Reptilian Diversity in Selected Riparian Systems in Misamis Occidental, Philippines

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ABSTRACT:

Reptiles are one of the most ecologically important organisms in the ecosystem. Studying their diversity is important in the conservation of the habitats to where each of these reptiles live. This study aimed to explore the diversity of reptiles in the areas around and within Labo and Clarin rivers, two of the most important river systems in the province of Misamis Occidental. Three sampling techniques were applied, which are visual encounter surveys, opportunistic encounters, and road-kill encounters. The results recorded a total of 21 species, including eleven endemic species, with nine Philippine endemic and two Mindanao endemic. Most notable among the species recorded was Lycodon ferroni, which is the second documented occurrence of the species and the first outside Samar Island. Labo River has the highest species richness, abundance and percent endemism of the two riparian systems, with the upstream sites of both rivers having the highest species richness and percent endemism. Studying the nearby riparian areas using other sampling techniques is recommended to fully understand the extent of reptilian diversity in the province and to effectively implement conservation and sustainability programs for the preservation not only of the reptile diversity but as well as the riparian ecosystem.

Keywords: Clarin River, endemism, Labo River, riparian, species richness

I. INTRODUCTION

Biological diversity is one of the fundamental components of a healthy, stable and sustainable environment. It is an important constituent in maintaining ecosystem functioning and the delivery of ecosystem services that contribute to human welfare and represent part of the total economic value of this planet (Costanza et.al., 1998; Christie et.al., 2012). Threats to global biodiversity is increasing, causing it to decline at unprecedented rates (Butchart et. al. 2010). Population and economic growth, land use change and climate change, as well as anthropogenic activities, are the main drivers of change that threatens global diversity (Christie et. al., 2012). Studying about biodiversity therefore is important in understanding the present condition of our environment, and at the same time it is the key to studying the patterns of species diversity and determining the ecological and evolutionary processes that have produced the observed patterns (Swenson, 2011).

Reptiles are among the most ecologically important organisms in the ecosystem. They are found around the world, represented in land, in freshwater, and in a great variety of habitats (Baard & de Villiers, 2000). Together with the amphibians, they are very good indicators of ecosystem health (Nuñeza et.al., 2010), due to their sensitivity to habitat disturbance and close contact with the air, water and soil around them ((Marks, 2006; Nuñeza et.al., 2016).They have been one of the important components of the food web in most ecosystems, either as a predator or a prey (Marks, 2006;Nuñeza et.al., 2016).As one of the dominant animals, reptiles have endured the drastic changes in the environment to be more influential with other populations. Lizards, particularly the herbivorous ones, have been found out to serve as nectar and fruit consumers as well as pollinators and seed dispersers, commonly on islands (Olesen & Valido, 2003).Snakes are ecologically important as predators, such as gopher snakes on songbird nests (Eichwoltz & Koenig, 1992), while crocodilians play an important role in maintaining the productivity and diversity of wetland ecosystems, to which humans depend (van der Ploeg et.al. 2011).

Reptiles are considered as ecologically and phylogenetically diverse (Huey, 1982). However, reptile diversity has been the least studied among terrestrial vertebrates (McCain, 2010), especially in the Philippines, but recent studies on Cagayan and Isabela provinces (Brown et.al. 2013), Subic Bay area (Devan-song and Brown, 2012), as well as Mt. Hamiguitan (Delima et. al. 2007; Relox et.al. 2010) and Southern Mindanao (David et.al. 2006) are evidences of the growing interest in studying them. Diversity among reptiles is particularly high in arid regions around the world (Pianka, 1973; Cosentino et.al. 2013). Information about their diversity is important in the conservation of the habitats to where each reptile lives. Globally, the diversity and population of reptiles along with amphibians are affected due to different factors, including the loss of habitat due to land-use practices (Hutchens and DePerno, 2009), planned infrastructures (Benayas et.al. 2006), or commercial use (Tisdell et.al. 2004). High damage made by improper agricultural practices such as illegal logging, leads to the loss of habitat and biodiversity (Botejue & Wattavinadage, 2012). Since reptiles are secretive in habits, they are poorly understood by the public compared to the other groups of animals in the wild. Being a significant indicator if the environment is disturbed or not (Webb & Manolis, 1989), reptiles are known to have poor dispersal abilities, which could lead to a decrease in their diversity, should their habitats be disturbed. In fact the current situation is that their population is declining along with amphibians, given their limited dispersal (Benayas et.al. 2005). Conservation methods are associated with likeability and commercial use of each reptile species (Tisdell et.al. 2004).

The province of Misamis Occidental is rich in riparian environments, with numerous river systems located within its geographical area. Labo River and Clarin River are two of these most important river systems. Labo River forms a natural boundary between the cities of Tangub and Ozamiz, while Clarin River does the same for the city of Ozamiz and the municipalitiy of Clarin (Labajo & Nuñeza, 2014). They are major providers of clean water needed for domestic, agricultural as well as for commercial use. They are also important in making sure that the living ecosystem located within their vicinity is as stable as possible. Being an important source of water in the province as well as an abode for various wildlife, identifying the current status of Labo River and Clarin River and its surrounding areas is important to know if the region is still biologically diverse, which is a significant indication if the environment is healthy or not. Unfortunately, no studies were conducted about the reptile diversity in the area. The closest study of reptile diversity was conducted by Nuñeza et.al. (2010) along Mt. Malindang, where the upstream portions of the two rivers are located. However, a study of the riparian areas around the remaining portions of the two rivers must be conducted in order to understand more the extent of diversity in the region.

II. LITERATURE REVIEW

Mindanao, the second largest island in the Philippines, has one of the largest remaining forest blocks in the Philippines (Relox et.al, 2011), which is home to a vast number of endemic reptile species, of which many are only found exclusively on the island and numerous taxa still expected to await discovery (Delima et.al., 2006; Nuñeza, 2010; Beukema, 2011). But despite of this great interest, Mindanao has received less attention from herpetologists compared to Luzon and central islands of the Visayas (David et.al, 2006). This lack of attention and information relating to the reptile diversity of this island can be attributed to increasing inflexible and security-related logical obstacles to research over the recent decades, as well as the incorrect impression that the herpetofaunal diversity of this region is well-known (Brown & Alcala, 1970; Ross & Lazell, 1990; Sanguila et.al., 2016).

Reptilian diversity in the Philippines has been the subject of recent studies on biodiversity, but most of these studies are concentrated on the island of Luzon and the major islands of Visayas. Efforts to provide a near-complete estimation of the reptile diversity and endemism on several islands, mountain ranges and other geographical subcenters of diversity have been conducted through comprehensive herpetological studies (Sanguila et.al., 2016), and yet only a few of these studies have been conducted on the island of Mindanao, particulary in the Northern region.

A study by Brown et. al. (2012) reported new distribution records for herpetofauna from 20 localities located within the northern Cordillera Mountain Range of Ilocos Norte, Luzon Island, Philippines, which constitute major geographic range extensions. Opportunistic collections, together with data from past surveys, documented the presence of 17 lizards, 16 snakes and one turtle species across the area. The results highlight the extent to which the fundamental distribution data for reptiles are lacking in this area, and suggest a proper and extensive documentation of Luzon's herpetofauna to avoid poor and misleading data. Diesmos et.al. (2005) conducted a similar study on the neighboring Cordillera Central, along the Balbalasang-Balbalan National Park, and recorded 16 lizards, 11 snakes and one turtle with high level of endemism. Out of these species, three scincoid lizards and one snake are considered new discoveries. Another significant outcome of the study was the rediscovery of "lost species", which have been previously considered as either rare or on the brink of extinction.

Brown et.al. (2000) also explored the herpetofauna within the Central Sierra Madre Mountains in Aurora Province, Luzon Island, Philippines, using established altitudinal transects. The results from the heavily forested area produced several key discoveries, despite it being in close proximity to Manila. The species account of 30 reptiles (19 lizards, 10 snakes and one turtle), which included the newly-described *Sphenomorphus tagapayo* and the poorly known *Sphenomorphus leucospilos*. These results showed the degree to which reptile populations in the mountainous areas of Luzon are understudied, because it proved that so many discoveries could be produced in such a short survey period of less than two weeks. It proved the vastness of the reptile diversity in the area, which led to a more extensive survey of the Sierra Madre Mountains.

The total number of documented reptiles was updated by a recent study by Siler et. al. (2011) on the same area, listing 30 lizard species, 22 snake species, and one turtle species. The study highlighted the observations of the rarely encountered species, including the aforementioned skink *Sphenomorphus leucospilos*, the forest gecko *Luperosaurus* cf. *cumingi*, and a new species of monitor lizard, *Varanus bitatawa*.

A similar study conducted by Brown et.al. (2013) concentrated on the herpetological diversity in the vast area covering Northern Sierra Madre Mountain Range and the Northeast Luzon Island, involving intensive elevational transects along the Mt. Cagua area. They documented 101 species, which represents approximately 35% of the total Philippine herpetofauna, and 70% of the recorded taxa are Philippine endemics. Out of this number of species, 30 are lizards, 35 are snakes, two are freshwater turtles, three are marine turtles, and two are crocodilians. The results suggest a more diverse region than previously imagined and warrants a further study of the herpetological diversity of Northern Philippines.

Devan-Song and Brown (2012) studied the area around Subic Bay in the southern Zambales Province, Luzon Island, using survey efforts on wide variety of habitat types and timed visual encounters. A total of 55 species were documented, of which 16 of these were found opportunistically or discovered as road-kill. There were 24 snakes, 16 lizards and one turtle documented from 24 localities. The new records, in addition to available historical museum specimen data, represent a diverse subset of species diversity, and a conservation program should be of priority in the area, due to the lack of any protected areas in the entire province. Mcleod et.al. (2011) also studied the reptile diversity along Angat Watershed Reservation in the neighboring province of Bulacan, resulting in an extensive record of 22 lizards, 2 turtles and 20 snakes, which indicate significant range extensions due to the fact that virtually nothing is known before of the herpetological diversity of the area.

Siler et. al. (2012) conducted herpetological survey in the Romblon Island Group (RIB), Romblon Province, using a series of surveys and a summary of historical museum collections. The resulting data documented 26 lizards, 15 snakes and one turtle species. It also reported on moderate levels of reptile endemism prevailing on the islands, which included taxa like the forest gecko species *Gekko romblon* and the newly discovered species *Gekko coi*. Despite the smaller and less diverse area, the islands contain notable levels of endemism when considered as percentage of the total fauna or per unit landmass area.

Bucol et.al. (2011) documented and updated the herpetofaunal species list of Siquijor Island through visual inspection and cruising method, of which 34 total species were found, 25 of this are reptiles. Among the reptiles, Gekkonidae is the most species-rich group with nine species, while colubrid snakes consist of seven species. The key new additions to the island’s herpetofaunal diversity include *Gekko mindorensis* and *Cuora amboinensis*. It has been suggested that further studies be conducted on the island, considering the certain morphological variations of the populations of three lizard species. Beukema (2011) also documented the first record of the genus *Tropidonophis* and the subsequent confirmation and rediscovery of the existence of *Parias flavomaculatus* on Siquijor.

Supsup et.al. (2016) recently studied and conducted a preliminary assessment on the herpetofauna of Cebu, which is thought to receive little attention from herpetologists because of the perception that only few reptiles and amphibian species thrive the area. They focused on the last remaining forest fragments of the island and using all available historical museum distribution data. A total of 63 reptile species were listed based on the combined data from fieldwork and historical museum records. The results recorded the continued presence of the rare lizard *Brachymeles cebuensis*, as well as secretive snake species *Malayotyphlops hypogius* and *Ramphotyhlops cumingii*, which are endemic to Cebu, persisting despite the continuous habitat degradation in the island. Conservation efforts must be sustained in order to preserve these endemic species.

Alcala et.al. (2004) explored and studied the effects of fragmentation and degradation of tropical rainforests on herpetofauna along nine tropical rainforest fragments on Negros Island. The results showed that out of the expected 61 species of herpetofauna in the nine forest fragments, only 46 have been documented, accounting for a reduction of 15 species over the past 50 years. This had been largely attributed to a decrease in canopy cover and forest fragmentation, which correlates to the reduction in species diversity.

Gaulke et.al. (2007) described a new species of lizard from the genus *Luperosaurus* coming from collected specimens from Panay Island, while Brown et.al. (2000) described another previously unknown snake species in the genus *Hologerrhum* from two forested localities in Antique Province from the same island. These discoveries are a clear indication that extensive and thorough studies about reptile species and herpetofauna in general is a top priority to have a clearer picture as to the extent of diversity here in the Philippines.

Studies on reptile diversity on the island of Mindanao have been conducted for the past years, yet they are not as extensive in terms of area covered compared to those conducted in Luzon or in the Visayan islands and thus, are poorly known (Nuñeza et.al., 2016). A study conducted by Nuñeza et.al. (2006) focused on the vertebrate diversity of Mt. Malindang, a major area of biodiversity in the province of Misamis Occidental, where the Labo and Clarin river systems are located and in close proximity. The results showed a total of 278 vertebrate fauna found, of which 51 are reptiles; out of the 42.09% Philippine endemics, 11.11 % belong to reptile group while out of the 35.04% Mindanao endemism, 48% belong to the reptile group. These findings showed that Mt. Malindang is a unique landscape offering a vast amount of diversity and endemism, which are threatened primarily by habitat loss and faunal exploitation, and for this reason a continuous conservation program must be maintained. The area surrounding Mt. Malindang is now part of the protected area of the Department of Environment and Natural Resources PENRO-Misamis Occidental. Nuñeza et.al. (2010) conducted an updated herpetofaunal study of the same area across 14 sampling sites to assess the distribution of threatened and endemic herpetofaunal species. 33 reptile species were found, of which 48% endemicity was observed with no threatened species. Just like in the previous study, the threat to Mt. Malindang's biodiversity is mainly habitat loss and destruction due to conversion of the forest to agricultural farms by the local inhabitants. Despite this, conservation is still a priority in this area due to the 18% recorded herpetofaunal species being found in Mt. Malindang.

A few areas around Mindanao, which are also regions of high biodiversity, are the subject of different herpetofaunal studies. Nuñeza et.al. (2015) surveyed 19 caves in Northern Mindanao, distributed across the provinces of Bukidnon and Misamis Oriental and in the cities of Iligan and Valencia. Nine species were recorded, in which five are reptiles, belonging to three families. Three of the five reptile species are Philippine endemic, with *Cyrtodactylus annulatus* being the most widely distributed. The presence of endemic species is an indication that these caves need to be protected and conserved.

Delima et. al. (2007) explored and provided the first accounts of herpetofauna in the Mt. Hamiguitan Range in Southeastern Mindanao, using a combination of transect sampling, pitfall trapping and microhabitat preferences. The results produced records of 14 lizards and five snake species, of which eight are Philippine endemic while six are Mindanao endemics. The high levels of species richness and endemism is evident, especially in the dipterocarp forest site, located outside the protected area. Relox et. al. (2011) also conducted a herpetofaunal study along the tropical forests of the same mountain, specifically along eight sites, divided into four identified types of habitats—lowland dipterocarp forest, mid to upper montane forest and mossy pygmy and dipterocarp forest. 15 reptiles were found, which are all squamates, and has a high level of endemicity, which is at 93.3%. Both studies noted the threats present in Mt. Hamiguitan, particularly anthropogenic disturbances such as habitat conversion, especially on lowland forests, and that conservation efforts be promoted, due to the high species richness and diversity as well as the level of endemism in the area.

Beukema (2011) conducted his study on herpetofaunal composition of the relatively extensive but fragmented forest patches along the lower Mt. Kitanglad Range in the province of Bukidnon, which is considered an area that potentially harbour a high number of species. 41 species were recorded; 22 of those are reptiles, of which eight are Philippine endemics while seven are Mindanao endemic. The lack of knowledge on the herpetofauna of Mt. Kitanglad still exist despite the increase of new records, as the amount of data is still insufficient compared to other studied assemblages of reptiles in Mindanao, and just like in Mt. Hamiguitan, the lowland forests are still threatened by habitat modification.

Sanguila et.al. (2016) recently concentrated herpetological study on the Northeast Mindanao region and its adjacent islands, which are considered as subcenters of endemic vertebrate biodiversity. 126 species, of which 49 are lizards, 35 are snakes, one freshwater turtle and one crocodile were documented and 85-90% of the total taxa are endemic to the Philippines. The number of species represent approximately 36% of the total Philippine herpetofauna. The vast number of documented species can be attributed to the fact that the area covered is large, and that Northeast Mindanao is considered as a major area of biodiversity. In fact, it has the highest herpetological species diversity of any Philippine faunal subregion of the same size. The results suggest the need to conserve this vast area, as it is the home to a large portion of herpetofaunal species.

David et.al. (2006) focused their study on the submontane area of Southern Mindanao, particulary in the area around Lake Sebu in the South Cotabato Province. 35 species were recorded, of which 33 are new records for the province, a strong testimony for the poor knowledge of the reptile fauna of Mindanao. Despite the high amount of species documented, it doesn't accurately represent the reptile fauna of the area, due to the fact that there are still missing species from the montane forests of Mindanao and many of the recorded species are based on native figures or data provided by the natives. Nuñeza et.al. (2016) recently studied the reptile diversity in Mt. Matutum Protected Landscape located in the same province, using cruising method along six sampling sites. Thirteen species of reptiles were documented, which belong to five families and 11 genera and having a 46.15% percentage endemism. Similar to the aforementioned studies, the disturbed lowland dipterocarp forest had the highest species diversity and endemism, and the threats to the reptiles remain the same- habitat degradation, particularly the conversion of forest to farmland.

These set of studies illustrate the vast amount of reptile diversity existing across the different regions located throughout the Philippine archipelago and the continuous effort exerted to document and describe each species. A high level of diversity and endemism highlighted each of the different studies, which adds significance to it. The level of diversity and endemism are also associated with the different threats endangering the very existence of every biodiversity region. Most of the studies attribute habitat modification and conversion of forest to agricultural farms as the primary threats, especially in the lower forest regions. The study presented in this paper follows the same approach, although in a more isolated area as it only covers the reptile diversity in selected riparian systems, particularly around Labo River and Clarin River, two of the most important river systems ecologically and economically in the province of Misamis Occidental.

III. OBJECTIVES OF THE STUDY

This study aimed to explore the reptile diversity in the areas surrounding and within Labo and Clarin Rivers. Specifically, it aimed to: 1) identify the various species of reptiles that thrive within and around the riparian areas of Labo River and Clarin River; 2) determine the species richness, relative abundance, species diversity, evenness and degree of endemism of the documented and collected specimens of the area; and 3) use the data from the biodiversity indices to compare the level of diversity in each station of the two study sites.

IV. MATERIALS AND METHODS

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The study was conducted along Labo River and Clarin River, two major river systems in the province of Misamis Occidental (Fig. 1). Their headwaters start from the southern peak and foot of Mt. Malindang, sloping down the cities of Tangub and Ozamiz and the municipality of Clarin, where it empties into Panguil Bay. Before the field sampling was done, a letter of permission for approval was submitted to the Biodiversity Management Bureau (BMB) of the Department of Environment and Natural Resources (DENR) PENRO of Misamis Occidental, as the upper areas of Labo and Clarin rivers are located within the buffer zone of the protected area in Mt. Malindang, based on the Republic Act. No. 9304, otherwise known as the Mt. Malindang Range Natural Park Act of 2004 (Fig. 2). Three sampling sites for each riparian system were chosen for the study, which are representations of the upstream, midstream and downstream portions of the river. In every station, transects were established with dimensions of 100 x 400 meters, with three replicates for each. The three sites for the riparian system of Labo River are located within Barangay Hoyohoy in Tangub City and Barangay Gala in Ozamiz City for the upstream, Barangays Kinuman Norte, Guimad, Pantaon and Dalapang in Ozamiz for the midstream, and Barangays Labo and Lapasan for the downstream. The three sites for the riparian system of Clarin River are located within Barangay Stimson Abordo in Ozamiz for the upstream, Barangay Guba in Clarin for the midstream, and Barangay Pan-ay in Clarin for the downstream. The areas in the upstream are forested regions and have limited anthropogenic influence. It is where the headwaters of Labo River and Clarin River flow. The midstream sites for both are a mixture of forested and agricultural areas, with human settlements evident in the area. The downstream areas are mostly agricultural areas, with the site surrounded by numerous households.

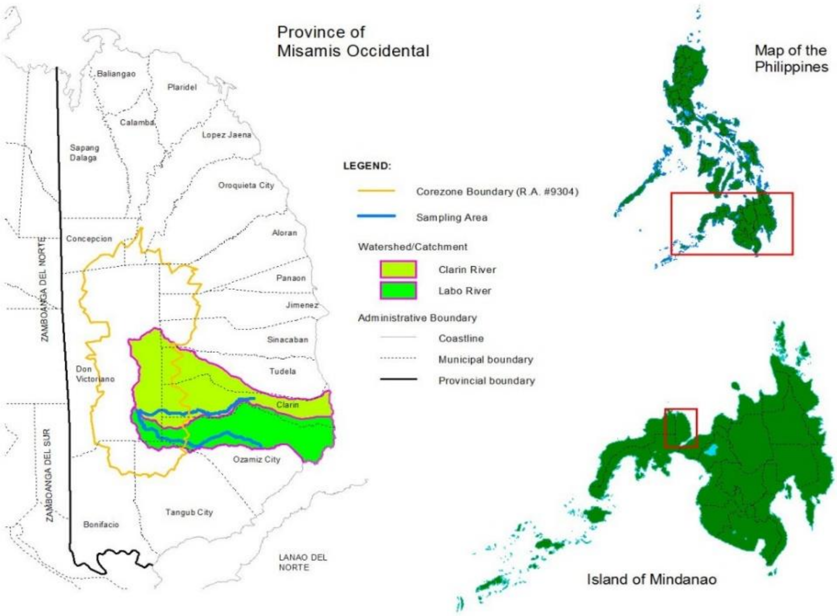

Figure 1. Map of the province of Misamis Occidental, showing the location of Labo River and Clarin River.

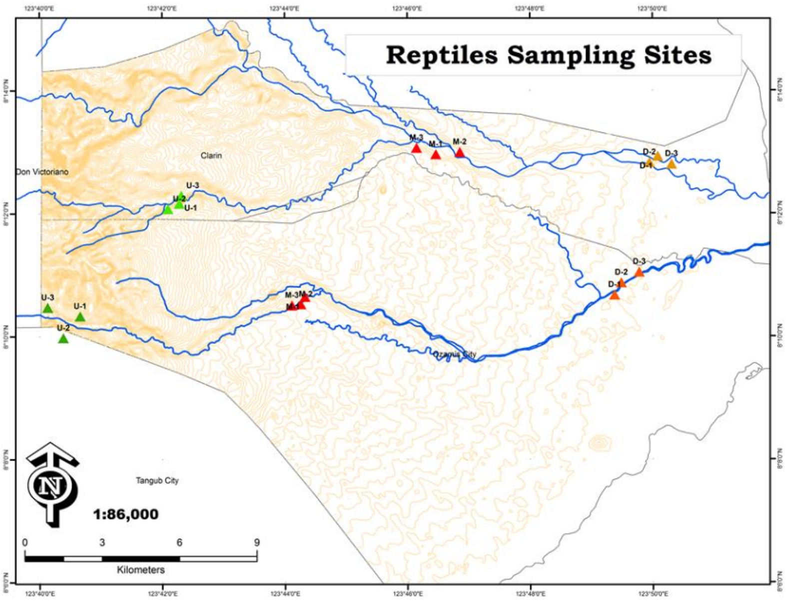

Figure 2. Map showing the sampling sites for both Clarin and Labo riparian systems

Field study for the collection of samples was done twice for three to five days for each sampling site. A strict ethic of habitat conservation was observed to leave the habitats of the reptiles as undisturbed as possible (ASIH, 2004). Three sampling techniques were applied, which were utilized by Devan-Song and Brown (2012): visual encounter surveys, opportunistic encounters, and road-kill encounters. The visual encounter survey, which will be based on Eekhout (2010) and Crump & Scott (1994), was done by randomly walking and searching for reptiles along the entire vicinity of each sampling site. This method is considered to have the broadest utility in terms of its effectiveness across all habitat conditions and ease of implementation (Manley et.al., 2006; Crosswhite et.al., 1999; Welsh, 1987). Opportunistic encounters and road-kill encounters were done concurrently, recording every reptile species detected along their natural habitat and picking up road-kills for preservation and identification later. These were done during the morning, early in the afternoon as well as during the night, as some reptiles are nocturnal. These are considered as the period of greatest activity for reptiles (Nuñeza et.al. 2012).

The captured samples were placed in sample bags with adequate ventilation. Every encountered reptile species was tried to capture; however, some of them can escape prior to capturing. Those individuals that escape were identified to species only if the identity is not ambiguous (Hanson & McElroy, 2015). Each collected specimen was measured using the following morphometrics: Head length (HL), Head width (HW) Eye diameter (ED), Snout to vent length (SVL), Tail to vent length (TV), Total length (TL) using a vernier caliper, while the Body weight (BW) using a spring balance. Each were identified according to family and genera using taxonomic guides and the taxonomy of Siler et.al. (2011 & 2012) and David et.al. (2006) as well as Photographic Guides and was verified by an expert herpetologist. After measurement and identification, each captured specimen was released back in the wild, while those that died during captivity and those that are discovered as roadkill were preserved. The temperature and humidity of each sampling site was measured.

Biodiversity indices such as species richness, relative abundance, species diversity (Shannon-Weiner H'), evenness and degree of endemism for every sample from each site were determined using the PAST Software. Species richness is determined by the total number of species in an assemblage or a sample and is the most basic and natural measure of diversity, according to Gotelli and Chao (2013). Relative abundance refers to the commonness or rareness of a particular species relative to other species in a given site or community (McGill et.al., 2007). Evenness states how evenly each individual in a community is distributed over the different species (Heip et.al., 1998). Species diversity indices are obtained using mathematical functions that combine richness and evenness in a single measure (Colwell, 2009), and for this study the Shannon-Weiner diversity index will be used. This diversity index is intended to reflect the likelihood that two individuals taken at random are of the same species (Brown et.al., 2007). When species richness and evenness increase, so does diversity (Nautiyal et.al., 2015). The conservation status of the species as well as whether it is endemic or not was determined based on the IUCN (The International Union for Conservation of Nature) list. The ecological use of species was obtained from existing documents and local people in the community.

V. RESULTS AND DISCUSSION

A total of 21 species were recorded from the two riparian systems of Labo and Clarin river, which includes nine families and 18 genera. Out of these, 12 species were recorded from the three sampling sites of the Clarin riparian system, belonging to six families and 10 genera, with six lizards and skinks and six snakes (TABLE 1). Four of the species were recorded in Clarin Sampling Site 1, while there were five species in Clarin Sampling Site 2, and five species in Clarin Sampling Site 3. Of these, six are endemic, which includes five Philippine endemic and one Mindanao endemic species. All of the species are evaluated by the IUCN as of least concern in terms of conservation status, except for two, *Bronchocela cristatella* and *Gekko gecko*, which are not yet evaluated. Some of the endemic species are shown on Fig. 3.

Table 1. Reptile species recorded at Clarin Riparian System

FAMILY AND SPECIES NAME	**Distribution**	**CONSERVATION STATUS (IUCN 2018)**	**SAMPLING SITES**			**TOTA**
			1 Upstream	**2 Midstream**	**3 Downstream**	
LIZARDS AND SKINKS						
AGAMIDAE						
Draco cyanopterus (Flying lizard)	Phil. Endemic	Least Concern	0	0	2	2
Draco bimaculatus (Two-spotted Flying Lizard)	Phil. Endemic	Least Concern	0	1	0	1
Bronchocela cristatella	non-e	Not Evaluated	1	0	0	1

(Green crested lizard)	ndemic					
GEKKONIDAE						
Gekko gecko (Tokay gecko)	non-endemic	Not Evaluated	0	3	5	8
Hemidactylus frenatus (Common House Gecko)	non-endemic	Least Concern	0	2	5	7
SCINCIDAE						
Tropidophorus misaminius (Misamis Waterside Skink)	Mindanao Endemic	Least Concern	2	0	0	2
SNAKES						
COLUBRIDAE						
Boiga cynodon (Dog-toothed Cat Snake)	non-endemic	Least Concern	0	1	0	1
Dendrelaphis caudolineatus (Striped Bronzeback)	non-ende	Least Concern	0	2	0	2

	mic					
Chrysopelea paradise (Garden flying Snake)	non-endemic	Least Concern	0	0	1	1
ELAPIDAE						
Naja samarensis (Samar Cobra)	Phil. Endemic	Least Concern	0	0	1	1
NATRICIDAE						
Rhabdophis auriculata (White-lined Water Snake)	Phil. Endemic	Least Concern	3	0	0	3
Rhapdophis lineatus (Zigzag-lined Water Snake)	Phil. Endemic	Least Concern	4	0	0	4
			SAMPLING SITES			**TOTA**
			1 Upstream	**2 Midstream**	**3 Downstream**	

Total No. of individuals			10	9	14	33
Total No. of species			4	5	5	12

Lycodon ferroniTropidophorus misaminius (Misamis Waterside Skink)

Parvoscincus steerei (Steere's Sphenomorphus)

Sphenomorphus mindanensis (Mindanao sphenomorphus)

Figure 5. Some of the Endemic Reptile species recorded at both Labo and Clarin riparian system

The Labo riparian system data recorded 17 species, belonging to nine families and 16 genera, with eight lizards and skinks and nine snakes (Table 2). Out of these, nine species were recorded in Labo Sampling Site 1, six species in Labo Sampling Site 2, and five species in Labo Sampling Site 3. Nine of the species are endemic, including seven Philippine endemic and two Mindanao endemic. Sampling Site 3 had the most number of individuals caught or sighted. Of particular note among the endemic species is the record of *Lycodon ferroni*, as it is the first documentation of the species outside Samar Island, where it was first documented and described by Lanza in 1999. Most of the species are either of Least Concern or Not Evaluated yet based on the IUCN Red List, with the exception of one Data Deficient species (*L. ferroni*), one Vulnerable (*H. pustulatus*) and one Near Threatened species (*S. mindanensis*). All three were recorded around the upstream areas of Labo River.

Table 2. Reptile species recorded at Labo Riparian System

FAMILY AND SPECIES NAME	Distribution	CONSERVATION STATUS (IUCN 2018)	SAMPLING SITES			TOTAL
			1 Upstream	2 Midstream	3 Downstream	
LIZARDS AND SKINKS						
AGAMIDAE						
Hydrosaurus pustulatus (Sailfin Water Lizard)	Phil. Endemic	Vulnerable	1	0	0	1
GEKKONIDAE						
Gekko gecko (Tokay gecko)	non-endemic	Not Evaluated	0	0	4	4
Hemidactylus frenatus (Common House Gecko)	non-endemic	Least Concern	0	2	6	8
SCINCIDAE						
Brachymeles hilong (Graceful Short-legged Skink)	Mindanao. Endemic	Not Evaluated	1	0	0	1

Eutropis multifasciata (East Indian Brown Mabuya)	non-endemic	Not Evaluated	0	1	0	1
Parvoscincus steerei (Steere's Sphenomorphus)	Phil. Endemic	Not Evaluated	1	0	0	1
Sphenomorphus mindanensis (Mindanao sphenomorphus)	Phil. Endemic	Near Threatened	1	0	0	1
Tropidophorus misaminius (Misamis Waterside Skink)	Mindanao Endemic	Least Concern	2	2	0	4
SNAKES						
CALAMARIIDAE						
Calamaria virgulata (Short-tailed Reed Snake)	non-endemic	Least Concern	0	1	0	1
COLUBRIDAE						
Boiga cynodont (Dog-toothed Cat Snake)	non-end	Least Concern	0	1	0	1

	emic					
Dendrelaphis caudolineatus (Striped Bronzeback)	non-endemic	Least Concern	0	0	1	1
Lycodon ferroin	Phil. Endemic	Data Deficient	1	0	0	1
ELAPIDAE						
Naja samarensis (Samar Cobra)	Phil. Endemic	Least Concern	0	1	1	2
HOMALOPSIDAE						
Cerberus rynchops (Dog-faced Water Snake)	non-endemic	Least Concern	0	0	3	3
LAMPROPHIIDAE						
Psammodynastes pulverulentus	non-en	Not Eval	1	0	0	1

(Common Mock Viper)	demic	uated				
NATRICIDAE						
Rhabdophis auriculata (White-lined Water Snake)	Phil. Endemic	Least Concern	3	0	0	3
Rhapdophis lineatus (Zigzag-lined Water Snake)	Phil. Endemic	Least Concern	2	0	0	2
			SAMPLING SITES			**TOT**
			1 Upstre	**2 Midstrean**	**3 Downstream**	
Total No. of individuals			13	8	15	36
Total No. of species			9	6	5	17

The two riparian systems have a combined species richness of 21, with the upstream sites having ten species, the midstream sites having nine species and the downstream sites having seven species. In the Clarin riparian system, Sampling site 3 (downstream area in Brgy. Pan-ay) had the highest relative abundance (42.42%) while Sampling site 2 had the lowest (27.27%). By comparison, in the Labo riparian system, Sampling Site 3 (downstream area in Brgy. Labo) also had the highest relative abundance (41.67%) while Sampling site 2 had the lowest (22.86%). In terms of endemism, a total of ten endemic species, which includes nine Philippine endemic and two Mindanao endemic, were documented across both Clarin and Labo riparian system, which has a rate of 52.38% endemism (Table 3). Of the combined sites, Sampling Site 1 (upstream areas) has the highest level of endemism at 80%, while Sampling Site 3 (downstream areas) has the lowest level at 28.57%. Both riparian systems have a combined low dominance, with an overall of only 0.1099, although the combined dominance of the downstream sites is slightly higher at 0.2628 (Table 3).

Table 3. Biodiversity Indices of the Species Collected on both Riparian Systems

Clarin and Labo Riparian Systems	Sampling Sites 1 Upstream	2 Midstream	3 Downstream	Total
Total No. of Individuals	23	17	29	69
Total No. of species (Species Richness)	10	9	7	21
Total No. of endemic Species	8	3	2	11
Relative abundance	33.33%	24.64%	42.03%	
Endemism	80.00%	33.33%	28.57%	52.38%
Dominance	0.1796	0.1419	0.2628	0.1099
Species Diversity (Shannon H')	1.96	2.069	1.567	2.562
Evenness	0.7096	0.8792	0.6843	0.6174

The high species richness in the upstream site is due to the fact that this sampling site is located within the buffer zone of the protected area of Mt. Malindang. Thus, its protected status makes it less susceptible of anthropogenic disturbance, which in turn preserves the overall integrity of the area. These findings are in contrast to the result conducted by Relox et. al. (2011) and Balmores and Nuñeza (2015), in which they concluded that lowland areas tend to harbor higher species richness and diversity of reptiles. This high rate on both downstream sites can be attributed to the fact that the Sampling site 3 of both riparian systems has lower elevation compared to Sampling site 1 and 2, and therefore has more heat in the surroundings that is needed by reptiles to provide optimum heat for their survival. This is probably due to the tendency of some reptiles, especially snakes, to move to lowland areas, which bear more rice fields and households, as these places harbor more rodents, which served as their food.

Both Clarin and Labo riparian systems traverse a distance that stretches from the foot of Mt. Malindang down to the marine waters of Panguil Bay. Along its length, both areas provide various habitats for different riparian organisms, including reptiles. The upstream sites, dominated by montane forests, with little to no anthropogenic influence, has a high level of species richness as well as endemism, although it is much higher in Labo compared to Clarin. This higher level documented on Labo could be attributed to the fact that the upstream area of Labo River is located nearer the southern peak of Mt. Malindang, and is therefore surrounded by steeper slopes compared to Clarin River, making it less accessible to anthropogenic disturbance. A number of notable species were recorded in this area of the Labo Riparian system. The recently described species *Lycodon ferroni*, which was found in the forest areas around Labo river, is documented here as the "second" recorded account for the species, having only been known before from a specimen collected by Lanza (1999) in Samar Island, specifically along the entrance of Lungib Ginbagsangan. The Mindanao endemic *B. hilong*, which was described by Brown & Rabor (1967) as a subspecies of *B. gracilis*, is also worth noting. *B. hilong* was found underneath rotten trees along the upstream is described by Brown & Alcala (1980) and Siler et. al. (2009) as a close but distinguishable species from *B. gracilis*, another species endemic to the Mindanao faunal region. Clarin doesn't have that high level of species richness compared to Labo, but it does have high endemism in due to the presence of two Philippine endemic species, *Rhabdophis auriculata* and *R. lineatus*, and the Mindanao endemic *Tropidophorus misaminius*. All three endemic species were also found on Labo's upstream area, and *T. misaminius* is noted as this species is only endemic on the islands of Camiguin, Basilan and Mindanao (Brown and Alcala, 1980; Beukemia, 2011; Sanguila et.al., 2016). *T. misaminius* was only documented in the upstream area of both riparian systems, which was the only riparian area in around both rivers that is dominated by forested areas, where the species can be found (Brown & Alcala, 1980). The three of them (*R.auriculata, R.lineatus* and *T.misaminius*) are direct river-dwellers, while the rest are tree dwellers and one in the grass near the river. Of the tree-dwellers, they were found residing in coconut trees found along the riverbanks. The lone grass-dweller, *Dendrilaphis caudolineatus*, was encountered along the damp grass area near the river along Sampling site 2. This high level of endemism in the upstream regions makes this area a susceptible area of conservation. The midstream is dominated by semi natural forests and some agro ecosystems, particularly ricefields, and a few houses, which obviously represent an increase in anthropogenic influence and disturbance. This can be related to the low species richness and endemism of reptilian fauna in the area, most especially in the Clarin riparian system, in which the only notable recorded species is the Philippine endemic *Draco bimaculatus*, which was found residing in coconut trees thriving around the river.

The downstream represents the most disturbance out of the three sampling areas for each riparian system. The presence of numerous residential areas, and in the case of Clarin river, a quarry site, hinders the diversity of organisms living in and around the river, including reptiles. The relatively lower species richness and endemism of this area compared to the upstream is a clear indication to that. However, it did have the highest relative abundance of the three sampling sites of both riparian systems, due to the high amount of specimens collected to the reptile species *H. frenatus* and *G. gecko*, which have become common household reptiles.

VI. CONCLUSIONS

Based on the data collected in this study, abundance of reptiles is evident along the two riparian system. Labo riparian system has a higher level of species richness and endemism compared to Clarin riparian system, with the upstream region having the most number of species and endemic species. The relative abundance showed a higher percentage on the downstream region compared to the other sampling sites, due to the numerous individuals recorded for the common household species *Gekko gecko* and *Hemidactylus frenatus*, which prefer to live near households of the lower elevation downstream area. The occurrence of *Lycodon ferroni* is a significant one because it indicates that the species is not only concentrated on the island of Samar and the possibility that the species could also be found on adjacent regions is a possibility. The high level of species richness and endemism across the two riparian systems is a clear indication of the importance of continuing to preserve and protect the areas surrounding both river, most especially along the upstream areas, where numerous endemic species thrive, including the newly described *Lycodon ferroni*.

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