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DIVERSITY AND ABUNDANCE OF FISHES AND MOLLUSKS IN BICOL RIVER

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ABSTRACT

The Diversity and Abundance of Fishes and Mollusks in Bicol River, Camarines Sur, Philippines was conducted to identify the major fish and macroinvertebrates, its abundance and diversity and characterize the fishing practices. A survey and actual test fishing were conducted. Biological data for fish community structure and biodiversity were analyzed using diversity analysis tools. Abundance of each species was computed following the formula of Odum and Barrett (2004). There are A total of Twenty-two (22) species of fish, twelve (12) native, ten (10) introduced, eight (8) marine and one (1) invasive fish species noted inhabiting the Bicol River Camarines Sur, Philippines. A total of five (5) species of crustacean and five (5) species of mollusk were identified, six (6) were native and four (4) are introduced fish species. Gillnet is the highest catch with 19 types of species caught. A total of 5.8 MT. was estimated as the annual production. Gillnet showed the highest annual production of 1.2 MT. Problems and constraints in all areas of the Rivers is a reality, this is due to water pollution, proliferation of water hyacinth and water spinach, erosion of the riverbank or riverside and construction of Tabon fishing gears. In terms of diversity, a total of 1,155 specimens collected belong to 27 species and 22 families. In terms on relative abundance (RA) of fish and macroinvertebrates the C. fluminea has the highest RA with 20.72% and 65.50% upstream and Midstream part of the river.

KEYWORD: Diversity, Abundance, Fishes, Mollusks, Bicol River.

1. INTRODUCTION

Biological diversity or biodiversity is defined as: 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity, 1992)[1].

Bicol River Basin is one of the major basins in the Philippines located in the Philippine region situated at the southernmost tip of Luzon. Bicol River is the longest river in Bicol Region and ranks 8th in the Philippines in terms of drainage basin area which is around 3.770 km^2. The river drains the southwestern of the island of Luzon and passes through Camarines Sur, Camarines Norte and Albay provinces in the Bicol Region (Bicol-RDC, 2008) [2].

The river starts from lake Bato and flows 94 kilometers downstream to its estuarine mouth at San Miguel Bay. It passes through the alluvial and coastal plains of the west Bicol valley and elongated, northwesterly trending depression in the Bicol Region. The basin has an area of 10,058 km^2 including its drainage basin (Otieno, 2004) [3]. Bicol River is the longest river in Bicol Region and ranks 8th in the Philippines in terms of drainage basin area which is around 3.770 km$^{2.}$ Stretching almost 94 km from its source which is Lake Bato and continuously draining to San Miguel Bay. The River traverses three Provinces Albay, Camarines Sur and Camarines Norte and covers 33 municipalities and 3 cities and affects several thousands of families living and depending on the river. The river has multiple usage from transportation to irrigation and source of livelihood (Bicol River Development, Inc., 2014) [4]

However, with the encroachment and interference of humans to the river ecosystem such as fishing activities, dumping of garbage and pollution, climate change and the like. Its natural processes have been altered. Heavy siltation has caused the river to be shallow that has resulted in the frequent flooding to its low lying valleys in the Bicol River Watershed Area. That affects thousands of residents and its livelihood. Furthermore, the

frequent and long residence time of flood water in the area has affected economic and other basic human activities that have incurred millions of losses to its economy in general.

A river's unique form and function are the results of the processes and interactions occurring along its longitudinal gradient (Vannote et al. 1980) [5], as well as of those occurring in the land around it (Hynes 1975, Leopold et al. 1964) [6]. The physical gradient from source to mouth, modify the chemical system, an interaction that in turn impinges on the biological system that is constituted by the organisms and the interrelations among themselves and with their environment (Flores, Mary Joyce L. and Zafaralla, Macrina T., 2012) [7].

The community characteristics of macroinvertebrates, such as diversity and richness, are often used as indicators of the degree of pollution of bodies of water to supplement and deepen the meanings of physicochemical information (Abel 1989, Arimoro et al. 2007; Barton 1996, Hellawell 1978; Plafkin et al. 1989; Silva et al. 2009; Wright et al. 1984) [.8,9,10,11,12,13,14]. There Biodiversity and abundance has not been studied in Bicol River hence this aims to provide baseline information of fishery resources in Bicol River and recommend action plan for biodiversity conservation and management.

2. METHODOLOGY

2.1. Study Area

The survey was conducted in the three municipalities of Camarines where the Upstream Part of Bicol River is located, the Municipal Bao, Nabua and Bula, Philippines for upstream, Naga, Minalabac, Milaor and Camaligan for Midstream and Gainza, Canaman, Pamplona, Gainza, Magarao and Bombon. The present study is delimited to the diversity and abundance of the fish and macro-invertebrate in Bikol River in Camarines from upstream, midstream and downstream (Figure 2).

2.2 Data Analysis

Biological data for fish community structure and biodiversity were analyzed using diversity analysis tools. Abundance of each species was computed following the formula of Odum and Barrett (2004) [15] as shown below:

$$K = \frac{\textit{the amount of the species i}}{\textit{the number of individuals of all species}} \quad x \quad 100\%$$

Condition of for each species abundance was categorized by the following:

0 : nothing
1-10 : Less
11-20 : enough
>20 : Many

Species richness (R) was calculated by the number of species present in an area. The relative abundance (RA) for each species was computed as: RA= (ai / A) 100%, where: ai is the number of individuals caught representing the species i and A is the total number of species collected in an area during a sampling period. The Diversity index was calculated following the Shannon-Weiner's diversity index (H') (Shannon & Weaver 1963) [16] as per standard method and shown below:

Where: s is the number of species; p is the proportion of individuals represented by species *i* and *ln* is the natural logarithm.

$$H' = \sum_{i=1}^{S} p_i \ln p_i$$

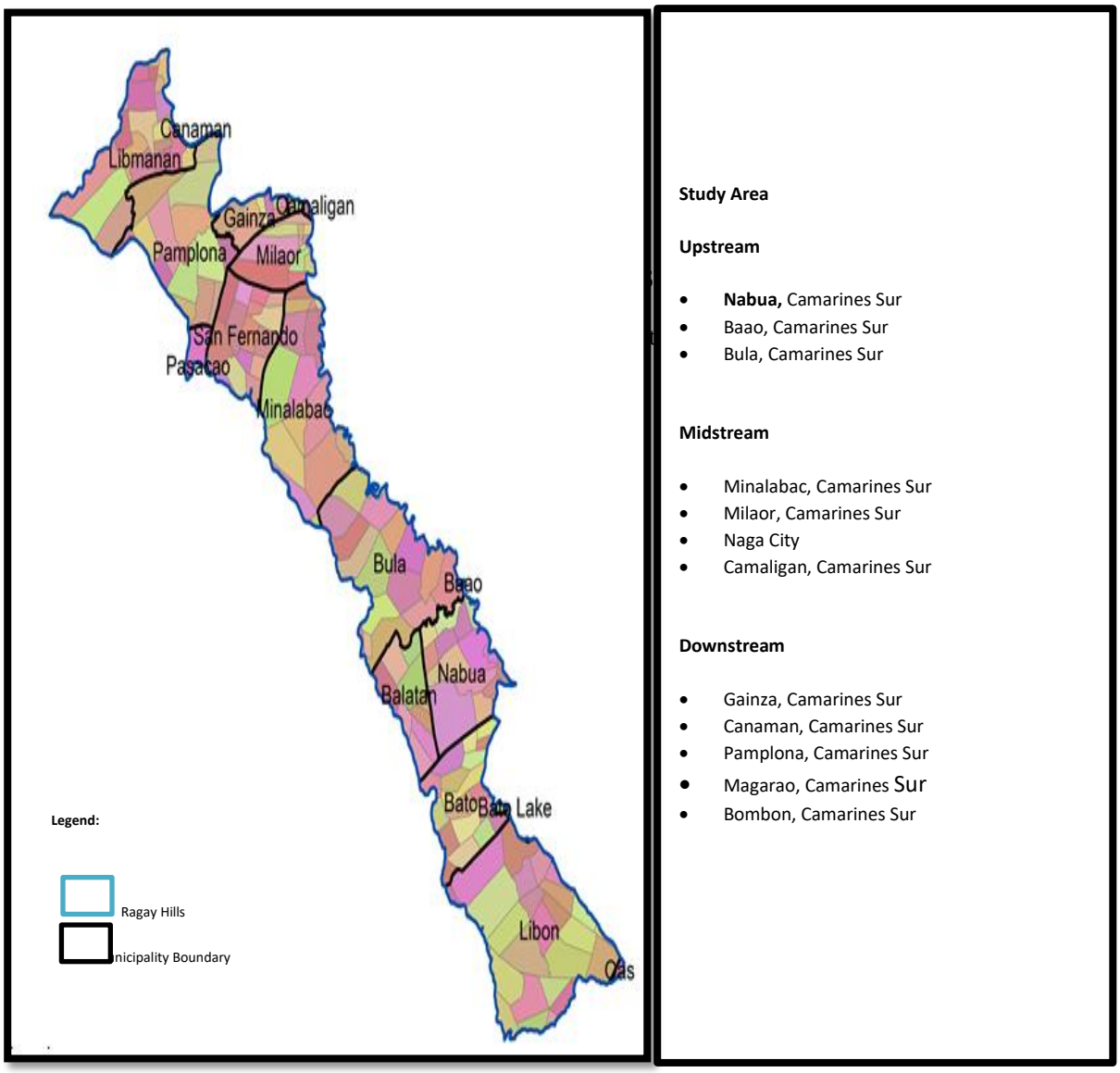


Figure 1. The Bicol River Basin Map

The proposed management plan and policy recommendation for BASIL Project and concern LGUs was crafted using Good Am. Suggested Policy directions: 1) Ordinances for sustainable riverine fisheries 2) Fish Repopulation protocol for Bicol freshwater bodies 3) Local ordinances for the abatement of introduction of invasive species.

3. RESULT AND DISCUSSION

3.1 Major Fishes and Macro-invertebrate in Bicol River Camarines Sur

A total of Twenty-two (22) species of fish, noted to inhabit the Bicol River Camarines Sur area (Table 1). In this study, twelve (12) native, ten (10) introduced, eight (8) marine and one (1) invasive fish species. The impacts of invasive alien species (IAS) on native fishes in the Philippines are "poorly understood because of lack of knowledge, lack of expensive and comprehensive technical information, failure to realize the potential ecological damage to biodiversity and consequent economic losses and as possible hazards to human health (Joshi, 2006) [17].

A total of five (5) species of crustacean and five (5) species of mollusk were identified in the bicol river, six (6) were native and four (4) were introduced. *Pomacea canaliculata* or Golden apple snail ("Kuhol") is a common

freshwater snail and a notorious agricultural pest in the Philippines and other countries in Asia (Mochida 1988, 1991; Naylor 1996) [18,19]. Concerted efforts have been undertaken to annihilate them but they still persist and even spread naturally and intensively. A total of five (5) species of crustacean and five (5) species of mollusk were identified in the bicol river, six (6) were native and four (4) were introduced. *Pomacea canaliculata* or Golden apple snail ("Kuhol") is a common freshwater snail and a notorious agricultural pest in the Philippines and other countries in Asia (Mochida 1988, 1991; Naylor 1996) [18,19]. Concerted efforts have been undertaken to annihilate them but they still persist and even spread naturally and intensively.

Similar finding conducted by Corpus, M.C. 2015 [20] in the river Camarines Sur stated that overall, the completed ichthyofaunal survey inventoried a total of 8,184 specimens belonging to 29 species, 22 genera, and 14 families). Bato had the highest fish abundance (n = 2,633) followed by Agos (n = 2,182), Baao-Bula (n = 1,412), Pawili (n = 1,400), and Bagacay (n = 557). Baao and an adjacent river Pawili had equal number of collected fish species (12 species). Bato had 20 species and its tributary Agos had 18 species. The isolated Bagacay sheltered two enigmatic goblins. In terms of richness, gobiids (8 species), cyprinids (3 species), and poeciliids (3 species) are the most dominant fish species recorded in all sites. Gobiid was the most dominant fish group in Agos (5 species), Pawili (4 species), Bagacay (2 species), and Bato (jointly shared by cyprinids with 3 species each family), whereas cyprinids (3 species) are the most common fish group in Baao.

In general, four fish species comprised ca. 52% of the total abundance collected from the five studied sites. These were Oreochromis niloticus (Cichlidae), with relative abundance of 18.64%, Glossogobius giuris (Gobiidae) 13.28%, Poecilia sphenops (Poeciliidae) 10.82%, and P. reticulata (Poeciliidae) 10.31%. Two fish species comprised 55.34% of the total abundance collected from Bato. These were O. niloticus, with relative abundance of 30.12%, and G. giuris 25.22%. The most abundant fish species in Agos were P. reticulata and P. sphenops[20]. This previous study may not be the same with the recent finding may due to the different area and amy also due to climate change.

In terms of economic importance all of the identified species are intensively fished for food except for the Janitor fish (*Pterygoplichthys multiradiatus* (Hancock, 1828). However, among the introduced fish tilapia and carps constitute the major catch in upstream and Midstream areas. Meanwhile the presence of marine and/or Brackish Water species contributes to the major and target species in the Downstream area. Some of the fish and macro-invertebrate species caught are shown in Figure 2.

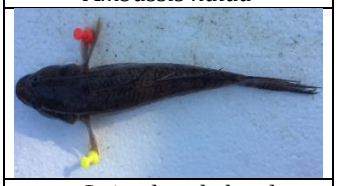
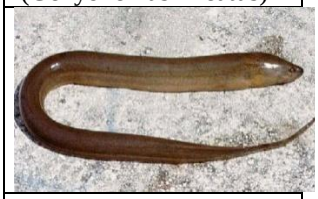
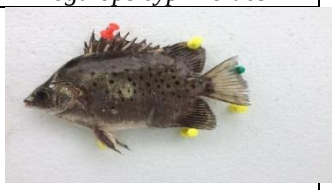
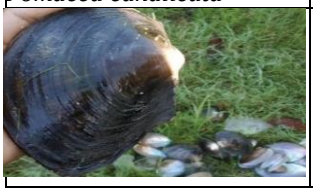
Table 1. Fish and macro-invertebrate inventory in Bicol River

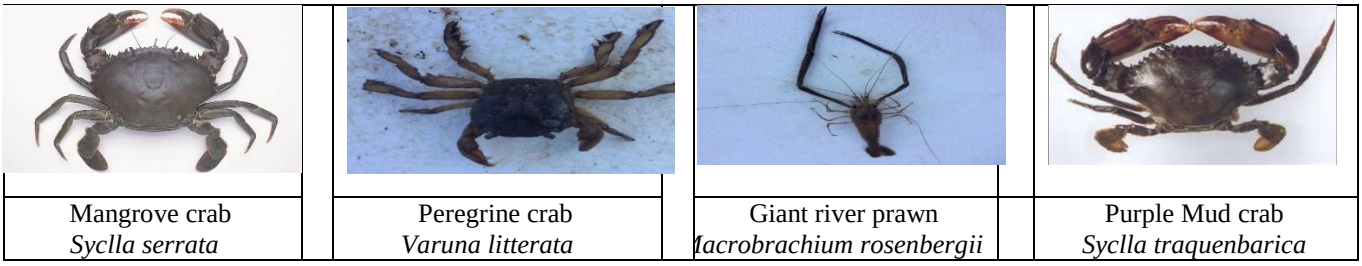
Family	Scientific Name	English Name	Common Name	Occurrence	Remarks
Ambassidae	*Ambassis nalua* (Hamilton, 1822)	Scalloped perchlet	Bakagan	Native (Freshwater Fish)	Found in downstream area of Bicol River
Anabantidae	*Anabas testudineus* (Bloch, 1792)	Climbing Perch	Puyo, Atas	Introduced	Found in slow streams, ditches, ponds, and farmlands along the River, labyrinth fish species
Anguillidae	*Anguilla japonica* (Temminck & Schlegel, 1846)	Giant mottled eel	Burirawan Marine Fish	Native	Migrated into lake via Bicol River, Marines Species
Butidae	*Bostrychus sinensis* (Lacepede, 1801)	Four-eyed sleepe	Bakla, Irabo	Native	Marines Species
Carangidae	*Carangoides ciliarius* (Ruppell, 1830)	Longfin cavalla	Talakitok	Native	Marines Species
Channidae	*Channa striata* (Bloch, 1793)	Snakehead murrel	Talosog	Introduced	Invasive species and Found in streams, lakes, ponds, and river
Cichlidae	*Oreochromis niloticus* (Linnaeus, 1758)	Nile tilapia	Tilapia	Introduced	Introduced farmed species and invasive species
Cyprinidae	*Labeo rohita*(Hamilton, 1822)	Rohu carp	Karpa	Introduced	Introduced farmed species
	Cyprinus carpio (Linnaeus, 1758)	Common carp	Karpa	Introduced	Introduced farmed species
	Ctenopharyngodon idella (Valenciennes, 1844)	Grass carp	Karpa	Introduced	Introduced farmed species
Clariidae	*Clarias batrachus* (Linnaeus, 1758)	Philippine catfish	Hito	Introduced	Introduced farmed species and invasive species
Elopidae	*Elops manchnata* (Forsskal, 1775)	Tenpounder	Bidbid	Native	
Gerreidae	*Gerres filamentosus* (Cuvier, 1829)	Whipfin Silver-biddy	Malagapas	Native	Marine fish species
Leiognathidae	*Eubleekeria splendens* (Cuvier, 1829)	Splendid ponyfish	Sapsap	Native	Marines Species
Loricariidae	*Pterygoplichthys multiradiatus* (Hancock, 1828)	Orinoco saifin catfish	Janitor fish	Introduced	Ornamental species
Megalopidae	*Megalops cyprinoides* (Broussonet, 1782)	Indo-Pacific tarpon	Bulan-Bulan	Native	
Mugilidae	*Crenimugil buchanani* (Bleeker, 1853)	Bluetail Mullet	Balanak	Native	Marines Species
Osphronemidae	*Trichopodus trichopterus* (Pallas, 1770)	Three spot gourami	Mirapina	Introduced	Ornamental and labyrinth fish species
Sillaginidae	*Sillago inguenuua* (Mc Kay, 1985)	Bay sillago	Aso-Os	Introduced	Found in silty-sand or muddy substrates.
Scatophagidae	*Scatophagus argus* (Linnaeus, 1766)	Spotted scat	Kikiro	Native	
Synbranchidae	*Monopterus albus* (Zuiew, 1793)	Asian swamp eel	Dugong, Palos	Native	
Sciaenidae	*Genyonemus lineatus* (Ayres, 1855)	White croaker	Pagotpot	Native	Marines Species

Table 2. Mollusks and Crustacean Inventory in Bicol River

Family	Scientific Name	English Name	Common Name	Occurrence	Remarks
Ampullariidae	*Pomacea canalicuta* (Lamarck, 1822)	Apple Snail	Kuhol	Introduced	Introduced farmed species and invasive species
Cyprenidae	*Corbicula fluminea* (O.F. Muller,	Asian clam	Bebe, Tulya	Native	

	1774)				
Gecarcinucidae	*Karkata ghanarakta* (Pati, Rajesh ,Raj, Sheeja, Kumar & Sureshan, 2017)	Freshwater crab	Kalakakas	Introduced	
Palaemonidae	*Macrobrachium rosenbergii*(Deman, 1879)	Giant river prawn	Buyod	Introduced	Introduced accidentally via cage farming
Portunidae	*Syclla serrate* (Forsskal, 1755)	Mangrove Crab	Aniit	Native	
	Scylla tranquebarica (Fabricus, 1798)	Purple mud crab	Aniit	Native	
Unionidae	*Anadontia anatine* (Fleming, 1828)	Freshwater mussels	Bebe	Native	
	Anadontia anatine (Stoliczka,1871)	Freshwater mussels	Bebe	Native	
	Anadontia anatine (Linnaeus, 1758)	Freshwater mussels	Bebe	Native	
Varunidae	*Varuna literata* (Fabricius, 1798)	Freshwater crab	Ogama, Kalampay	Introduced	Found in slow-moving, stagnant fresh, brackish in estuarine habitats

			
Climbing Perch *Anabas testudineus*	Scalloped perchlet *Ambassis nalua*	Freshwater eel *Anguilla Japonica*	Four-eyed sleeper *Bostrychus sinensis*
			
Carangoides ciliarus	Striped snakehead Channa Striata	Philippine catfish *Clarias batrachus*	Bluetail Mullet *Crenimugil buchanani*
			
Grass Carp *Ctenopharyngodon idella*	Common Carp *Cyprinus carpio*	Tenpounder *Elops manchnata*	Splendid ponyfish *Eubleekeria splendens*
			
White Croaker (Genyonemus lineatus)	Whipfin silver-biddy (Gerres filamentous)	Rohu Carp (Labeo rohita)	Indo-Pacific tarpon *Megalops cyprinoides*
			
Asian swamp eel *Monopterus albus*	Nile Tilapia *Oreochromis niloticus*	Orinoco saifin catfish *Pterygoplichthys multiradiatus*	Spotted scat *Scatophagus argus*
			
Bay sillago *illago inguenuua*	Three spot gourami *Trichopodus trichopterus*	Golden Apple Snail *Pomacea canalicuta*	Asian clam *Corbicula fluminea*
			
Freshwater mussels *Anodontia sp.*	Freshwater mussels *Anodontia sp.*	Freshwater mussels *Anodontia sp.*	Freshwater crab *Karkata ghanarakta*



Mangrove crab *Syclla serrata*	Peregrine crab *Varuna litterata*	Giant river prawn *Macrobrachium rosenbergii*	Purple Mud crab *Syclla traquenbarica*

Figure 2. The Fish and Macro-Invertebrate Caught in Bicol River Camarines Sur

3.3 Catch Composition by Gear

Multi species composition is noticed in the catch of different gears. Gillnet is the highest catch with nineteen (19) species followed by cast net with Seventeen (17) types of fish species caught and the lowest are Fishpot, fish trap and tabon with only 4 types of species caught. Common species caught by most of the gears is the common carp (Table7).

A total of 5.8 MT. was estimated as the annual production in Bicol River Camarines Sur (Table 8). Among the fishing gear used in the sampling site gillnet showed the highest annual production of 1.2 MT and the least was shared by hook inline (0.88 MT).

Table 7. Species Caught per Ge

Gear / Species	Cast net	Hook n Line	Fish pot	Fist trap	Gillnet	Scoop net	Tabon
Anabas testudinues	X	X	X	X	X		
Ambassis nalua	X				X		
Anguilla japonica		X	X	X			
Bostrychus sinensis	X				X	X	
Carangoides ciliarius	X				X	X	
Channa striata			X	X	X		
Clarias batrachus	X				X		
Crenimugil buchanani	X				X		
Ctenopharyngodon idella					X	X	X
Cyprinus carpio	X				X	X	X
Elops manchnata	X				X		
Eubleekeria splendens	X	X			X	X	
Genyonemus lineatus	X				X	X	
Gerres filamentosus	X				X	X	
Labeo rohita	X	X			X		
Megalops cyprinoides	X				X	X	
Monopterus albus		X	X	X			
Oreochromis niloticus	X	X			X	X	X
Pterygoplichthys multiradiatus	X	X			X	X	
Scatophagus argus					X		
Sillago ingenuua	X				X	X	
Trichopodus trichopterus					X	X	X

3.4 Fish Production by Gear

Table 8. Fish Production by Gear

Gear Type	Ave. Catch/trip (kg)	Ave. Fishing day/mo.	Ave. fishing mo./year	Production/mo. (kg)	Annual Production (kg)	% Annual Production
Gill Net (Pokot, Lambat)	7.50	18	9	135.0	1215	16.0
Cast Net (Laya)	6.33	20	7	126.7	887	11.6

Push Net (Sakag)	8.50	23	6	195.5	1173	15.4
Scoop Net	3.50	18	6	63.0	378	5.0
Fish Traps (Bobo)	5.17	26	7	134.3	940	12.4
Liftnet (Bintol)	9.50	25	5	237.5	1188	15.6
Hook In Line (Binwit)	0.67	12	11	8.0	88	1.2
Total					**5,869**	**77.1**

3.6 Fish Community Structure and Diversity of Fishes and Macro-Invertebrates.

The morphometric relationships between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007) [21]. In addition, length-length relationships are also important in fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002) [22].

Length-weight relationships (LWRs) and length length relationships (LLRs) are still scarce for most tropical and sub-tropical fish species (Martin-Smith, 1996; Harrison, 2001; Ecoutin et al., 2005; Hossain et al., 2006a; Hossain and Ahmed, 2008; Hossain et al., 2009a; Hossain et al., 2009b) [23,24,25,26,27,28,29]. To the best of our knowledge, there is no previous information on LWRs and LLRs of fish species from the Bicol River in Camarines Sur. Subsequently, the researchers carry out the first complete and comprehensive description of the LWR and LLR of fish, mollusk and crustacean species from the Bicol River Camarines Sur.

Table 9. Morphometric Information of Fish in Bicol River

Species	Frequency	$\bar{x}$ Total length (cm)	$\bar{x}$ Standard length (cm)	$\bar{x}$ Body Depth (cm)	$\bar{x}$ Body Weight (grams)
Ambassis nalua	3	10.67	8.67	3.67	90.00
Bostrychus sinensis	7	14.71	11.80	3.07	150.00
Crenimugil buchanani	1	11.00	10.00	2.50	100.00
Elops manchnata	3	25.67	21.17	5.50	185.00
Megalops cyprinoides	1	30.00	24.00	7.00	225.00
Cyprinus carpio	66	28.30	23.77	8.48	520.94
Clarias batrachus	2	30.00	26.50	4.50	115.00
Pterygoplichthys multiradiatus	11	28.45	23.55	5.86	367.27
Scatophagus argus	5	10.90	11.33	7.40	210.00
Gerres filamentosus	6	12.50	11.00	3.92	65.00
Trichopodus trichopterus	1	8.00	6.50	3.00	10.00
Genyonemus lineatus	9	12.11	9.50	4.21	163.33
Monopterus albus	2	45.00	43.00	2.00	100.00
Labeo rohita	1	34.50	31.00	16.00	105.00
Eubleekeria splendens	3	15.33	10.33	6.33	45.00
Carangoides ciliarius	1	10.00	8.00	5.00	15.00
Channa striata	3	17.67	31.00	4.67	183.33
Oreochromis niloticus	30	18.13	14.80	7.03	263.50

In terms of the abundance of fish in every stream it was found out that *Bostrychus sinensis, Ctenopharyngodon idella, Cyprinus carpio, Oreochromis niloticus,* and *Pterygoplichthys multiradiatus* are abundant in all streams in Bicol River (Table 9). In terms of the number of species found upstream the lowest compared to downstream.

Grass carp (Ctenopharyngodon idella) has the potential to cause great ecological harm in Canadian waters. Fisheries and Oceans Canada is conducting a qualitative and quantitative risk analysis to determine the ecological risk that this species poses in Canada. To undertake the risk analysis, it was necessary to develop a biological synopsis for the species (Cudmore, B. and Mandrak N.E., (2004) [30].

On the other hand, Common carp (Cyprinus carpio) is considered to be a very important aquaculture species in many Asian and some European countries. It affects the aerobic decomposition of organic matter and nutrient availability in the water column via bioturbation of benthic sediment during

feeding on benthic organisms. If the density of common carp is not excessive, an increase in nutrient availability may enhance photosynthesis and plankton production, whereas if it is excessive, it causes dramatic ecological disruption at both the community and ecosystem levels by changing the abiotic properties of the water. Therefore, the density of common carp is a very important factor that has a great effect on the aquatic ecosystem (Rahman, M.M., 2015) [31].

Tilapia was introduced into many countries for aquaculture. These fishes are at present widespread in water bodies of several tropical and subtropical countries, where they have been cultured (Altun et al., 2006) [32]. The tilapiines have been divided into three major genera, primarily on the basis of breeding habits: Oreochromis, the maternal mouth brooders, Sarotherodon, the biparental and paternal mouth brooders and Tilapia, the substrate spawners (Nagl etal., 2001) [33]. The Nile tilapia, O. niloticus (Linnaeus, 1758) is endemic to Africa, but has been introduced in many parts of the world for aquaculture (Vreven et al., 1998) [34].

Table 10. Morphometric Information of Mollusks and Crustacean in Bicol River

Species	F	$\bar{x}$ CL (cm)	$\bar{x}$ TL	$\bar{x}$ BW(g)
Macrobrachium rosenbergii	114	3.1	5.5	1.4
		$\bar{x}$ CL (cm)	**$\bar{x}$ CW (cm)**	**$\bar{x}$ BW(g)**
Karkata ghanarakta	10	2.4	4.2	10
Varuna litterata	114	2.1	3.2	10
Syclla serrata	5	9.5	14	140
Syclla traquebarica	4	9.6	15	120
		$\bar{x}$ SH (cm)	$\bar{x}$ SW (cm)	$\bar{x}$ BW(g)
Pomacea canalicuta	180	2.4	2.02	3
Corbicula fluminea	504	3.03	3.5	2
Anodontia sp.	59	5	9	10

*Karkata ghanarakta (*Kasasakas, Kalakakas), *Varuna litterata*(Ogama, Kalampay) and *Marobrachium rosenbergii* (Buyod) (Table 10) can be caught in upstream and Midstream however the species of *Scylla serrata* (Aniit) and *Scylla tranquebarica* (Aniit) can only be caught in downstream. Generally, mangrove crabs *Scylla sp* could tolerate a wide range of salinities. In fact, they are able to survive in freshwater for a few hours, this enables us to be able to disinfect them in freshwater, killing any harmful bacteria that could only survive in saline water. The mangrove crabs prefer salinity of 15-25 ppt. It is essential to understand the ideal salinity range to be able to optimize the growth and minimize the mortality of the species of the mangrove crabs. The mangrove crab classified by Keenan et al. (1998) [35] as *Scylla serrata* is locally known as "king crab" or "alimango" in the Philippines. It spends most of its life cycle in brackish waters such as mangroves and estuaries where courtship and mating occur. Berried crabs then migrate 18 to 20 kilometers offshore where their eggs hatch into zoea. Megalops and crablets migrate back to near shore areas of lower salinity, such as rivers and mangroves for feeding and shelter until they grow to maturity (Arriola 1940) [36].

Table 11. Frequency and Relative Abundance (RA) of Fish and Macro-Invertebrate in Three site Bicol River Camarines Sur

Fishes	**No. of Ind./station**			**RA of Ind/Station**		
	Upstream	**Midstream**	**Downstream**	**Upstream**	**Midstream**	**Downstream**
Ambassis nalua	0	3	0	0.00	0.46	0.00
Bostrychus sinensis	0	4	3	0.00	0.61	1.53
Crenimugil buchanani	0	1	0	0.00	0.15	0.00
Elops manchnata	0	3	0	0.00	0.46	0.00
Megalops cyprinoides	0	2	0	0.00	0.31	0.00
Cyprinus carpio	46	11	9	15.13	1.68	4.59
Clarias batrachus	2	0	0	0.66	0.00	0.00

Ctenopharyngodon idella	9	0	0	2.96	0.00	0.00
Pterygoplichthys multiradiatus	2	9	0	0.66	1.37	0.00
Scatophagus argus	0	3	2	0.00	0.46	1.02
Gerres filamentosus	0	6	0	0.00	0.92	0.00
Trichopodus trichopterus	1	0	0	0.33	0.00	0.00
Genyonemus lineatus	0	0	9	0.00	0.00	4.59
Monopterus albus	0	2	0	0.00	0.31	0.00
Labeo rohita	0	1	0	0.00	0.15	0.00
Eubleekeria splendens	0	1	2	0.00	0.15	1.02
Carangoides ciliarius	0	1	0	0.00	0.15	0.00
Channa striata	1	0	2	0.33	0.00	1.02
Oreochromis niloticus	16	10	4	5.26	1.53	2.04
Mollusk						
Pomacea canalicuta	53	58	69	17.43	8.85	35.20
Corbicula fluminea	63	429	12	20.72	65.50	6.12
Anodontia sp.	47	12	0	15.46	1.83	0.00
Crustacean						
Karkata ghanarakta	10	0	0	3.29	0.00	0.00
Varuna litterata	0	62	52	0.00	9.47	26.53
Marobrachium rosenbergii	54	37	23	17.76	5.65	11.73
Scylla serrate	0	0	5	0.00	0.00	2.55
Scylla tranquebarica	0	0	4	0.00	0.00	2.04
Total	304	655	196	100.00	100.00	100.00

The relative abundance of fish and macro-invertebrates in the Bicol River was shown in Table 11. It was revealed that *C. fluminea* has the highest relative abundance of 20.72% and 65.50% upstream and Midstream, respectively but downstream it belonged to the lowest relative abundance it was because of the higher salinity in downstream. It was followed by *M. rosenbergii* with 17.76% in upstream and the lowest relative abundance in upstream was the Saline species including *S. serrate, S. tranguebarica, G. lineatus, E. splendens and S. argus* but it was inversely to the relative abundance in downstream due to the salinity concentration in the area.

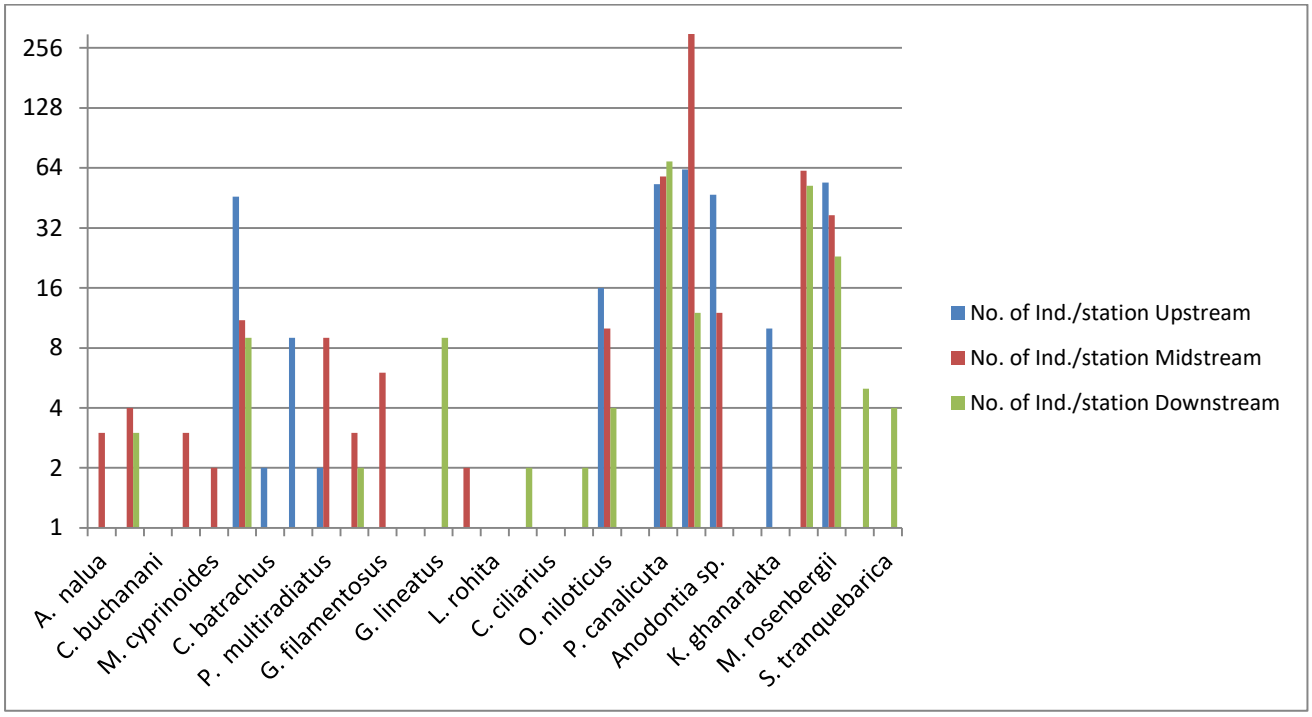


Figure 5. Number of Individual Caught in all Three sites in November 2019- July 2020 per station

Figure 5 reveals that *C. fluminea* is the highest in terms of number of individuals per stream with sixty three (63), four hundred twenty nine (429) and twelve (12) individuals in Upstream, Midstream and Downstream respectively. It was followed by *P. canaliculata*. In fishes the highest number of individuals caught is *Cyprinus carpio (Carpa)* since it was the primary target species of the fishing used by the fisher. The present number of *Pterygoplichthys multiradiatus* (Janitor fish) was alarming since it was considered an invasive species tending to spread prolifically and undesirably in the Bicol River. Janitor fish have no natural predator and it is a rapid breeder and means fast to grow its population. The lowest in terms of catch in actual fishing are the *Crenimugil Buchanan, Megalops cyprinoides, Trichopodus trichopterus, Labeo rohita,* and *Carangoides ciliarius* with only one individual catch.

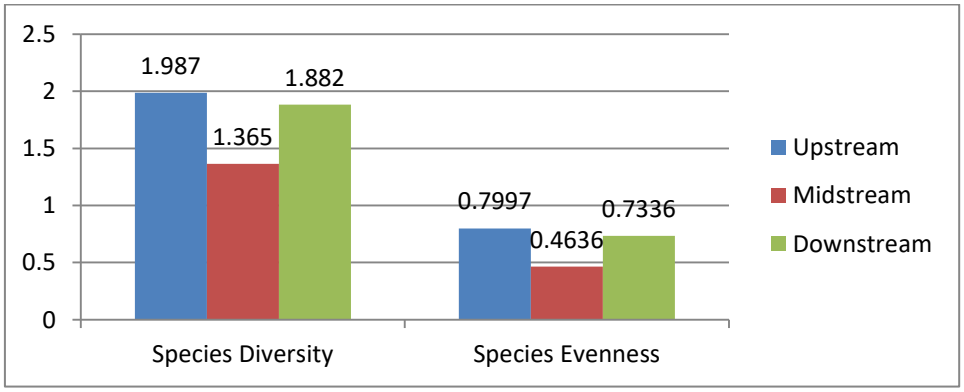


Figure 6. Evenness and Diversity Index of Fish and Macro-Invertebrates Collected in the Three Sampling Sites in Bicol River Camarines Sur

Based from the result, the equitability index of faunas in Bicol River shows relatively high values comprising of 0.80 and 0.73 in Upstream and downstream respectively while 0.46 in midstream, the result of high values of evenness can be inferred from an individual species dominating in a particular ecosystem (Odum and Barrett 2004) [15]. In this study, it was noted that the *C. fluminea* dominated the samples and had the highest dominating abundance among the species collected in midstream. It has a relative abundance of 65% (Figure 6) which results in low evenness in the midstream. Statistical results show that there is a significant difference ($p=0.43$, $p>0.05$) (Table 12). The result of diversity in the three sites can be gleaned from the idea that these stations are connected to each other, however change in water quality especially in salinity makes the differences.

Table 12. The Analysis Of Variance of Diversity Index of Fish and Macro-Invertebrates Collected In Three Sampling Sites In Bicol River Camarines Sur

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3971.793	2	1985.897	0.848097	0.431862	3.105157
Within Groups	196693.6	84	2341.59			
Total	200665.4	86				

However, based on interviews conducted, results along biodiversity by three areas are shown in Table 13. It was noted that the level of awareness of the respondents is 87%, 81% and 85% for upstream, midstream and downstream respectively. These results can be considered high. This high level of awareness could be explained by the fact that the Bicol River ecosystem is perceived as habitat for various species, providing food, livelihood and medicine to people and protection from extreme & destructive effects of typhoons. As to the different ecosystems Rivers, stream, and irrigation has a direct effect upstream of Bicol River while in midstream only the rivers and stream has a direct effect on the ecosystem. On the other hand, there are important factors that contribute to problems at the three sites such as: Weather disturbance, Fishing (using traps and electro-fishing), Runoff from sewage, deforestation, farming and other land use and Sedimentation, erosion from farming and unsustainable land use. However, the respondents from downstream concluded that Runoff from sewage, deforestation, and farming are coming from upstream and midstream. Sad to note that some fishers still illegal fishing like electro- fishing and traps. However, interestingly to note that no fishers use the poisonous substance like "tuble" and the use of biaqos fishing gears in Bicol River due to the strict implementation Act 4003 section 11 and RA 10654 section 92-93 by the LGUs. Moreover, as observed there was no over fishing in the river

4. CONCLUSION AND RECOMMENDATIONS

Based from the actual counts during the conduct of the research there were more than 22 fish species that are commonly caught in the Bicol River with tilapia as the highest and only followed by common carp, janitor fish around 3 mollusks species and five (5) crustacean species. Declining fish catch due to loss of spawning and migration routes and low water level due to the deposition of silt, Weather disturbances and occurrence of water hyacinth thick mats.

Bicol Rivers Camarines Sur support diverse communities of fishes, mollusks and crustaceans which indicate that rivers are productive and functional however are under threat both by anthropogenic and natural phenomena. Conditioned rivers threaten high pollution from household, industries and farming activities in the areas. Furthermore, siltation was evident in all areas of the river such as the upstream, midstream and downstream as observed from dark and gloomy waters in rivers. Diverse species has been observed been in the midstream and downstream which the marine species is navigating to the Fishing is the primary and the secondary source of income of people living near the riverbank however due to the implementation of Republic Act 4003 section 11 and Republic Act 10654 section 92-93 limiting the fishing in the rivers hence, the river at present doesn't over fishing. However, due to weather disturbance and growth of water hyacinth in thick mats and the introduced invasive fish and micro-invertebrate species the river diversity and abundance may be affected.

Communities along the rivers and lakes were all aware of the ecosystem condition of the surrounding water bodies and its associated aquatic flora and fauna. They understand the importance of these resources and the benefits they acquire whether cash or noncash. However, the increasing demand for fish has direct and indirect impacts resulting in imbalances of ecological well-being of lakes and rivers. Concrete action plan of LGU and other agencies should be well crafted in consultation with lake's stakeholders to revive the declining ecological health status of lakes and rivers in Bicol. With this in view, it is recommended that the policy direction of the LGUs towards sustainable lake or river ecosystem management to address poverty reduction and improved food security be pursued. This can be operationalized by first accepting the inadequacies and doing something about it by taking advantage of whatever opportunities available in the external environment.

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