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Preliminary report on the amphibians and reptiles of Lake Mainit watershed, Northeastern Mindanao, Philippines

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Abstract

Lake Mainit is honored with plentiful assets in both upland and lake ecosystems and is one of the Key Biodiversity Areas (KBA) in the Philippines. A field survey of amphibians and reptiles was conducted in the four municipalities comprising Agusan del Norte portion of Lake Mainit Watershed to determine the species richness, endemicity and conservation status. The methods used were a combination of field observation, reconnaissance survey, pitfall trap method and opportunistic collection. The study found out that 17 species belonging to 13 families, with a total of 69 individuals in the four sampling areas. *Polypedates leucomystax* recorded the most common species and highest number of individuals followed by *Platymantis corrugatus*. Highest species diversity index was recorded from Santiago with H'= 1.5. Philippine endemic species were *H. pustulatus*, *P. corrugatus*, *N. samarensi*, *M. stejnegeri*, *H. granducola*, *P. mindanensis*, and *S. fasciatus* while the two recorded vulnerable species *were H. pustulatus* and *M. Stejnegeri*, along these lines, the event of these two species qualifies the area to be protected. In this manner, the low species richness in Lake Mainit watershed could probably go to be archived if the place is completely assessed. Conservation action is still essential to protect and conserve biodiversity in the entire areas.

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Introduction

The Philippine Archipelago is one in all the eighteen megadiversity countries that, along is ten times richer in diversity than the Galapagos Island in South American country, with over twenty thousand species of plants and animals endemic to the biological richness of the country (Heaney & Regalado, 1998; Ong *et al*, 2002; Diesmos & Brown, 2009; Bucol *et al*, 2011). It houses a spectacular and numerous assemblage of amphibians and reptiles placed at the interface between the faunal zones of the Orient and Australia, has currently jointly recognized as one of the most vital centers of herpetofaunal diversity in South East Asia, creating it so much richer, the amount of endemicity are a lot of higher and therefore the biological process history is much a lot of complicated than are assumed (Diesmos *et al*, 2002; Ngilangil *et al*, 2015).

The Mindanao Pleistocene Aggregate Island Complex (Mindanao PAIC) is one giant biogeographically vital sub- province inside the Philippine terra firma (Taylor, 1928; Inger, 1954; Heaney, 1985, 1986; Voris, 2000; Brown & Diesmos, 2009; Sanguila *et al*, 2016). Mindanao was formed by the accretion of the island-arc associated with the east- central block and also the western continental peninsula block, separated by the Sindangan- Cotabato- Daguma lineament (Yumul *et al*, 2003; Sanguila *et al*, 2016). The central part Mindanao has giant isolated mountains that are separated from one another by substantial stretches of low- lying areas that were formed as a result conjointly of collision and geologic process events over the past ten millions years (Hall, 1996, 1998; Yumul *et al*, 2003, 2009; Sanguila *et al*, 2016).

This extremely dynamic geologic history suggests the chance of faunal limits to spreading inside early paleoislands, a mechanism which may presumably have contributed to the diversification of the primary amphibian and reptile lineages that inhabited Mindanao (Brown & Alcala, 1970; Brown & Guttman 2002; Evans *et al*, 2003; Sanguila *et al*, 2011; 2016; Brown *et al*, 2013; Barley *et al*, 2013).

Amphibians and reptiles, cold- full- blooded animals, are regarding one- fourth of all well- known vertebrate species distributed worldwide (Zug *et al*, 2001; Ali & Bukhari, 2018). They are good biological indicators as a result of they are more sensitive to the environment than other wildlife (Hopkins, 2007; Coritico *et al*, 2018) and a very important part of healthy scheme as they play a vital role in the food pyramid by maintaining the balance of food cycle thus, they provide an excellent starting point for inventorying and monitoring biodiversity. Moreover, they recycle nutrients between aquatic to terrestrial environments, and removal of those species from any scheme can cause to disturbances in predator- prey dynamics, invertebrate populations, alga communities, leaf litter decompositions, and nutrient cycling, however their population is depleting day by day because of several anthropogenic activities like intensive grazing, forest cutting and burning, mining areas restorations (McLeod & Gates, 1998; Ngilangil *et al*, 2015) fragmentation, and changes in microclimatic variables through a disturbed gradient within the home ground structure (Ward, 2006; Ngilangil *et al*, 2015).

Lake Mainit is recognized as the deepest (219.35 meters), fourth biggest (17, 060 ha), one of the cleanest lakes in the Philippines, flanked by mountain ranges at the north, east and west, with a broad aluvial plain at the south and is circumscribed by eight municipalities that comprise the Lake Mainit Watershed (LMDA, 2005; SFM Program, 2009; LMHGC- ESIA, 2013 and Padilla *et al*, 2015. Subsequently, Lake Mainit is honored with plentiful assets in both upland and lake ecosystems as appeared in researches and studies conducted by various institutions (Gracia, 1981; Demetillo *et al*, 2015). However, the forest cover of Lake Mainit has been fragmented and degraded into vast open grassland habitats, while some areas are converted into agricultural lands. Remaining forest cover in the watershed is currently threatened by various unregulated anthropogenic activities such as rural development, cryptic small-scale mining, and illegal logging of the remaining tree stands (LMDA-EMP, 2014 and Padilla *et al*, 2015).

Be that as it may, the information was generated quite a long while prior, which right now needs assessment and validation. Thus, this study aims to determine species distribution, abundance, endemism and conservation status of amphibians and reptiles within the sampling sites of the Lake Mainit watershed area.

Materials and methods

Sampling Sites

The watersheds of Lake Mainit are arranged inside the political limits of Agusan del Norte, Agusan Del Sur and Surigao Del Sur (Fig. 1). Among the eight municipalities that contain, Tubay, Santiago, Jabonga and Kitcharao are the main focused areas of assessment due to the following criteria; accessibility, and peace and order situation.

In any case, preceding the real field information accumulation, a community entry protocol meeting has been directed per municipality to illuminate the partners about the biological assessment in Lake Mainit watershed. In the municipality of Tubay, the examination site is arranged in barangay La Fraternidad and part of Santa Ana while in Santiago, Barangay Pangaylan, is one of the natural barangays arranged at 09◦15.8.65N and 125◦ 35.013E. In Kitcharao, it is arranged in the northernmost part and Barangay San Pablo of Jabonga is discovered northwest of the lake.

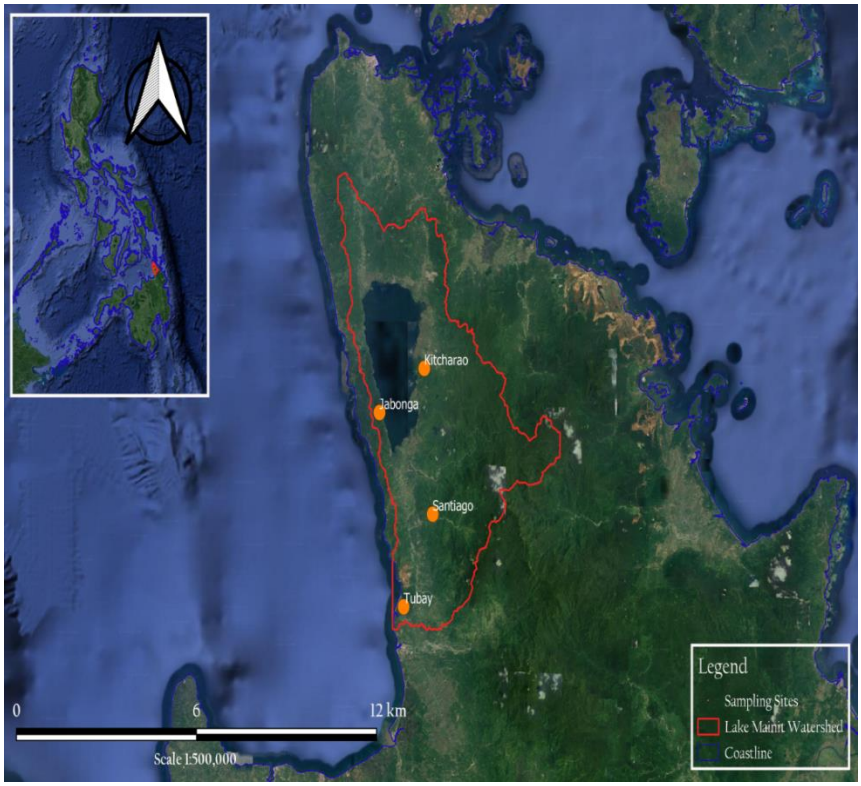

Fig. 1. Map of the Philippines showing the location of Lake Mainit Watershed within, and the four sampling areas.

Amphibians and Reptiles Assessment

Maps were utilized to at first arbitrarily asses and characterize the area for sampling site determination. Field observation, reconnaissance survey, pitfall trap method and opportunistic collection were led for the collection of reptiles and amphibians. These strategies utilized intensive sampling of arboreal, surface and underground strata in the chosen sites (Almeria & Nuñeza, 2013; Demetillo *et al*, 2015). Likewise, transect walk was additionally done since it is a rapid biodiversity assessment technique that utilizes a hike, recording of species, and physical characteristics. This strategy looks for every real biological community, decides stratified zones, and maps the areas across a landscape. Alpha scientific categorization was done with the end goal to list the

entire amphibians and reptiles encountered, with the assistance of nearby guide and field ordered keys of Alcala (1986); Alcala & Brown (1998); Diesmos *et al* (2003); David *et al* (2006); Brown *et al* (2009); Diemos *et al* (2015), species were identified. Assessment of status of each species recorded in the field was determined whether threatened, endemic, rare or economically important. Photographs were taken for the species that was not distinguished and for proper documentation. Global Positioning System (GPS) was utilized to determine the location of each plot. Voucher specimens were preserved in 80% alcohol.

Data Analysis

Species richness was measured per sampling site. The diversity indices of the different sampling areas which include the Shannon- Wiener Index was also computed in which it is a measure of the average degree of 'uncertainty' in predicting to what species an individual chosen at random from a collection of species and individuals will belong (Magurran, 1988).

Results and discussion

Species Distribution and Abundance

A sum of 17 amphibians and reptiles species representing 13 families was recorded in Lake Mainit Watershed. The family Rhacophoridae and Ceratobatrachidae have the number of individuals while Agamidae, Viperidae, Elapidae, Scincidae, and Colubridae documented the lowest number in the four sampling areas.

Polypedates leucomystax recorded the most common species and highest number of individuals in the four sampling areas followed by *P. corrugatus* and *H. granducola*. *P. leucomystax* was normal and appropriated all through the archipelago; it holds on well in conveyed environments and was universal in farming territories (Sanguila *et al*, 2016) like in Jabonga and Kitcharao. *D. volans*, *F. limnocharis*, *N. samarensis*, and *T. annulatus* were only observed in Tubay while *H. granducola*, *K. pleurostigma* and *P. mindanensis* in Santiago and *H. pustulatus* and *A. prasina* in Jabonga (Table 1). Among the four sampling areas, Barangay Pangaylan in Santiago documented the highest abundant species (9) and individuals (24), followed by Jabonga (9 and 23 respectively). Barangay Pangaylan is a waterway valley encompassed by soak inclines of mountain ranges and coconut cultivating is the essential wellspring of pay of the community, however a portion of the inhabitants enjoys little scale mining in the hilly areas. While, Barangay San Pablo of Jabonga is portrayed also as hilly and precipitous areas encompassing the lake and furthermore coconut is the primary money products of the local occupants, the Mamanwa. The remaining primary forest was additionally seen in the southern segment (Demetillo *et al*, 2015). Therefore, these few species that were discovered just in a specific area can be a marker of a specific natural surroundings and were viewed as uncommon and must be a need for assurance and conservation since they have likewise a very few of individuals.

Table 1. Occurrence of Amphibians and Reptiles in the four sampling areas

Name Local	Species	Common Name	Lake Mainit Watershed			
			S1	S2	S3	S4
Agamidae	Draco volans	Flying dragon	1			
	Hydrosaurus pustulatus	Philippine Sailfin lizard			1	
Bufonidae	Rhinella marina	Marine toad	1		3	1
Ceratobatrachidae	Platymantis corrugatus	Rough- backed forest frog		4	8	4
Colubridae	Ahaetulla prasina	Jade vine snake			1	
Dicroglossidae	Fejervarya cancrivora	Asian brakish tree frog	1			1
	Fejervarya limnocharis	Common pond frog	1			
Elapidae	*Naja samarensis*	Peter's cobra	1			
Megophryidae	*Megophrys stejnegeri*	Mindanao horned frog		2	1	
Microhylidae	*Kalophrynus pleurostigma*	Black- spotted narrow- mouthed frog		2		
Ranidae	*Hylarana granducola*	Big eyed frog		9		
	Staurois natator	Splash frog		3		
Rhacophoridae	*Polypedates leucomystax*	Common tree frog	4	1	6	6
Scincidae	*Eutropis multifasciata*	Common sun skink		1	1	
	Pinoyscincus mindanensis	Mindanao sphenomorphus		1		
	Sphenomorphus fasciatus	Banded sphenomorphus		1	2	
Viperidae	*Tropidolaemus annulatus*	Pit viper	1			
Total			10	24	23	12

Concerning species diversity level, the most noteworthy species diversity index was acquired from Santiago with H'= 1.55, trailed by Jabonga (H'= 1.33), Tubay (H'= 1.154) and Kitcharao (H'= 1.127) which, as per Fernando Biodiversity Scale (1998), these qualities were arranged as low different areas.

In general, the territory of Santiago was considered as secondary old growth forest to a pristine forest with higher elevations going from 200-600 msl (Demetillo *et al*, 2015). Biodiversity is high in mountain area because of the varied ecological conditions which give rise to a wide range of habitats (Barthlott *et al*, 1996).

Moreover mountains have been less altered by various human activities because of the logistical difficulties inherent in the mountain areas (Gotame, 2008). In any case, the outcome acquired in this assessment does not demonstrate moderate to high diversity index. This is for the most part impacted by the brief time frame on the field because of contentions between the armed government people and the rebels

Conservation Status and Endemic Species

Of the total 17 amphibians and reptiles species encountered, 7 species were endemic, 9 were widespread and 1 was native. Among these, 14 were least concern based on the International Union for the Conservation of Nature (IUCN), 1 was not yet assessed and 2 were vulnerable. The Philippine endemic species were *H. pustulatus*, *P. corrugatus*, *N. samarensi*, *M. stejnegeri*, *H. granducola*, *P. mindanensis*, and *S. fasciatus* while *P. leucomystax* was the only native species recorded (Fig. 2).

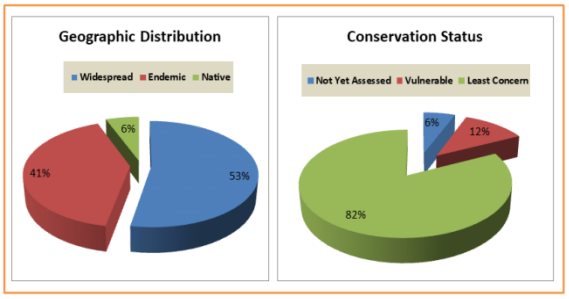

Fig. 2. Endemicity and Conservation Status of Amphibians and Reptiles.

Hydrosaurus pustulatus and M. Stejnegeri were the recorded vulnerable species (Fig. 3). *H. pustulatus* on this study were experienced along the waterways which were additionally affirmed by the study of Smith (1993) and Siler *et al* (2014), that they are occupant of marsh riparian halls, waterfront woods and mangroves, however because of the quick and proceeding decline and fragmentation of the habitat whereupon it depends, this species as having a 'vulnerable' conservation status (IUCN, 2016). Some other way, since 2004, *M. Stejnegeri* characterization is never again valid given new data on its very far reaching appropriation (all through all islands of the Mindanao PAIC), its wide natural resilience of unsettling influence, and the way that it is ordinarily experienced and locally plentiful (Sanguila *et al*, 2016).

Fig. 3. Amphibians and reptiles recorded from Lake Mainit Watershed. (A) *Polypedates leucomystax* (Gravenhorst, 1829), (B) *Platymantis corrugatus* (Duméril, 1853) Photo: MLR Alcala, (C) *Rhinella marina* (Linnaeus, 1758), (D) *Sphenomorphus fasciatus* (Gray, 1845) Photo: K Cobb, (E) *Megophrys stejnegeri* (Taylor, 1920), (F) *Hydrosaurus pustulatus* (Eschscholtz, 1829), (G) *Naja samarensis* (Peters, 1861), (H) *Hylarana grandocula* (Taylor, 1920), (I) *Pinoyscincus mindanensis* (Taylor, 1915).

Yusuf and Francisco (2009) have recognized the Philippines alongside Indonesia (Sumatra, Java, West Papua) and Malaysia (Sabah) as among the most vulnerable countries in Southeast Asia, in view of the high presentation frequencies of droughts, cyclonic storms, landslides, and floods, which are all accepted

to be driven by changes in temperature and precipitation. For the Philippines, the event of ruinous storms amid the previous three years will in general offer trustworthiness to these projections which could affect Philippine creatures of amphibians and reptiles. In any case, one route for amphibian species to get away from the drying of reproducing lakes and pools because of droughts is creating adjustments that hasten their larval development. But such evolutionary responses typically require long periods of time. The current capacity of Philippine amphibians land and water to adjust to changing natural conditions by responses such as shortened larval periods is not known (Alcala *et al.*, 2012). In this way, the occurrence of these vulnerable species qualifies the area to be protected.

Conclusion

Lake Mainit watershed is the habitat of 17 amphibians and reptiles, of which 2 vulnerable species and 7 endemic species. These studies suggest that the area is considered low in terms of biodiversity status and endemicity which is noteworthy for conservation and protection. Thus, this study will have an extrapolative value to the existing scanty knowledge on these species for the conservation management.

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