sleeper	Ubog	+	+	+	+
	Ophiocara porocephala	Northern mud gungeon	Ubog	+	+	+	-
	Giuris margaritacea	Snake head gudgeon	Bagtis	+	+	-	-
	Oxyeleotris marmorata	Marble goby	Ubog nga tanga	+	-	-	-
	Belobranchus belobranchus	Throat spine gudgeon	Tanga	+	-	-	-
Gobiidae	*Exyrias puntang*	Silver spotted goby	Bagtis	+	-	-	+
	Genus *Glossogobius*	Goby	Kimi	-	-	-	+
	Periophthalmus argentilineatus	Barred mudskipper	Tambasakan	-	-	+	+
	Genus *Awaous*	River goby	Bagtis	+	-	-	-
Kuhliidae	*Kuhlia marginata*	Spotted flagtail	Dumagan	+	+	-	+
Terapontidae	*Terapon jarbua*	Jarbus terapon	Buga-ong	-	-	-	+
	Mesopristes cancellatus	Tapiroid terapon	Buga-ong	-	+	-	-
Leiognathidae	*Leiognathus splendens*	Splendid ponyfish	Lawayan	-	-	-	+
Ambassidae	*Ambassis interrupta*	Long-spined glass perchlet	Rangan	+	+	+	+
	Ambassis urotaenia	Banded-tail glassy perchlet	Rangan	+	+	+	+
Haemulidae	*Pomadasys argenteus*	Silver grunt	Uli-balay	-	-	+	+
Apogonidae	*Apogon semilineatus*	Lateralstripe cardinal fish	Mu-ong	-	-	+	+
	Apogon hyalosoma	Humpbacked cardinalfish	Mu-ong	-	-	+	-
Hemiramphidae	*Zenarchopterus dispar*	Feathered river garfish	Siliwan	-	-	+	+
Siganidae	*Siganus guttatus*	Orange spotted spinefoot	Danggit	-	-	-	+
Syngnathidae	*Hippichthys spicifer*	Belly barred pipefish	Likog-likog	-	-	+	+
Tetraodontidae	*Arothron reticularis*	Reticulated puffer	Butete	-	-	-	+
	Arothron manilensis	Narrow-lined puffer	Butete	-	-	-	+
	Arothron immaculatus	Immaculate puffer	Butete	-	-	-	+
Muraenidae: Subfamily Uropterygiinae	*Uropterygius concolor*	Unicolor snake moray	Nipa-nipa	-	-	+	+
Lutjanidae	*Lutjanus argentimaculatus*	Mangrove red snapper	Mangagat	+	-	+	+
Total no. of species per site:				13	8	16	30

HS – Headstream, UM – Upper Midstream, LM – Lower Midstream, DS - Downstream.

Fish species composition in each sampling site was compared and the results indicate that sporadic visitors such as species from Eleotridae, Ambassidae, and Gobiidae, were collected in all sampling stations. Another sporadic visitor with marine origin, mangrove red snapper (*Lutjanus argentimaculatus*), was also found far-off inland in the upstream region of the river. Migratory species such as representatives from Family Mugilidae (*Chelon subviridis* and *Liza vaigiensis*) were collected from the upper midstream and the headstream areas.

A number of sampling techniques were employed in this study to acquire a comprehensive data of fish species occurring in the entire stretch of Bugang River. To compensate for the limitations of each sampling gear and the disparity in preferred habitat types of different fish species, various sampling methods were used. Gill netting is applicable in still waters with sandy-muddy to rocky-sandy substrates. Modified fish weir, a local contrivance which is made of bamboo, is used at headstream area. In fast moving and deep waters (6-7 feet) where gill netting cannot be done, hook-and-line is more applicable. Scoop net was also employed in collecting mudskippers, other gobies,

sleepers, eels, cardinal fish, pipe fish which could not be caught by gillnet with larger-sized mesh.

Bugang River has a rich fish faunal composition. Fish species of Bugang is comparable to Bago River in Negros Occidental, Philippines with fifty-five (55) species (Pacalioga et al 2010), Langaran River in Misamis Oriental with twenty-six (26) species (Gomez-Roxas et al 2005) and to the major watersheds of the Makiling Forest Reserve in Laguna with sixteen (16) species (Paller et al 2011).

Riverine and estuarine habitats have physical features that provide home for different fish species. Included here are aquatic plants, their roots, logs and woody debris, rocks and overhanging vegetation. These habitats mainly offer food sources, protection from current, and serve as refuge from predators (Angermeier & Karr 1984). Mangroves along brackish waters also serve as an important habitat type for many species of juvenile fish owing to their pneumatophores, prop roots and fallen woody remains (Robertson & Duke 1987). Fresh and brackish waters act as nurseries for a variety of fish species including sea bass (*Lates calcarifer*), rabbit fish (*Siganus* sp.), herring (*Megalops cyprinoids*), mullet (Mugilidae) and Teraponids (Teraponidae) (Russell et al 2003).

In a riverine system, fish species richness normally follows an increasing pattern from upstream to downstream (Welcomme 1985; Bayley & Li 1994). Adhering to this, species richness of fish in the Bugang River was found to be highest in the downstream region (Figure 3). A total of thirty (30) species belonging to twenty families were collected in this area, with Gobiidae, Tetraodontidae and Mugilidae as the most abundant, contributing 3 species respectively. The high species richness in this area is accounted to its proximity to Pandan Bay. The mangroves along the area and sandy-muddy substrate furnished diverse habitats for fishes. Meanwhile, the lowest species richness was observed in the upper midstream. Eight species from 5 families were noted in this site. The reason for low species richness might be due to presence of exploiting efforts in the spot. It must be noted that the Malumpati Cold Spring, an important tourist destination in Pandan, is situated here, contributing considerable anthropogenic efforts in the site, particularly swimming and fishing.

Conclusions. Bugang River supports a rich population of fish species. Thirty-eight species of fish have been recognized, although classification of few individuals was limited to genus level to avoid misidentification. Further, evaluation of the economic utilization of Bugang River indicated that it supports many food fish, as exemplified by interviews from local people.

Revealing the fish species richness of Bugang River further enhances its tourism significance. The fish faunal population thriving in the area typifies its distinction as a natural attraction. Stirring more interest to travellers and sight seers, especially those that want to be drawn closer to environment and its wildlife, the tourism industry of Pandan, Antique can have more superior potentials.

In due course, this calls for sounder and firmer management strategies for the conservation of Bugang River. Plans must gear towards the responsible and sustainable utilization of the river system and its biota. Measures have to be directed towards the regulation of human activities within the river body, such as limiting fishing efforts to simple hook-and-line, gill netting with standard mesh size and bamboo traps and pot to minimize disturbance and inhibit destruction or alteration of microhabitats.

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